2

Longlife

Sustainable, energy efficient and resource saving, residential buildings in consideration of unified procedures and new and adapted technologies

Project in the Baltic Sea Region Programme 2007-2013

Development of standards, criteria, specifications

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2. Contribution

Longlife Partners

Berlin Institute of Technology, Institute of Architecture, Department Design and Structure, Germany

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3. Abstract

Energy and Cost Efficiency as the key characteristics of the sustainability have been the main consideration of different parts of research represented in the Longlife 2 Report.

Longlife 2 Report is in fact the final result of work package 4 “Developments of Standards and Criteria for Sustainable Building and Construction”.

Work package 4 was created based on the work package 3 “Analysis and comparison of state of technology, administration and legal procedures, financial situation, demographic needs, similarities and differences in the participant countries: Denmark, Germany, Lithuania, Poland and Russia”.

Three competence teams from each participant country studied, analyzed and examined these concepts from different point of view and introduced a framework to define the fundamental concepts of sustainability.

This crucial phase of project based on the objectives and activities of each team could be described as follow:

Team 1” Engineering and Building Technology standards” and related expertise emphasized on the most architectural solutions and characteristics of sustainability in very wide spectrum. That is realized through adaptable methods of design, typology, standards, assessment systems, proper and available materials with the best physical features, the most efficient and advanced structures and technologies in order to have the most possible energy and resource saving beside the less life cycle cost of the residential building.

Team 2 “ Method of planning permit and tendering Procedure” and its expertise from another point of view worked on the legal and administrative aspects of sustainability and examining possibility and capacity of each involved country to realize sustainable construction.

Team 3 “Economical and Financial basis, Industry and quality” and its related expertise explained and examined the adequate and necessary tools for implementation of sustainability regarding present market and financial conditions of each of the involved country.

The Longlife 2 Report is supposed to prepare essential know-how ” Guideline of common standards and criteria” for work package 5 ”Designing the Sustainable Prototype” and provide the necessary benchmarks for construction phase of Longlife sustainable building ”Pilot Projects”. That could be adapted to each involved country despite of various differences in planning procedure, structural and technological level and financial, administrative and legal circumstances.

The goals that were described through the” Longlife 1 Report” were emphasized based on the similarities identified through questionnaires, have been made reachable. Therefore process of achieving benchmarks, summaries and explanation concerning every proposed individual question in the “Longlife 1 Report” has got vital importance throughout the “Longlife 2 Report”.

Defining Longlife Performance Pass© and its main criteria and characteristics has been made one of the main objectives of Longlife, because the process of dissemination and evaluation of the sustainability has got crucial importance.

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3.1. Abstract in Danish – Resumé

Bæredygtighedens primære kendetegn, energi- og omkostningseffektivitet, har haft stor bevågenhed i de forskellige dele af den forskning, som præsenteres i Longlife 2 Rapport.

Longlife 2 Rapport er slutresultatet af arbejdspakke 4 "Udvikling af normer og kriterier for bæredygtige bygninger".

Arbejdspakke 4 blev udarbejdet på basis af arbejdspakke 3 "Analyse og sammenligning af teknologi, administrative og juridiske procedurer, finansiel situation, demografiske behov - ligheder og forskelle i deltagerlandene Danmark, Tyskland, Litauen, Polen og Rusland".

Tre kompetencegrupper fra hvert deltagerland studerede, analyserede og undersøgte koncepterne bag energi- og omkostningseffektiviteten fra forskellige synsvinkler og introducerede en struktur, som skal danne basis for definitionen af de grundlæggende bæredygtighedskoncepter.

Denne vigtige fase i projektet var baseret på hver gruppes målsætninger og aktiviteter og kan beskrives således:

Gruppe 1 "Standarder for ingeniørarbejde og konstruktionsteknologi" og de tilknyttede eksperter fokuserede på et stort spektrum af arkitektoniske løsninger og særlige kendetegn på bæredygtighed. Arbejdet blev gennemført ved brug af designmetoder, typologi, standarder, vurderingsmetoder, hensigtsmæssige og tilgængelige materialer med de bedste fysiske egenskaber, de mest effektive og avancerede sammensætninger og teknologier, for at opnå de størst mulige energi- og ressourcebesparelser, samt færre omkostninger til beboelsesejendomme i hele deres levetid.

Gruppe 2 "Metode vedrørende planlægning, byggetilladelser og udbudsprocedurer" og de tilknyttede eksperter arbejdede med bæredygtighedens juridiske og administrative aspekter og undersøgte de enkelte deltagerlandes muligheder og forudsætninger for at skabe bæredygtigt byggeri.

Gruppe 3 "Økonomisk og finansielt grundlag, byggeindustri og kvalitet" og de tilknyttede eksperter forklarede og undersøgte de redskaber, som er egnede til og nødvendige for at implementere bæredygtighed under hensyntagen til de eksisterende markedsforhold og de finansielle forudsætninger i de enkelte deltagerlande.

Den foreliggende Longlife 2 Rapport har til hensigt at præsentere vigtig knowhow i en "Vejledning om fælles standarder og kriterier" som grundlag for arbejdspakke 5 "Udvikling af en bæredygtig prototype" og stille de krav, som er nødvendige for det egentlige byggeri af "pilotprojekterne". Disse krav skal kunne tilpasses alle deltagerlandene uanset forskelle i planlægningsprocedurer, strukturelle og teknologiske niveauer og finansielle, administrative og juridiske forhold.

De mål, som er beskrevet i"Longlife 1 Rapport" er understreget på basis af arbejdet i arbejdspakke 4, bla. ved hjælp af spørgeskemaer, og er derved gjort realiserbare. Processen med at skabe et sammenligningsgrundlag, sammenfatninger og forklaringer vedrørende hvert eneste spørgsmål i "Longlife 1 Rapport" har været af stor betydning for arbejdet med "Longlife 2 Rapport".

Definitionen af et Longlife Performance Pass© er bevaret, og dets primære kriterier og karakteristika er blevet gjort til nogle af Longlife projektets vigtigste mål, fordi selve det at formidle og evaluere bæredygtigheden er erkendt af afgørende betydning.

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3.2. Abstract in German – Kurzfassung

Energie- und Kosteneffizienz als Schlüsselmerkmale der Nachhaltigkeit sind die Hauptthemen dieses Longlife 2 Forschungsberichtes, der das Endergebnis des Arbeitspacketes 4 „Entwicklung gemeinsamer Standards, Anforderungen, Kriterien für nachhaltiges Bauens“ darstellt.

Das Arbeitspaket 4 basiert auf dem vorherigen Arbeitspackets 3 „Analyse und Vergleich im Bezug auf den Stand der Technik, die administrativen und rechtlichen Verfahren, die finanzielle Situation, die demographischen Belange, Unterschiede und Gemeinsamkeiten in den folgenden Partnerländer: Dänemark, Deutschland, Litauen, Poland und Russland“.

Drei Kompetenzteams aus allen Teilnahmeländer haben energie- und kosteneffiziente Konzepte aus verschiedener Sichtweise studiert, analysiert und geprüft und ein System eingeführt, um die grundlegenden nachhaltigen Konzepte zu definieren.

Diese entscheidende Projektphase basiert auf den Zielen und Tätigkeiten der einzelnen Teams und kann wie folgt beschrieben werden:

Team 1 „Bautechnische Standards“ und die dazugehörige externe Expertise haben ein weites Spektrum architektonischer Lösungen und Kennzeichnungen der Nachhaltigkeit umrissen: Entwurfsmethoden, Typologieasuwahl, Bewertungssysteme und passende und verfügbare Baumaterialien mit den besten physikalischen Eigenschaften, effiziente und fortschrittliche Konstruktionen und Technologien. Dies ermöglicht eine Energie- und Resourceneinsparung mit gleichzeitiger Minimierung der Lebenszykluskosten des Wohngebäudes.

Team 2 „Baugenehmigungsmethoden und Ausschreibungsprozeduren“ und die dazugehörige externe Expertise haben die baurechtlichen und administrativen Aspekte der Nachhaltigkeit erarbeitet und die Möglichkeiten und Kapazitäten für nachhaltiges Bauen in jedem beteiligten Partnerland betrachtet.

Team 3 „Bauwirtschaftliche und ökonomische Grundlagen, Industrie und Qualität“ und die dazugehörigen externen Expertisen haben die angemessenen und benötigten Instrumente für die Ausführung der Nachhaltigkeit im Bezug auf den gegenwärtigen Markt und die finanziellen Bedingungen in jedem Partnerland entwickelt.

Der Longlife 2 Forschungsbericht „ Richtlinie für einheitliche Standards und Kriterien für nachhaltigen Wohnungsbau“ soll grundlegendes Wissen für das nächste Arbeitspaket 5 „Entwerfen eines Prototypes“ vorbereiten und die erforderten Richtwerte für die Konstruktionsphase des Longlife „Pilotprojektes“ festlegen. Der Prototyp muss in jedem Land angepasst werden, weil Unterschiede bestehen im Planungsverfahren, auf Konstruktions- und technischer Ebene sowie bei finanziellen, administrativen und rechtlichen Rahmenbedingungen.

Auf der Grundlage des im Longlife 1 Bericht enstandenen allgemeinen Fragenbogens werden ausgewählte Aspekte vertieft und als Richtwerte zu gemeinsamen Standards entwickelt.

Der Longlife Performance Pass© als Hauptziel des Projektes vereint und bewertet diese Standards mit seinen Hauptkriterien und Kennzeichnungen, um die Nachhaltigkeit in zukünftigen Wohnbauprojekten bemessen und vergleichen zu können.

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3.3. Abstract in Lithuanian – Santrauka

Energinis ir kainos efektyvumas yra pagrindinės subalansuotos statybos charakteristikos, kurioms skirtas ypatingas dėmesys ataskaitoje „Longlife 2 report“. Ši ataskaita yra 4-ojo darbo paketo “Subalansuotos statybos ir konstrukcijų standartų bei kriterijų vystymas“ rezultatas.

4-asis darbo paketas remiasi 3-ojo darbo paketo “Technologijų būklės, administracinių ir teisinių procedūrų, finansinės situacijos, demografinių poreikių panašumų ir skirtumų šalyse dalyvėse: Danijoje, Vokietijoje, Lietuvoje, Lenkijoje ir Rusijoje analizė ir palyginimas”rezultatais .

Trys atitinkamų specialistų grupės iš kiekvienos projekto partnerių šalies skirtingais aspektais tyrė, analizavo ir testavo šias koncepcijas ir pateikė struktūrą, apibūdinančią pagrindinius subalansuotos statybos kriterijus. Šis projekto etapas yra paremtas kiekvienos specialistų grupės atitinkamais tikslais ir vykdytomis veiklomis, kurios yra apibūdintos žemiau:

1-oji grupė “Techniniai reikalavimai ir statybų technologijų standartai” atliko tyrimus ir išskyrė plataus spektro architektūrinius sprendinius ir subalansuotos statybos charakteristikas. Tai pasiekta pasitelkiant adaptyvius projektinius sprendimus, pastatų tipologiją, standartus, vertinimo sistemas, tinkamų fizinių charakteristikų statybines medžiagas ir jų prieinamumą, pažangius ir efektyviausius konstrukcinius sprendimus bei technologijas. To pasekoje gautas efektyviausias energijos bei jos resursų vartojimo (taupymo) rezultatas orientuojantis į minimalią pastato gyvavimo ciklo kainą.

2-oji tyrimų grupė “Statybos leidimo ir rangos darbų konkurso procedūros metodai” teisiniais ir administraciniais subalansuotos statybos aspektais ištyrė projekte dalvaujančių šalių galimybes kokybiškai realizuoti tokius objektus.

3-oji tyrimų grupė “Ekonominė ir finansinė bazė, industrija ir kokybė” ištyrė ir išaiškino, kuros priemonės yra reikalingos subalansuotai statybai vystyti, atsižvelgiant į esamą rinkos ir finansinės būklės situaciją kiekvienoje šalyje dalyvėje.

Ši ataskaita yra skirta sukurti “know-how” “Nurodymus pagal galiojančius standartus ir kriterijus” 5-ajam darbo paketui “Subalansuoto pastato prototipo projektavimas” ir pateikti atitinkamas gaires Longlife subalansuotų pastatų “pilotinių projektų” statybai . Tai bus taikytina kiekvienoje šalyje dalyvėje, nežiūrint į statybų planavimo procedūrų, konstrukcijų ir technologijų lygio, finansinių, administracinių ir teisinių procedūrų padėtį.

Tikslai, aprašyti ataskaitoje “Longlife 1 Report ”, tapo pasiekiami, kai klausimynų pagalba buvo nustatyti panašumai tarp partnerių šalių. Gairės, santraukos ir kiekvieno individualaus aspekto paaiškinimai ataskaitoje “Longlife 1 Report” įgavo itin didelę svarbą ataskaitoje “Longlife 2 Report”.

Subalansuotos statybos idejų sklaida ir jo vertinimas įgijo lemiamą svarbą. Dėl to vienas pagrindinių Longlife tikslų yra jo energinio naudingumo sertifikavimo (paso) esminių vertinimo kriterijų ir charakteristikų apsprendimas.

3.4. Abstract in Polish – Streszczenie

Efektywność Energetyczna i Ekonomiczna, jako podstawowe miary zrównoważenia budynków, były głównym tematem rozważań i analiz przedstawionych w drugim raporcie programu Longlife (Longlife 2 Report).

Drugi raport programu Longlife jest efektem końcowym etapu WP4 „Opracowanie standardów i kryteriów dla budynków zrównoważonych".
Etap WP4 został oparty na wynikach etapu poprzedzającego - WP3 „Analiza i porównanie technologii, procedur prawnych i administracyjnych, sytuacji finansowej, potrzeb demograficznych, podobieństw i różnic pomiędzy państwami partnerskimi: Danią, Niemcami, Litwą, Polską i Rosją".

Po analizie i ocenie szeregu koncepcji zwiększających efektywność energetyczną i kosztową inwestycji, trzy zespoły kompetencyjne z poszczególnych państw przedstawiły zarys podstawowych koncepcji zrównoważonego budownictwa.

Ten kluczowy etap projektu w oparciu o cele i działania każdego zespołu kompetencyjnego można opisać następująco:

Zespół nr 1 - „Rozwiązania konstrukcyjne i standardy technologiczne budynków" - stworzył szeroką charakterystykę budynku zrównoważonego oraz wybrał najbardziej odpowiednie metody stworzenia jego projektu. Należy tu wymienić przede wszystkim adaptacyjne metody projektowania, kształtowania typologii, standardów, systemów oceny, wyboru odpowiednich materiałów budowlanych oraz zaawansowanych technologii w celu minimalizacji zapotrzebowania na energię i redukcji kosztów życia budynku.

Zespół nr 2 - „Procedury uzyskania pozwolenia na budowę, procedury przetargowe oraz metody planowania" - pracował nad prawnymi i administracyjnymi aspektami zrównoważenia. Zespół dokonał także oceny możliwości wdrożenia idei zrównoważonego budownictwa w poszczególnych krajach partnerskich.

Zespół nr 3 - „Podstawy ekonomiczne i finansowe budowy" - opracował ekspertyzę dotyczącą narzędzi finansowych niezbędnych do implementacji idei zrównoważonego budownictwa w krajach partnerskich przy uwzględnieniu ich uwarunkowań lokalnych.

Ten raport został stworzony w celu dostarczenia niezbędnej wiedzy dotyczącej wytycznych dla wspólnych standardów i kryteriów dla kolejnego etapu, jakim jest WP5 „Projekt zrównoważonego budynku prototypowego". Ponadto raport ma umożliwić stworzenie niezbędnych systemów oceny konstrukcyjnej fazy budowy prototypów Longlife. Wspomniane kryteria i systemy ocen powinny zostać zaadaptowane w każdym z krajów partnerskich pomimo istnienia pewnych różnic w procedurach na poziomie planistycznym, projektowym i technologicznym, a także różnych okoliczności finansowych, administracyjnych i prawnych.

Cele opisane w raporcie nr 1 projektu Longlife („Longlife 1 Report") stały się możliwe do osiągnięcia dzięki wynikom kwestionariuszy, które pozwoliły zidentyfikować występujące podobieństwa i różnice pomiędzy krajami. Dlatego też kontynuacja pracy nad kryteriami oceny, podsumowaniem i wyjaśnieniem wszystkich kwestii poruszonych w raporcie nr 1 jest istotnym elementem raportu Longlife nr 2 („Longlife 2 Report").

W związku z potrzebą rozpowszechnienia i rozwinięcia idei budownictwa zrównoważonego, definicja kryteriów jakości budynków stała się jednym z podstawowych celów projektu Longlife.

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3.5. Abstract in Russian – Краткое описание

Ключевые характеристики жизнеустойчивости - энергетическая и экономическая эффективность являлись основным предметом исследования в различных частях отчета 2 проекта Лонглайф, который является конечным результатом рабочего пакета «Разработка стандартов и критериев для жизнеустойчивого строительства».

Рабочий пакет номер 4 был создан на основе рабочего пакета 3 «Анализ и сравнение в области технологий, административных и правовых процедур, финансового положения, демографических потребностей, сходства и различия в странах-участницах: Дания, Германия, Литва, Польша и Россия».

Различные компетентные группы из каждой учавствующей в проекте страны рассматривали, анализировали и исследовали энерго- и экономически эффективные концепты с различных точек зрения и представили основу для определения фундаментального жизнеустойчивого концепта.

Эта ответственная фаза проекта основана на целях и сфер деятельности каждой из команд:

Команда 1 «Инженерные и строительные технологии, строительные нормы» и соответствующая ей экспертиза были сфокусированы в основном на разработке архитектурных решений и определении жизнеустойчивости в достаточно широком спектре. Все это было осуществлено с помощью приемлемых методов проектирования, выбора типологии, стандарта, системы оценки, подходящих и доступных строительных материалов с наилучшими физическими свойствами, наиболее эффективных и прогрессивных конструкций и технологий с целью достижения максимально возможного энерго- и ресурсосбережения, сокращая стоимость жизненного цикла жилого здания.

Команда 2 «Методы выдачи разрешения на строительство и проведения тендеров» и соответствующие эксперты работали над правовыми и административными аспектами жизеустойчивости и исследовали спосбности достижениия жизнеустойчивого сторительства для каждой участвующей в проекте страны.

Команда 3 «Экономические и финансовые основы, индустрия и качество» и соответствующая эксперты исследовали и изложили необходимые эффективные средства для осуществления «жизнеустойчивости» относительно существующего рынка и финансовых условий каждой задействованой стране.

Данный отчет нацелен на подготовку основополагающих научно-технических знаний для следующего рабочего пакета 5 «Проектирование прототипа» и предоставление необходимых эталонов для этапой строительства «жизнеустойчивого» дома Лонглайф «Пилотный проект».

Он мог бы быть адаптирован в каждой стране-участнице несмотря на несколько различий при планировании, на техническом и конструкционном уровне, а также учитывая финансовые, административные и правовые условия.

Цель, касающаяся общности между странами-участниками, описанная в отчете номер 1 стала достигнута прежде всего благодаря опроснику.

Следовательно процесс достижения эталонов, выводов и пояснений, касающихся каждого предложеного в первом Лонглайф отчете вопроса, имели решающее значение при создании второго отчета. При этом дефиниция Longlife Performance Pass © и его основных критериев и характеристик, как одна из главных целей проекта Лонглайф, играет значительную роль в процессе распространения и оценки жизнеустойчивых идей.

4. Introduction

Generally speaking, sustainable development has been defined in the various way as wise, caution and logical utilization of resources, where the economic, cultural, social and environmental issues are its four basic pillars.

Despite of all international program, efforts and global performance regarding development plans based on sustainable considerations, monitoring projects are presenting yet the overusing natural resources and increasing energy consumptions in different ways.

Considering this basic and fundamental issue, Longlife project, a Baltic Sea project has been started with the Agenda of; Sustainable, energy efficient and resource saving Residential Prototype in consideration of unified procedure and advanced technology in countries around Baltic Sea.

As the main aim project focused on the optimization of methods of construction, adapts and implements advanced technologies for constructing Residential buildings and harmonizing building procedure between involved countries, in order to reduce energy consumption and cost through whole life cycle of building.

During the first phase as it is already explained in the first report; Longlife analyzed and compared the state of art for Energy Efficiency; Sustainability and Resource saving, through Life cycle cost efficiency of building, while keeping adoptable and affordable qualities in Prototype residential building in whole participant countries.

In the present phase “Report” Longlife has developed common standards, criteria and specification for a sustainable, resource saving residential building. Here the main objective have been to achieve unified procedures for energy efficiency, sustainable construction, resource saving approaches and reduction of Life cycle cost of buildings in one hand and simplification of the path for “transnational Planner, Investors and Administration” to realize European Union in other hand.

As mentioned before third phase -in form of WP5- will consisted of the designing of Prototype building, based on the provided “Common Standards” applicable on the whole procedure of planning, construction and performance regarding various administrative, legal and tendering frame work of participant countries.

As principal approach; the working methods have been based on “Triple helix”, namely; Three transnational competence teams, “Universities, Administrations and Housing Companies”, that each part is composed of five members from participant countries “Denmark, Germany, Lithuania; Poland and Russia”. Whole group are working jointly and through whole process of project, an approach that has realized the “transnational co working between fifteen different project partners.

Berlin University of Technology, faculty VI, Institute of Architecture, Department Design and Structure is the lead partner. Longlife has started in January 2009 and still will finish in January 2012.

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5. Summary - Overview

During last decade the essential topics of sustainability namely: “climate change”, ever growing “energy consumption and its environmental, social and economic consequences”, “resource saving policies and its necessities” has got crucial importance. Insofar as EU- Parliament issues resolutions such as: “reducing energy consumption about 20% till 2020” and described a “Strategic Goals“and objectives such as:
1. Moving towards a low carbon energy system
2. Ensuring security of energy supply for all
3. Ensuring that the first two goals also strengthen the EU's competitiveness and deliver energy to all consumers at affordable prices.
Among the last objectives; “Energy- efficient Building, “EeB” described that high energy efficient innovative technologies and measures might resulting in very low energy building, where the total annual energy consumption of the buildings should not exceed 60 kwh/m²/ year (primary energy).

Therefore immense team of researchers from different disciplines, engineers with different technical background, as well as staff from implementations and legal sectors have got involved in these topics from various points of view.

Since enlargement of European Union and central position of “Baltic Sea” as the EU’s internal sea, “Baltic Sea Region” has got critical importance in researches as strategic point in EU.
The **EU Strategy for the Baltic Sea Region** contributes to more intensive cooperation between the Baltic countries and shapes the region into a regional cooperation model for the whole EU. The most important strategy for the Baltic Sea Region is creating a complex common development strategy for a macro-region of this type. Where is observed as highly heterogeneous area in economic, environmental and cultural terms, yet the countries concerned share many common resources and demonstrate considerable interdependence.
The interdependence, along with the need to confront similar challenges, is an important justification for joint action within the framework of the strategy for the Baltic Sea Region.

Following this strategy, Longlife project was established to introduce ” Sustainable, energy efficiency and resource saving residential building in consideration of unified procedures and new and adapted technologies” in Baltic Sea Region. Longlife is a project contributing to the “Flagship” projects of “European Union” that covers the flagship project "Anticipate regional and local impacts of climate change through research".

Longlife project strategic goals are as follow:

- Reducing annual energy consumption of residential buildings down to 40 kWh /m²/year
- Reducing Life cycle cost of residential buildings
- Optimizing regional typologies of building and construction methods
- Developing, transferring and adapting and implementing new technologies
- Harmonizing country- specific planning and other procedure in order to improve sustainability of buildings

The first publication of Project, Longlife 1 Report “Analysis and Comparison” focused on the analysis of state of technology, administration and legal procedures, financial situation, demographic needs, similarities and differences in the participating countries.
Based on the findings and results of Longlife 1 Report “Analysis and Comparison”, Longlife 2 report “Development of Standards, Criteria, Specifications” paid attention to developing standards, criteria, specifications and guidelines.

The final stage is developing a catalogue of the methods, procedures, technologies, materials and elements, as the necessary tools for developing Longlife Prototype. The prototype that in turn would be the fundamental of Longlife pilot projects.
To achieve this crucial goal and its tool "Guidelines and Catalogue" three competence teams with the support of appropriate external expertises have been studying, analysing and preparing group of scientifically rich reports to specifying Longlife main topic from different point of view.
Brief reviews on each part of the Longlife Report two "Development of Standards, Criteria, Specifications" are as follow:

Team 1 of Longlife project" Engineering and Building Technology standards" under the leadership of "Gdansk University of Technology" provided findings in three different levels:

1- The questionnaires of Longlife 1 Report "Analysis and Comparison" resulted and ended up with the indicators or benchmarks with specific concentration to the regulations and rules. Some of the most important findings are as follow:
   - Type of the residential building: detached, multi-storey apartments' with min. 4 levels
   - Size / area and ratio in % of each apartment: from 1 room to 5 rooms' apartment. A great variety of apartments is recommended.
   - Common requirements for living spaces: Standardization of living requirements with regional differences. The m^2 per person can be set at a maximum to assure sustainability
   - Organisation of living area/sleeping area: Functional separation of living and sleeping areas is recommended. Entrance should be placed in living area rather than sleeping area
2- Research with following key findings:
   - Global energy situation forces to increase consumption of renewable energy resources.
   - Normative "$\mathbf{e_r}$ "coefficient value of fossil fuel and renewable energy resources for design of low energy residential building should be used and normative regulations of this coefficient should be made.
   - The proposed regulatory criteria $\mathbf{e_r}$ = 2 value for the year 2015 is suggested.
3- External expertise with three report s focused on :
   - Report one: Identification and documentation of existing assessment,
   - Report two: Comparison concerning indicator catalogues, methods of weighting and scoring
   - Report three: Outline of a framework for a Longlife certification scheme". Third report provided an initial outline of a generic framework for a Longlife assessment, certification and communication scheme for sustainable construction through the variety of tools.

Team 2 of Longlife Project "Method of planning permit and tendering procedure " under the leadership of Roskilde Municipality provided findings as follow:

1- The questionnaire of Longlife 1 Report "Analysis and Comparison" developed to the series of benchmarks with following topics as spotlight:
   - currently applied planning methods
   - Building permit rules

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- Tendering rules and laws
- Construction process
- Conditions and habits of operating / facility management
- Commercial parameters, housing industry key data, urban

2- To facilitate the cooperation between the participants the lead partner of team 2 "Roskilde Municipality " developed a questionnaire in the form of a wish list for the 6 main head-lines under this thematic area:

- Planning
- Building requirements
- Tendering
- Supervision
- Inspection
- Incentives

3- The wish list and the answers and comments received from the participants shows the measures which would developed a guideline for administrative, legal and tendering procedures including a framework to harmonise administrative and legal procedures to be used by administrations and planners.

4- The external expertise by focusing on the "Comparison of the legal framework in Germany, Denmark, Poland and Lithuania" supported research process of team 2 "Method of planning permit and tendering procedure**"**.

It begins with an overview of the European legal framework related to sustainability requirements. Then respective building laws in Denmark, Germany, Lithuania and Poland are introduced. Despite the complexity of Legal sustainability requirements and building permit procedures; the following key findings are recommended:

- Legal sustainability requirements and building permit procedure is very complex
- The motivation for shaping a legal framework for sustainability in the housing sector is growing
- The the implementation of the European Performance of Buildings Directive is a great milestone in terms of promoting energy efficiency
- The Member States are also endeavoring to enhance their performance
- Municipalities may take in important role in going beyond national and European standards by setting stricter requirements on a local level.
- Facilitating and encouraging local initiatives -Municipalities- may contribute to the promotion of sustainability in the housing sector and trigger creative and innovative solutions
- All of the countries examined are on a promising track, although the goals set by the EU are fairly demanding, so there is no reason to slow down in their efforts.

Team 3 "Economical and Financial basis, Industry and quality" under the Leadership of "ProPotsdam GmbH" following the other teams provided findings such as:

1- Based on the analysis of questionnaires of Longlife 1 Report “Analysis and Comparison”, the configuration of the “Longlife- Pilot- Project” is divided into steps. Some of them are as follow:

- Step1: Description of common characteristics of the pilot projects
    i. Appropriate building with 4 storeys
    ii. 30-40 apartments
    iii. Size of apartments with variation of 50 m^2 , 70-80 m^2 and 85- 120 m^2
- Step 2: Description of energy standard suitable for each country
    i. The concept of the „Passive House“ with the yearly primary energy demand of about 40 kWh/m^2 per year could be a common denominator
    ii. In all countries are no legal restrictions for maximum CO_2-emission.
- Step 3: maximum construction costs
    i. An average value as a basis for the pilot project is as gross rent (incl. operating cost and heating) between 7 and 10 €/m^2 and as net rent between 7 and 8 €/m^2.
    ii. Maintenance costs are included in the net rent and the data for operating costs ranges from 0,4 €/m^2 (Lithuania) to 3,00 €/m^2 (Poland) monthly
    iii. The prices for construction costs show an extraordinary variety between the different countries. While Denmark and Germany are calculating with about 2.500 €/m^2, Lithuania and Poland name about 500 €/m^2
    iv. The property share is between 49 and 482 €/m^2 but averages around 190 €/m^2

2- Improving the energy efficiency of residential buildings is identified by several studies as one of the cheapest ways to save (fossil) energy and cut CO_2-emissions The external expertise imposed the crucial question why supposedly cost-effective measures, providing net benefits to the investor, are not taken by the relevant actors in the building sector; it ended up to the following recommendations:

- Prevailing market conditions and behavioural patterns of individual decision-makers may inhibit the realization of higher energy efficiency levels that would yield net gains for the investor in the long-run.
- The difference between the actually realized level of energy efficiency and the level deemed optimal creates the so-called energy efficiency gap. In order to overcome the various market barriers a policy package comprising diverse instruments is required. No single policy instrument can capture the entire potential of cost-effective energy efficiency improvements in the residential buildings sector.
- Rational environmental and climate policy has to balance the benefits and costs of policy action. The optimal level of efficiency is that which is consistent with efficient overall resource use, including efficient use of government resources required for the implementation of environmental policy.
- Reaching an economically optimal level of energy efficiency regularly does not imply to maximize the technically feasible level of energy efficiency.
- The optimal energy efficiency level and the appropriate energy policy strategy to achieve it differ across countries or even regions according to the diverging underlying circumstances (e.g., climate, availability of resources and technologies, institutional structures, etc.).

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6. Methods

Longlife has formed three transnational competence teams and five national units or regional teams.

The cooperation between the three transnational competence teams – science, politics and economy - team 1, team 2 and team 3 – it is enable to work in an integrative style and as **triple helix**.

Through the public-private partnership (PPP) composition - the cooperation science, politics and economy - team 1, team 2 and team 3 - it is also possible to move the project aims faster and closed.

All participating countries - Denmark, Germany, Lithuania, Poland and Russia - have members in the three transnational competence teams:

Science - team 1: technology, energy, planning

Politics - team 2: administration procedures

Economy - team 3: industry, costs, financing, quality

Team 1 consists of universities; team 2 consists of administration as well as Housing and urban development agencies and team 3 consists of investors and building societies. In the figure below the triple helix is imaged to show the three competence teams and five national units.

TEAMS (transnational)	regional team GERMANY	regional team POLAND	regional team LITHUANIA	regional team RUSSIA	regional team DENMARK
specialist: TEAM 1 technology energy planning	Berlin Institute of Technology	Gdansk University of Technology	Vilnius Gediminas Technical University	St. Petersburg State University of Architecture and Civil Engineering	Cenergia
specialist: TEAM 2 administrative procedures	Center of Competence for Major Housing Estates	Municipality of Gdynia	Housing and Urban Development Agency	Joint stock company ‚Hypothecary Agency of Leningrad oblast'	Municipality of Roskilde
specialist: TEAM 3 industry cost quality	Pro Potsdam GmbH	Municipality of Gdynia	Building Planning Systematics Center	North-West Inter-Regional Center AVOK	Building Association of Zealand

All involved countries work in the three competence teams. All project partners work at the same time in the same work-package; they are divided in the three competence teams. They share the knowledge in the national units. All three competence teams have a team leader for the whole duration of the project. The work-package leader is responsible to coordinate the work in the competence team between the partners from the involved countries. As well, each work-package has a work-package leader.

The lead partner, the work-package leaders and the team leaders follow the Longlife project Structure.

In the work package 3 Analysis and comparison the aim was to develop a comparable base of international information of the five participating countries and to show the building process in Denmark, Germany, Lithuania, Poland and Russia during the entire life cycle of the building, the similarities and differences in an easy comparison chart according to the three transnational competence teams.

For this a questionnaire was jointly developed in the three transnational competence teams - Engineering and building technology standards, administration tools, method of planning, permit and tendering procedures and economical and financial basis, industry and quality.

This questionnaire was filled out by all project partners and later brought together by the Lead Partner, Berlin Institute of Technology, Institute of Architecture, Department Design and Structure, Germany and the work package leader, Gdansk University of Technology, Department of Fundamentals of Building and Material Engineering, Poland.

Two parts of the output are developed in order to compare the answers. The first part is a chart filled out with short answers to be able to compare easily the contributed information. The second part is an annex with detailed information of the three competence teams sorted by participating countries to get an overview of the national processes and standards.

In a last step we formulated in columns summaries and benchmarks, which will be used as the basis for comparison of sustainability for the next work package – Development of standards, criteria and specifications for a sustainable, resource saving residential building – to deepen specific information that we'll need to design a prototype residential building.

We provided with a virtual project room an access to the project's work results, to discuss the steps and news and to have the possibility for up-and download documents for all project partners.

The work package 4 "Development of standards, criteria, specifications" followed the structure of questionnaire and developed the benchmarks to design a Longlife prototype building.

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7. Workshops, meetings, events

- Workshop 23-25 September 2009 Roskilde, Denmark
- Workshop 17-21 January 2010 Vilnius, Lithuania
- Workshop, 20 April 2010, an additional workshop for team 1, 2 and 3 in Berlin, Germany
- Video Conference. Weekly base between teams, started in April 2010
- Longlife design class, first session 14 April 2010, Berlin, Germany

  The goal of the design class was designing a prototype of a sustainable, energy efficient residential building in Potsdam, whereas environmental aspects, ecological materials and structural design approaches were the main objectives of the design process.

- Official handover the Longlife 1 Report to the Vice Chairman, Housing & Building national Research Center (HBRC), 19-21 May 2010, Egypt
- Workshop and Team Meetings, 23 June 2010, St. Petersburg, Russia
- Longlife 2010 International Conference St. Petersburg, 24 June 2010, St. Petersburg, Russia

  The International Conference in St. Petersburg was the project midterm conference.
  The International Conference worked in three sessions and started the cooperation with Russian Universities, engineers, architects, administrations, housing associations and buildings companies to implement new technologies to reduce energy consumption and minimize the operational costs in the buildings life cycle.

  Session 1: Presentation of current results of the Longlife project

  Session 2: Intersections between Longlife and other projects in the field of sustainability in the Baltic Sea Region

  Session 3: Information from Russian engineers, architects, municipalities, representatives of housing associations and building companies how to reach sustainability

  Through the International Conference in St. Petersburg, project Longlife presented the result, the process etc., shared and exchanged ideas, technologies and experiences with researchers, engineers, government officers and company delegates.

- The Meeting and signing Memorandum between the five projects in the Baltic Sea Region Programme 2007-2013 ,24 June 2010
  During the Longlife 2010 International Conference in St. Petersburg, Russia on 24 June 2010, the five projects have exchanged information and knowledge, according to the same basic objective to enhance the awareness for sustainability. They discussed the possibility to work together further, and agreed to suggest their project partners to enhance the cooperation between these projects in the future and to inform about the proceedings and the results. This can be a step for further developing the Baltic Sea Region towards a model region for sustainability in Europe.

- Longlife design class, final presentation 15 July 2010

- Longlife Design Class, Press Release 19 July 2010

  Twenty-two students worked in seven groups for four month and designed a sustainable, energy and cost efficient Prototype Residential Building.
  The new experience was that the students designed not only the architecture of a building but rather a complete concept. They used the new approach of integrated planning. The design process included environmental, ecological, resource saving and cost efficiency aspects. Also the development of an energy concept, energy requirements, and proper materials and optimized construction system were required, while still designing based on the principals of modern and timeless aesthetics.

- The meeting and finalization of agreement and Memorandum between the five projects in the Baltic Sea Region Programme 2007-2013, 24 June 2010

- SET2010, Shanghai, China 24-27 August 2010;
  Longlife has presented the project on the 9th International Conference on Sustainable Energy Technologies in Shanghai, China. It was very helpful that Gang Liu, TU Berlin, was the co speaker in Chinese language.

  The SET Conference 2010 has covered a wide range of sustainable technologies. It was a good opportunity for Longlife to update the latest developments and applications on sustainable technologies.

  The conference participants came from China, Germany, Taiwan, Korea, Japan, India, Sweden, Norway, Netherland, USA, Canada, Italy, UK, Iran, UAE, Portugal, Russia, Turkey, Switzerland, Chile and Brazil.

  A lot of conference participants were very interesting in the project results, for example the requirements, standards and indicators for sustainability.
  Longlife has also presented the exhibition about the Longlife design class and handed over to Professor Raffa Riffat, President of World Society of Sustainable Energy Technologies (WSSET). We decided to cooperate in the future very close. SET 2011 will take place in Turkey.

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8. Design program and benchmarks

8.0 Introduction

This chapter is consisted of three parts that are forming the structure of report. A unique approach throughout the project; that in fact is a unifying tool to acting as the main line connecting wide range of topics of project together. The unifying parts are as follow:

Engineering and Building Technology Standards

Method of planning, Permit and tendering procedure

Economical and Financial basis, Industry and quality

In the first sub chapter, two main and fundamental parts are explained. While first part "Development of standards, criteria for sustainable and low energy residential building" is paying attention to the subtopics such as: concept and standardization of low energy building and the structure of energy resources demand, second part is consisted of the main founding of questionnaire of team 1 "as the Backbone of the project" and in the frame of Topic/ Subtopics, Benchmarks, variation/ tolerance and Comment/ recommendation is examined.

Under the second sub chapter the main founding of questionnaire of team 2 "Guideline for administrative, legal and tendering procedures" are explained and analyzed.

Under the sub part of third part the result of questionnaire of team 3 under the title of "Economical and financial basis, industry and quality" have been analyzed and examined.

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8.1 Engineering and building technology standards

8.1.1 Overview

Development of society has come into such a stage that consumption of fossil fuel has become global problem. The solution of this problem could lei in various approaches such as: the increase of total effective consumption of energy resources, search for new ones, increase of known renewable energy resources consumption and etc. It is getting more evident that Society cannot exist to unlimited extent using finite energy resources. Therefore in order to protect environment from excess emissions and saving energy resources clean, green, energy efficient, passive, zero energy sustainable buildings are increasingly being constructed. Even though definitions of these buildings are merged, still their characteristic parameters are quite different, as an example, eco or green buildings can be not energy effective. Apparently, one of the reasons for this situation is that building assessment systems [DGNB, LEED, MINERGIE^{R} and others] cover a very wide range of parameters, including energy efficiency. Therefore the energy efficient building regulations for energy demands in various countries differ a lot. The proposed technical parameters of the energy efficient buildings are described, which would help to standardize the identification and to make the definition of such buildings.

Structure of the energy production and consumption necessitates transformation. There are lots of scenarios of consumption development, where decrease of fossil fuel consumption and increase of renewable energy resources is mentioned. Fig. 1 presented by Shell and International Agency of Energy (IAE) shows energy production development of different fuel resources in overall fuel balance.

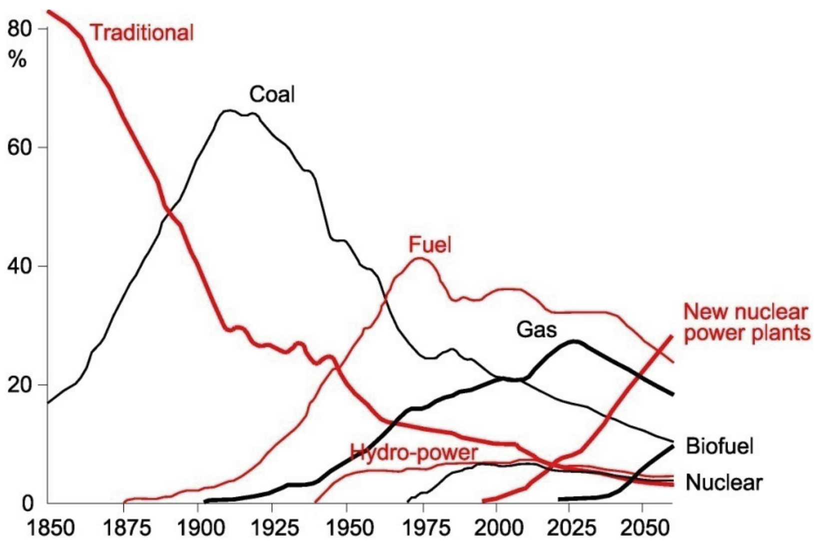

Fig. 1. Energy production development of different fuel resources in overall fuel balance

According to chart lines shown in Fig. 1, there was decrease of carbon consumption in the beginning of the XX-th c., when oil and gas were discovered. In 1980s there was decrease of oil extraction and in short time the decrease of gas extraction is expected. That is why increase of renewable energy resources development is expected and in overall it will make up to 30 % of all global fuel in 2050. In this respect there are more optimistic scenarios. Fig. 2 shows highly aspirated, but more realistic, the so called- AIP (Advanced International Policy) scenario presented by EREC-European Renewable Energy Council, 2009.

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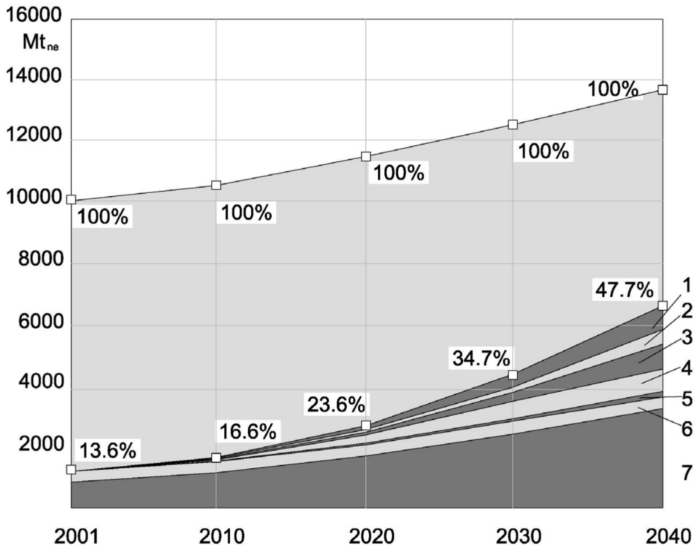

Fig. 2. Global energy production scenario by EREC*: 1 – geothermal; 2 – solar heat; 3 - solar electricity; 4 – wind power; 5 – small HE; 6 – large HE; 7 – biomass power.*

Fig. 2 reveals that it can be achieved in 2040, that 50% of all served energy could be renewable energy.

On the other hand, global experience of fossil fuel consumption reveals its very low effectiveness. There is estimation [Hegger et al 2008], that primal energy (the energy of renewable and non-renewable energy resources that was not converted or transformedin any way) in overall is consumed only in 30% (Fig. 3).

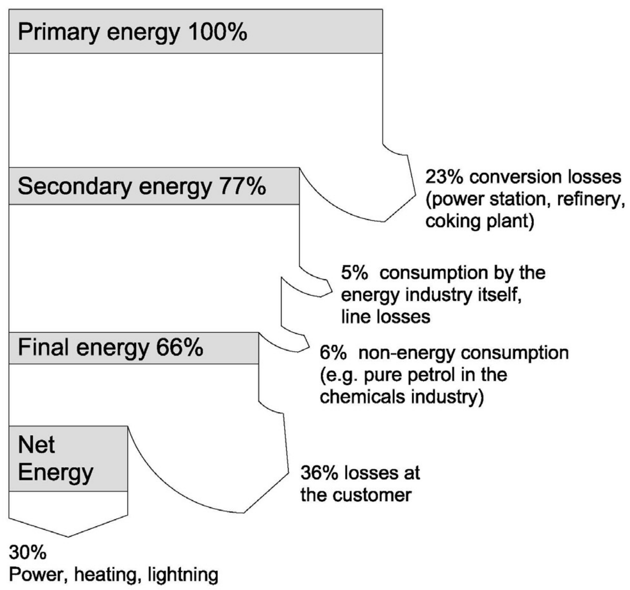

Fig. 3. Energy consumption efficiency of non-renewable energy resources

Of the above mentioned there are two conclusions:

- Effectiveness of energy consumption must be increased in all possible ways;
- Energy production should be transformed with increase of renewable energy resources consumption.

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All of this is important in case of building construction and particularly in residential sector, where 40% of all energy resources are consumed. In directive 2006/32/EC of the European Parliament and the Council as well as in the conclusions of EU Council document 7224/07 REV1 it is told by year 2020 that it should be saved over 20 % of energy consumption in EU countries (Action Plan for Energy Efficiency: Realising the Potential COM (2006) 545).

The role of housing construction sector is one of the most important considering optimising energy savings and increasing the efficiency of energy consumption approaches. Effective energy saving is possible not only through decreasing energy resources demand for heating purposes, but also by including the whole complex of building investment lifecycle. This point of view means that energy resources could be saved even at a selection of building materials stage. Different materials require different energy resources demand for the production (so called „grey energy“). Within the context of the considered problem it should be stated that smaller amounts of grey energy consumption for the material has become very important. The construction process should require as less treatment of materials as possible, its efficiency getting more obvious when considering the amount of time and working power resources. During the design process, all the decisional solutions such as designing: architectural, structural, building services‘, etc. should fulfil energy requirements of energy-efficient building and allow energy-efficient technological building processes.

As the main aim of LONGLIFE project in particular and overall building construction industry in general, it means that the energy efficiency of the renewable and non-renewable energy resources should be compared throughout its product life cycle:

- Stock production;
- Production of elements, structures;
- Transportation of stock, elements, structures;
- Technological process of construction period;
- Building maintenance period (in buildings - heating, air conditioning, hot water production, other domestic needs);
- Building demolition; reuse of its materials, elements, structures.

8.1.2 Concept for standardization of low energy residential buildings

Sustainable development [Agenda 21] required environmental protection, every possible pollution reduction, and efficient use of natural resources. Over the past decade European Parliament and the Council, adopted a number of important resolutions and directives on energy efficiency. To promote this change, the new energy efficiency parameter of residential buildings is to be introduced: energy stock ratio er (the ratio of fossil fuel (non-renewable) and renewable sources of energy, necessary for the build, maintenance and demolition). Considering all this, energy efficient building during its life cycle could be defined by two technical parameters of energy:

- Annual normative energy consumption (kWh/m^2);
- Coefficient e_r - energy stock ratio.

Energy stock ratio e_r value for energy efficient building, for example, from the year 2015 could be equal to or less than 2. With the ratio equal to 2, renewable sources will supply the building in one-third of the total energy demand. It is clear that the regulatory power factor value must be based on the special research. Of the above, to describe the needed energy efficiency of the building life cycle, not only of the

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building maintenance period we have to identify and normalize the energy stock ratio e_r regulatory values for total building life cycle. Today we have the biggest amount of the needed data to find out at least the energy stock ratio e_r value on the period of use.

Primary energy demand within building construction process comprises the extraction of raw materials, production of details and structures, transportation, storage, utilisation of wastes, and etc. This kind of energy consumption is required at building construction, operation and demolition stages.

The physical bulk of building, according to the demand of „grey"energy is the most recipient. Usually it is associated to buildings' sole weight – if more light materials could be used for building structures it would probably contain less "grey"energy. For example, it is needed 1764 MJ of Primary Energy Input (PEI) to produce one cubic meter of concrete, 4098 MJ – for the reinforced concrete (2% of reinforcement) and 600 MJ for the lightweight concrete [Hegger et al 2008]. It is obvious that the density of materials is not directly proportional to the PEI, for this reason, this point of view needs to be proved and requires special researches. Nevertheless, it is also clear that smaller mass of volume directly corresponds to smaller transportation and construction costs, as well as better sound insulation and thermodynamic characteristics.

Some of the building facades directly influence "grey"energy demand as well as demand of energy resources during building operational time. The popular glass facades usually fixed by using aluminium structural elements [PEI_{glass} =35000 MJ/m^3; $PEI_{aluminium}$ =753380 MJ/m^3; Hegger et al 2008], require research on the influences of building energy efficiency. It is relevant especially in such variable climatic conditions as Baltic Sea region, where buildings have to adapt to seasonal changes. Within different climate zones to some extent, building envelope solutions were formed leaving not too much space for transparent (fig. 4). Also it is worth to mention, the solutions of traditional architecture (for shape, materials, etc.) provide possibilities to get optimal result with minimal expenses.

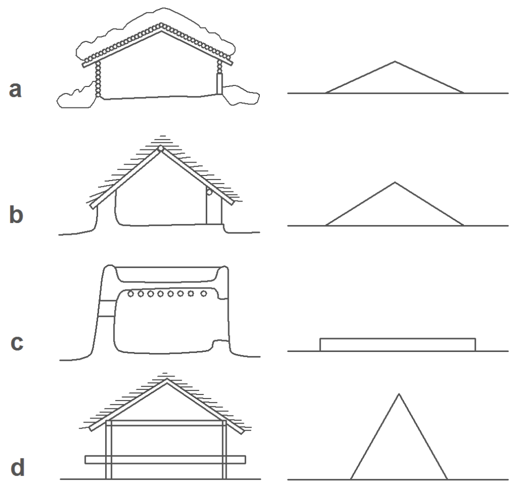

Fig. 4. Typical shapes and roof slopes of houses according to climate zones: cold (a); temperate (b); dry, hot (c); moist, warm (d) [Hegger et al 2008]

Nevertheless, windows used in contemporary times cannot be comparable to the quality of the old ones. Glass facades are effective for solar insulation (Transformation) and heat inflow in wintertime. Unfortunately their thermodynamic characteristics are still insufficient and it is not possible to apply effective thermal insulation. On the other hand, overheat of inner spaces during summertime necessitates the installation of a conditioning system which is very inefficient according to the energy consumption.

Primary energy demand also includes building construction process. The selection of technological solutions for construction works is an important link within a chain of energy resources efficient consumption. During the soviet times construction sites looked like mounting works to erect the prefabricated details end elements. Nowadays building construction process takes a lot more operation works and expenditures on the site. The production of prefabricated details and structures requires labour expenditures and consumption of energy resources as well. However, its efficiency, quality control, waste of materials and recycling is on a higher level than the production itself in a building construction site.

Preliminary researches on the demand of energy resources show that less expenditure were experienced to erect a multi-storey apartment house made of pre-casting elements and masonry structures. According to comparable weights, the house made of pre-casting elements required 30 % less energy than the one, made out of masonry structures [Martinaitis 2001]. During the operational period both buildings mentioned earlier have a similar energy resources demand – heating and ventilation systems require the major part of energy consumption.

More thorough researches on energy consumption for the whole building lifecycle costs by operating on the comparative as well as absolute values are needed. Within the next chapter some evaluations of energy consumption during the operation period of a building are presented.

8.1.3 The structure of energy resources demand and possibilities for saving during the operation time of a building

Overall annual energy demand was determined for each partner country during the realisation of LONGLIFE project. It varies within different partner countries: 120-150 KWh/m^2 in Denmark; avg. 195 KWh/m^2 in Germany and 96–420 KWh/m^2 in Lithuania. During the last period energy prices in Denmark were stabile, in Germany (during the last 10 years) it increased 40 % and in Lithuania (during last 8 years) it increased 66%. It was determined that energy consumption of apartment houses depending on different architectural and structural solutions during the hole operational period consists of 30 to 70 % of the total energy consumption. It is widely understood, that the more energy efficient house is, the less energy is demanded during the operational period. For this reason, it means Lithuania has the highest potential to save energy resources and decrease CO_2 emissions comparing to the other partner countries.

A research on energy efficiency of three different multi-storey apartment houses with a similar proportion of effective and building envelope areas was made. Buildings were composed by different architectural and plan solutions and erected at a different period of time. Calculations were made according to the methodology set by STR 2.01.09:2005 „Energy Performance of Buildings. Certification of Energy Performance of Buildings“. There are many certification systems evaluating energy efficiency, sustainability or even ecological and social aspects of a house (for example, German DGNB, LEED in the USA and many others). However, the official one in Lithuania is STR 2.01.09:2005. The houses evaluated by this methodology are defined by characteristics stated below (table 1).

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Table 1. Description of researched houses

House	Year of constr.	Type of structures	Effective area, m^2	Envelope area / Effective area index	Proportions of heated volume, m^3: Height up to Cornice/ parapet	Proportions of heated volume, m^3: Height up to Roof top	Proportions of heated volume, m^3: Width, m	Proportions of heated volume, m^3: Length, m	Description of compactness
No. 1	1973	Masonry, (typical proj.)	1390	1,35	- / 14,3	-	11,50	29,70	Compact, facade is with protruded elements
No. 2	2002	Masonry	1752	1,33	I volume: 15,25 II volume: 9,00	20,70 13,20	11,70 8,20	23,20 17,60	Incompact, facade is even
No. 3	2007	Masonry	1237,21	1,31	10,0	13,80	14,30	27,60	Compact, facade is even

Several types of external walls with various thermodynamic characteristics cover volumes of the houses. House No.1 is formed of external walls without insulation layers, majority of windows are old, wooden and double-glazed. Facades are not even (with protruded elements). U-value of the external walls for the houses No.2 and No.3 almost fulfils nowadays regulations: house No.2 (incompact – composed out of 2 contiguous volumes) average heat transfer coefficient of external walls U_w is close to 0,21 W/(m^2K), average roof characteristic U_r is less than 0,2 W/(m^2K), floors under cellar U_{cc}=0,25 W/(m^2K); house No.3 U_w=0,23 W/(m^2K), U_r= 0,18 W/(m^2K), U_{cc}=0,20 W/(m^2K). New wooden windows with double-glazing equip both houses.

After applying STR 2.01.09:2005 methodology and processing calculations using “NRG-sert” (approved by Ministry of Environment, Rep. of Lithuania) computer programmed package, energy performance and qualifying index (C) values were got (table 2):

Table 2. Qualifying index and energy performance class of evaluated houses

House	**Qualifying index C value**	**Energy performance class**
Nr. 1	2,18	E
Nr. 2	0,93	B
Nr. 3	0,90	B

The figure 5 shows the presented calculated values of energy loss (Q):

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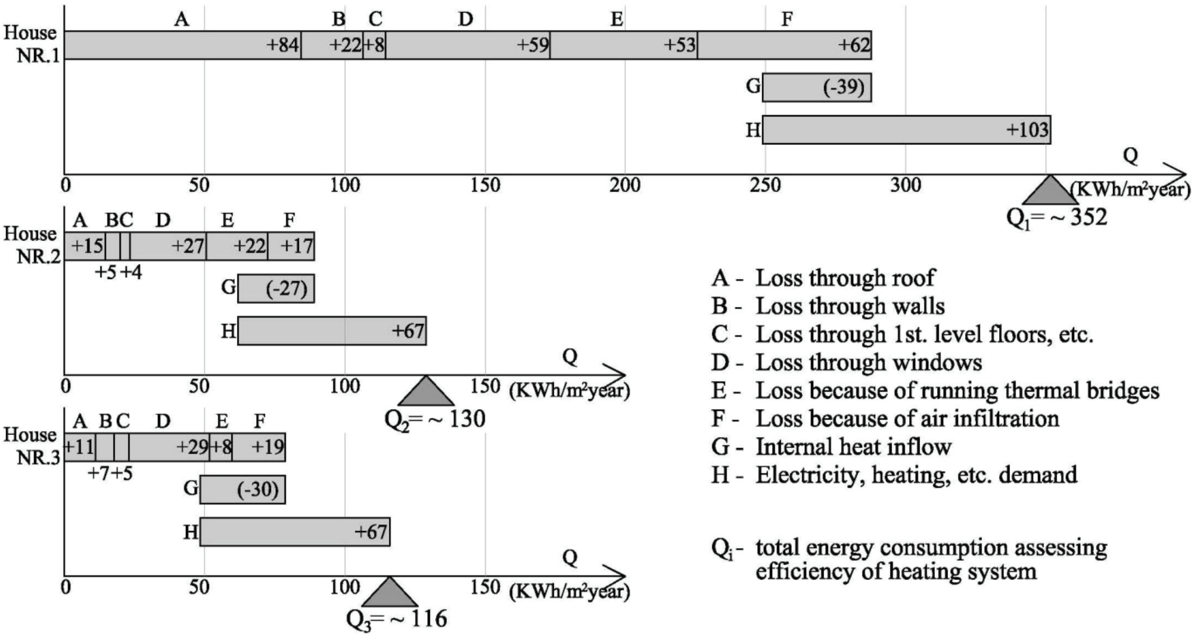

Fig. 5. The diagrams of annual energy demand within different energy efficiency class of multi-storey apartment buildings

As it was expected, the worst results were obtained by the house No.1 - the oldest and without a thermal envelope. A brand-new, compact house No 3 obtains the best performance. It could also be concluded from the diagrams that the better parameters of external walls (U-value) are, the more important parameters belonging to the building exploitation (heating, ventilation, hot water preparation and control systems, etc.) get. Due to this, energy loss of the house could be grouped as:

- Dependent on the thermal characteristics of the building envelope (positions A-F);
- Intended to obtain healthy and comfortable internal microclimate (position H).

The enhancement of parameters belonging to the first group could be called as an application of “passive” measures to increase the energy efficiency of the building. Similarly, the enhancement of the parameters belonging to the second group (including responsive usage of electricity, hot/cold water, etc.) could be called as an “active” measures targeted to the same purpose. Loss of the second group will not to be discussed in this article. It is worth mentioning that the efficiency of heating and ventilation systems depends on the quality characteristics of external walls. This means that by improving the mentioned above characteristics the value of the second group could also become better.

For the better interpretation of A-F loss characteristics, it is worth to evaluate every factor (forcing building energy performance) in percents and compare it to the external wall areas expressed in percents as well. It is shown in table 3:

Table 3. Evaluation of factors forcing building energy performance comparing to external wall areas

House No.	Walls			Roof			Floors			Windows			Losses: running thermal bridges		Losses: air infiltration		Total losses, KWh / m² year
	Losses,		*Area, %*	Losses,		*Area, %*	Losses,		*Area, %*	Losses,		*Area, %*					
	KWh / m² year	%		KWh / m² year	%		KWh / m² year	%		KWh / m² year	%		KWh / m² year	%	KWh / m² year	%	
1	84,5	29,4	*48,0*	22,0	7,6	*18,7*	8,2	2,8	*16,5*	58,5	20,3	*16,8*	52,6	18,3	62,0	21,6	287,8
2	14,6	16,4	*50,4*	5,4	6,1	*19,9*	3,5	4,9	*15,0*	27,0	30,4	*14,7*	22,0	24,7	16,5	18,5	89,0
3	11,2	13,9	*35,9*	6,5	8,9	*25,9*	5,4	6,3	*22,9*	28,7	36,7	*15,3*	8,1	10,1	18,9	24,1	78,8
After setting parameters of external of house nr.2 to houses nr. 1 and 3:																	
2-1	14,0	12,2	*48,0*	5,2	4,5	*18,7*	3,9	3,4	*16,5*	30,6	26,6	*16,8*	37,7	32,8	23,5	20,5	114,9
2-3	10,3	16,7	*35,9*	7,2	5,6	*25,9*	6,2	4,4	*22,9*	28,7	30	*15,3*	8,1	24,4	18,9	18,9	79,4
After increasing the height of house nr.3 by one floor:																	
3a	11,5	15,1	*40,6*	5,1	6,7	*22,6*	4,2	5,5	*19,9*	28,5	37,4	*16,9*	7,6	10,0	19,2	25,2	76,1

The percentage of external walls of the houses No.1 and No.2 are similar. This shows that it is possible to evaluate the importance of influencing energy efficiency parameters by comparing the house performance. According to the presented results, the most effective measure to save energy is the quality of external walls and its main characteristic - heat transfer coefficient (also opposite proportion to the U -value). By changing value of the coefficient from 1,27 to 0, 21 W/m^{2}K the loss drops down more than 5 times (approx. 70 KWh/(m^2 year)). Comparing the characteristics of windows, it seems that the new ones (wooden with double glazing, one selective case) influence energy performance not that much – these transparent walls decrease energy loss of old windows approximately twice. However, after assessment of air infiltration, which is related to sealing of windows, the effect of it could be equal to the insulation of walls.

Undoubtedly, comparing old and new buildings the results of new ones should be better due to tighter regulations. Moreover, the accomplished comparison can reason economic efficiency by refurbishing the old ones. However, this comparison doesn‘t reveal the influence on energy efficiency by architectural and plan solutions of the houses. For this purpose the data of energy loss in the house No.3 is important. Its area of external walls is different comparing to the ratio of the houses No.1 and 2. Moreover, the annual consumption of energy per square meter is 10% better than in the house No.2. This means that the increase of energy efficiency in house No.3 was influenced by better thermal characteristics of walls or by the compactness of the building.

In order to demonstrate the influence for building energy efficiency by previously mentioned characteristics it is necessary to compare buildings by modelling their external walls using the same structural solutions of thermal envelope. For this purpose the properties of external walls in the house No.2 are assigned to volumes of houses No. 1 and No.3. The results of the modelling are presented in the middle part of table.3.

Considering the features of compact and regular forms to take less area of external surface in the same volume than incompact ones (picture 6), the building No.3 is modelled to be increased in size by one floor. Ergo, width and height proportions of the house become equal and closer to compact form. Thereby, ratio of effective area and area of external walls decrease to 1,17. The loss results through external walls per square meter of effective area per year are shown at the bottom of the table 3.

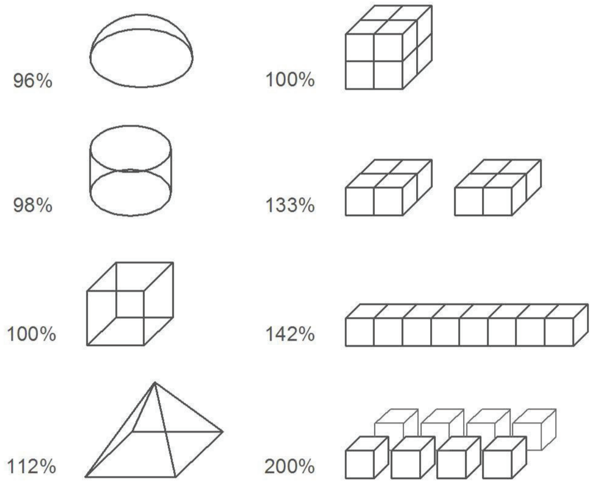

Fig. 6. Transmission of heat losses of various 3D shapes with the same volume [Hegger et al 2008]

The energy efficiency data of the modelled buildings revealed that one of the main factors for the house No.3 to show best energy efficiency is compact architectural solution. The influence to efficiency by partition characteristics is likely to be smaller than influence of the shape. In this case, results of energy performance changed fractionally after assignment of external wall characteristics of the house No.2 to house No.3. The facades of a house which are not even (with protruded elements) cause the upspring of running thermal bridges, despite the compact volume of the building. This statement is also confirmed by the results of the old construction building that, after assigning the properties of modern buildings, became better but remained worst to that type of shape.

Unfortunately, the performed calculations are not enough to determine the maximum effect that could be achieved by architectural solution to the energy efficiency of a building. On the other hand the obtained information is a solid base for further researches on this topic.

It can be concluded that the protruded elements of the facades provide more energy loss than incompactness of the building. This is partly demonstrated by a small increase of energy efficiency of the raised building during its modelling (only 3-4 %).

Summarising the results of performed calculations, it is worth to mention the possibility to increase energy efficiency of buildings by improving quality of windowing systems. These transparent walls take 15-16 % of total building envelope area and release approximately 30 (and more) percents of energy compared to the total consumption through external walls. If taking into account the energy loss considering air infiltration, the total waste of energy through windows is even larger. On the other hand, after improving the sealing of windows it is important to take care about indoor microclimate.

It is worth to pay attention to the negative outcomes, which are leaded by protruded elements of the facades when avoiding larger impact of running thermal bridges. If protruded elements are a part of architectural solution idea they have to be formed out of lightweight materials (with better thermodynamic characteristics) or in a layer of external decoration (out of insulation layer).

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8.1.4.1 Architectural and Urban Design

1.1 Architectural and Urban Design			
topic / subtopic		benchmark	variation / tolerance
1.1.1	1.1.1 type of residential building	detached, multi-storey, multi-dwelling building with min. 4 levels + optional basement and/or roof level	2-6 storeys
a)	number of apartments in each building	total of 12-30 apartments	total of 12-30 apartments with 3-5 apartments on each floor
b)	size/area (m²) and ratio in % of each apartment type in the building	1-room/25 - 35 m² = 15 % 2-room/45 - 60 m² = 25 % 3-room/60 - 80 m² = 30 % 4-room/80 - 110 m² = 25 % 5-room/110 - 150 m² = 5 % A great variety of apartments is recommended.	tolerance 10% (size) variation of typology (5 %)
c)	requirements for living rooms	min. area 18 m², min. width/depth 3,50 m	
d)	requirements for kitchens	min. 8 m², min. width/depth 1,80 m. natural daylight/view to outside mandatory	
e)	location of kitchen in combination with the living room	kitchen should be close to and may be in open connection with main living room	in 1-2 room apartments, kitchen may be integrated in main living room. In larger apartments, separation doors between kitchen and main living room should be provided depending on floor plan solution
f)	kitchen ventilation	mechanical ventilation mandatory	
g)	requirements for bathrooms	bathrooms should have natural daylight if possible. Views from outside should be prevented. mechanical ventilation mandatory	
h)	bathtub	bathtub is recommended in bathrooms of 3-5 room apartments	bathtub should be avoided in apartments with universal access
i)	shower	shower is mandatory for all apartments	
j)	sink	1 washbasin in each bathroom is mandatory	bigger apartments should have 2 washbasins or double washbasin
k)	separate WC	separation of bathroom and WC is optional	larger apartments should have additional, separate WC. WC should be integrated in bathroom in apartments with universal access

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8.1.4.1 Architectural and Urban Design

l)	circuit points for washing machine and dryer	technical installations for washing machines are optional in every apartment, if not central place for all	technical installations for washing machine can be placed in bathroom or next to kitchen. In large apartments a separate utility room next to kitchen is recommended
1.1.4	common requirements for living spaces	Standardization of living requirements with regional differences. The m² per person can be set at a maximum to assure sustainability	every room should have a net area of minimum 7 m². living rooms should have a net area of minimum 16 m²
b)	number of persons per household	2-3 persons per houshold. Demographic development as well as market situation in each country should be considered in the variation of the apartments typology.	+/- 1 person
c)	area in m² per person	minimum floor area per person should be 25 m²	
d)	height of rooms	net height ≥ 2,50 m	recommended height ≥ 2,70 m maximum height = 3,00 m
e)	information about usual living spaces	kitchen, bathroom, WC (separate or integrated in bathroom), living room(s), bedroom(s), storage room plus central hall (depending on floor plan configuration)	number and variation of rooms depends on size of each apartment.
1.1.5	building envelope design limitations (e.g. material, windows etc.)	definition of facade materials can be defined by local building regulation plans or influenced by definition of energy performance	
a)	window surface area	net glazed area (windows/doors) of exterior walls should be minimum 12,5% of floor area in any room to allow for sufficient daylight. Skylights (ceiling windows) can be reduced to 10% of floor area.	depending on size of apartment and floor plan solution, bathrooms may have mechanical ventilation instead of window
f)	general requirements for living space (cooking / dining/ living)	kitchen, dining and living areas should relate to each other, and be well- lit (natural daylight)	a separate dining area is recommended in larger apartments

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8.1.4.1 Architectural and Urban Design

g)	organisation of living area / sleeping area	functional separation of living and sleeping areas is recommended. Entrance should be placed in living area rather than sleeping area	
h)	hallway	each apartment should have a central entrance/hall with space for a wardrobe	
i)	storage room in the apartment	a separate storage room with a minimum area of $1m^2$ should be integrated in each apartment (except 1-room apartments)	alternatively storage could be provided by built-in closets of min. 60x180 (D x L) cm
1.1.6	specific standards		
a)	elevator	an elevator is mandatory if the building has more than 2 levels. In any case the building must be prepared for later installation of an elevator	if all apartments shall be accessible for people with reduced mobility (universal access), an elevator is mandatory
b)	cellar / basement	basement floor is optional but recommended for positioning of technical installations, storage space, parking etc.	
e)	garage/parking space	no garage or parking space within the building	garage or parking space may be defined by local building plan regulations and should be treated in the planning documents
g)	flat roof or pitched roof	roof shape may be defined by local building plan regulations. roof shape may also be influenced by choice of energy production equipment (e.g. photovoltaics).	roof should be architecturally treated as the buildings 5th facade. any technical equipment must be integrated in the overall architectural treatment. use of roof as common terrace or green roof should also be considered
h)	bicycle comfort (e.g.basement or parking space for bicycles)	a storage room for bicycles, prams, wheelchairs etc. inside the building with an area of min. 2,5 m^2 multiplied by number of apartments in the building is mandatory	an additional, covered bicycle shed may be integrated in the outdoor facilities
i)	laundry drying room	a common laundry drying room is optional	
1.1.8	functional guidelines for space efficiency, floor-space index (FSI), site occupancy index (SOI)	space efficiency guidelines - occupancy index 80% of built area should be net usage area. Area for construction, circulation, common functions should not exceed 20%.	tolerance: 5% if multiple common features are offered to all tenants, the ratio may vary accordingly see also 1.1.6 j)

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8.1.4.1 Architectural and Urban Design

a)	solar orientation	all apartments should have double orientation/exposure, large apartments preferrably triple orientation	1-room apartments may have single orientation
b)	possibility to redesign	plan layout should integrate flexibility over time, i.e. allow for future modification within each apartment and/or allow for combination of small apartments into bigger ones or division of big apartmens into smaller units	
1.1.10	barrier free construction	in the building with more than 4 appartments, ground storey must be barrier free. In the buildings with elevators and more than 4 appartments, one storey must be barrier free.	barrier free construction should be included in the construction-law of all European countries
1.1.13	criteria to describe the quality of the urban context and the site	Part of the certification process of the new building should be the local environment as a site factor. Landscape design, ecological value and biological habitat (number of existing species), public transport (distance and number of rides per day), amenities (distance and number of amenities), site selection (use of previously developped or contaminated land)	
b)	gardens	common garden access for every user/ tenant shoud be considered as part of outdoor/landscape design	garden acces for ground floor apartments should be considered
c)	garbage handling	covered garbage containers should be either integrated in the building in a ventilated space without any nuisance to adjoining apartments or placed in a separate space integrated as part of outdoor/landscape design	local guidelines for garbage pick-up must be followed. separation of garbage / recycling should follow local regulations but is recommended in any case. separation of garbage should start in every apartment; necessary facilities should be integrated

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8.1.4.2 Structural Design

1.2 Structural Design			
	topic / subtopic	benchmark	variation / tolerance
1.2.1	climatic conditions	combination and application of regional information	
1.2.2	type of roof structure	flat roof or pitched roof	choice of flat or pitched roof may depend on selected load-bearing structure, urban context and local plan regulations
1.2.3	type of load bearing structure	primary/load bearing structure could be steel or concrete or timber or masonry or timber	
1.2.5	use of industrially prefabricated building components	a certain degree of pre-fabrication is both economic, time-saving and supports dismantling/recycling at the end of a buildings lifetime	degree of pre-fabrication depends on local traditions, quality, availability etc.
1.2.7	criteria to make a decision in favour of a certain construction method	financing tool for ecological construction. the construction method should be based on the the best compromise between technical feasibility, durability, quality/lifetime and economy/ construction time	

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8.1.4.3 Energy standards

1.3 Energy standards			
	topic / subtopic	benchmark	variation / tolerance
1.3.1	national code for energy efficiency of buildings	Further comparison and examination of the different implementations of the EU Directive to use the same calculation. Comparison of national computer calculating programmes. National codes for enegry efficiency. the overall, primary energy consumption for all building related components (exclusive of individual user equipment) should be less than 40 kWh/m²/a and decrease to 0 kWh/m²/a by the year 2050	Proposition to recommend for each country the lowest possible realistic value for annual primary energy consumption (today and stepping down in the future) as well as to recommend the amount of energy to be supplied by renewable energy sources). The objective is not only to reduce energy consumption but also to define the relevant source of primary energy and to include the effect (e.g. the use of wind or solar energy) on lifecycle cost.
1.3.2	average final energy consumption of residential buildings in kWh/m²/a	Fixation of different energy consumption levels for regions	min. is national compliance minus 30%
1.3.3	national code for thermal insulation of buildings	Comparison of the codes, new common standards. National codes for thermal insulation. Definition of U-value for building envelope (single components as well as overall total)	
a)	Requirements for insulation	Definition of U-value for building envelope (single components as well as overall total)	
1.3.4	method to calculate energy demands	Implement a unified calculation method for the energy demand of residential buildings. Sustainable concepts integrate : CO2 emissions (0kg CO2 - equiv. /m²NEA*a or 42% energy costs savings), Insulation and air infiltration, heating, cooling, ventilation, lighting, renewable energy used, low energy domstic products, orientation of building for solar gains.	

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8.1.4.4 Building Materials

1.4 Building Materials			
	topic / subtopic	benchmark	variation / tolerance
1.4.1	type of building material used for...		
a)	roof structure	external materials with low solar reflectance steel reinforced concrete (flat roof) or timber frame (pitched roof)	roof structure may be defined by local planning regulations
b)	load bearing structure	use of less concrete and steel, use of recycled aggregates steel reinforced concrete	
c)	foundation	use of less concrete and steel, use of recycled aggregates steel reinforced concrete	
d)	external wall	external materials with low solar reflectance non load-bearing prefab concrete elements, masonry walls or timber with insulation between outer and inner facade layer (except for massive masonry construction)	alternative materials for exterior cladding are also possible
e)	internal wall	light masonry or timber/steel frame walls with cladding	internal wall material must be selected according to local tradition and desired comfort. Flexibility and recycling possibilities should be considered when choosing interior wall materials. hazardous materials or composite materials (e.g. steel frame/gypsum plaster boards) should be avoided.
f)	floor	wooden flooring is preferred for living spaces. Tiles are preferred in wetrooms. Other materials can be selected after careful evaluation of comfort, quality, economy etc.	flooring material must be selected according to local tradition and desired comfort. hazardous materials or composite materials (e.g. steel frame/gypsum plaster boards) should be avoided
g)	ceiling	ceiling material must be selected according to local tradition and desired comfort. hazardous materials or composite materials (e.g. steel frame/gypsum plaster boards) should be avoided	ceiling material must be selected according to local tradition and desired comfort. hazardous materials or composite materials (e.g. steel frame/gypsum plaster boards) should be avoided
h)	facade	facade materials must be carefully chosen by evaluation of quality, ecology and economy	facade material must be selected according to local tradition and desired comfort. may also be defined by local planning regulations

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8.1.4.4 Building Materials

i)	windows	glass and framing should be defined according to availability on local market as well as economical and ecological criteria	materials with a low recycling value or bad ecological aspects should be avoided
j)	thermal insulation	thermal insulation must be selected on the basis of and the best compromise between ecological, functional and economical evaluation	materials with a low recycling value or bad ecological aspects as well as hazardous materials should be blacklisted
1.4.4	ecological product declaration (EPD) of building materials	new obligatory ecological standards for materials by involving for example the primary energy demand. environmental product declarations (EPDs) are mandatory for all materials used in the building.	materials with a low recycling value or bad ecological aspects should be blacklisted
1.4.5	criteria involved in environmental product declaration	Obligatory ecological criteria for materials: sustainable certification systems include 39 kg CO_2 - Equiv/ m^2NGFa *a (GWP); 0,0000035kg R11-equiv/m^2NGFa*a (ODP); 0,0105kg C_2H_4 equiv/m^2 NGFa*a (POCP); 0,0147kg PO_4-equiv / m^2NGFa *a(EP); 0,2170 kg SO_2-equiv/m^2NGFa*a (AP), material sourcing and legal timber, reuse of existin gbuzilding structure, use of recycled materials	environmental product declaration should follow EU standards. Information must include data for absorbed energy during construction, health risks, recycling potential etc.
1.4.6	declarations or codes for waste materials / recycling	any used materials lifecycle and recycling potential should be defined	

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8.1.4.5 Building physics

1.5 Building physics			
	topic / subtopic	benchmark	variation / tolerance
1.5.1	material standards or characteristics to describe material and building conditions	Using the same terms and units. Reuse of existing building structure, use of recycled materials if possible.	
a)	external walls	U ≤ 0,20 W/(m²·K)	DK / LT / : 0,2 W/(m²·K) PL: 0,3 W/(m²·K)
b)	roofs	U ≤ 0,3W/(m²·K)	DE: 0,15 W/(m²·K) PL: 0,3 W/(m²·K)
c)	windows	U ≤ 1,3W/(m²·K)	DE: 1,3 W/(m²·K) PL: 2,0 W/(m²·K)
1.5.2	requirements for thermal comfort (internal thermal conditions) in winter and summer	should be medium to high	
1.5.6	requirements for the building envelope	U-value, air tightness, energy efficiency, moisture resistence, lighting, acoustic insulation, fire prevention. Blower door test	
1.5.7	requirements for fire prevention	local/national requirements for fire prevention e.g. definition of resistance classes of building parts must be fulfilled	
1.5.9	criteria for energy efficiency of domestic equipment	criteria for energy efficiency of lighting, low energy domestic products, heating, cooling, ventilation	

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8.1.4.6 Technical facilities and services

1.6 Technical facilities and services			
	topic / subtopic	benchmark	variation / tolerance
1.6.1	type of energy source in the building	use of local, sustainable and renewable energy. central / district heating	energy source of central / district heating should include a growing percentage of renewable energies
a)	type of heating system within the building	energy efficiency of heating system.	if e.g. geothermal energy is used, energy should be distributed through activated slabs or walls
b)	type of heating generators	energy efficiency of heating generator. heat pump, wood pellet, solar energy (for hot water)	heat pump based on renewable energy (e.g. geothermal)
1.6.3	type of cooling	energy efficiency of cooling system , mechanical cooling systems in residential buildings should be avoided	passive cooling systems are welcome (e.g. thermally activated slabs, night cooling through natural ventilation). external solar shading should be implemented to avoid over-heating in hot periods
1.6.4	type of ventilation system	energy efficiency of ventilation systems and use of heat exchanger mechanical ventilation system with heat recovery	maybe different winter/summer
1.6.5	requirements for maintenance and cleaning of these systems	regular maintenance to guarantee low operation cost and continuous (energy) efficiency of any kind of installation. easy way to clean and maintain the systems	
1.6.6	requirements for water supply and domestic sewage	low water consumption in householdshoulkd be achieved	
1.6.9	part of renewable energy	rising the percentage of renewable energy and lowering the general consumption of energy in dwellings. 20% min	
1.6.13	requirements for energy efficiency of technical equipment	use of energy efficient products. Energy efficiency requirements for fans, pumps, etc. energy efficiency of any technical equipment must be defined	as a minimum, the energy consumption of any given technical component must be part of the calculation of the buildings' overall consumption

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8.1.4.7 Definition of quality standards

1.7 Definition of quality standards			
	topic / subtopic	benchmark	variation / tolerance
1.7.1	"Energy Performing Certificates" applicable to the building	energy certificates Developing a European or international energy performing certificate for comparable results	Longlife Performance Pass is to be developed
1.7.2	"Green Building Certificate" applicable to the building	see all other points where standards of Green building certificates are mentioned Developing a European or international green building certificate for comparable results	Longlife Performance Pass is to be developed
1.7.4	following up / monitoring procedure for energetic performance of the building	follow-up procedures or quality control procedures for the energy performance of buildings and systems monitoring procedure should be defined in order to verify and maintain calculated values for energy performance	Longlife Performance Pass is to be developed

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8.1.4.8 Quality of process and integration of sustainable aspects

1.8 Quality of process and integration of sustainable aspects			
	topic / subtopic	benchmark	variation / tolerance
1.8.1	sustainability as part of the preparation and planning of the project	integrated planning as a base of design process should cover the whole lifecycle of building from the planing phase to the dismantling phase	integrated planning
1.8.3	sustainability as part of the construction process and / or define quality assurance of the execution	supervision based on sustainable criteria of construction 1. Low-waste construction site 2. Low-noise construction site 3. Low-dust construction site 4. Environmental protection at the construction site	supervision

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8.1.4.9 Quality of site

1.9 Quality of site			
	topic / subtopic	benchmark	variation / tolerance
1.9.1	risks or distinctive relations in the micro environment of the building (Climate, neighbourhood, …)	Considering the characteristics of the site on the urban and the quarter level like climate, topography, neighbourhood, transport connection The Longlife building will be developed without a spezific site.	
1.9.2	image and condition of site and quarters		
1.9.3	transport connection		
1.9.5	criteria to describe the quality of urban design context and site	Part of the certification process of the new building should be the local environment as a site factor. Landscape design (100% permeable area, density, floor : footprint - ratio >=3,5:1), ecological value and biological habitat (number of existing species), public transport (distance and number of rides per day), amenities (distance and number of amenities), site selection (use of previously developped or contaminated land)	
1.9.6	playgrounds	playground within the visual field of the bigger apartments should be part of outdoor/landscape design. playing facilities in the vicinity of apartment buildings contribute to life quality of families with small children as well their security.	playgrounds may be common elements in the close neighbourhood

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8.1.5.1 EnEV Standards

Aspect	**Building element/System**	**Referenceperformance / Value(unit)**	
I 01	Exterior wall, floor ceiling exposed to the outdoor condition	Transmission coefficient	$U = 0{,}28\ W/(m^2 \cdot K)$
I 02	Exterior wall exposed to the ground, baseplate, walls and ceilings to unheated spaces (except the spaces in I 01)	Transmission coefficient	$U = 0{,}35\ W/(m^2 \cdot K)$
I 03	Roof, top floor ceiling, the partition wall between the pitched roof and the floor in front of the eaves	Transmission coefficient	$U = 0{,}20\ W/(m^2 \cdot K)$
I 04	Window, Glass doors	Transmission coefficient	$U_w = 1{,}30\ W/(m^2 \cdot K)$
		Total energy transmittance of glazing	$g_{\perp} = 0{,}60$
I 05	Roof window	Transmission coefficient	$U_w = 1{,}40\ W/(m^2 \cdot K)$
		Total energy transmittance of glazing	$g_{\perp} = 0{,}60$

8.1.5.1 EnEV Standards

Aspect	Building element/System	Referenceperformance / Value(unit)	
I 06	dome light	Transmission coefficient	Uw = 2,70 W/(m²·K)
		Total energy transmittance of glazing	$g_{\perp}$ = 0,64
I 07	external doors	Transmission coefficient	U = 1,80 W/(m²·K)
II	Components onto I.01 to I.07	Thermal bridges addition	ΔU_{WB} = 0,05 W/(m²·K)
III	Airtightness of building envelope	rated value n50	Calculation according to • DIN V 4108-6 : 2003-06: with leak test • DIN V 18599-2 : 2007-02: onto category I

8.1.5.1 EnEV Standards

Aspect	**Building element/System**	**Referenceperformance / Value(unit)**
IV	Sun protection device	no requirement
V	Heating system	• Heat produced by condensing boilers (improved), heating oil (EL), List: a. Buildings, up to 2 residential units within the thermal envelope b. Buildings, with more than 2 residential units outside the thermal envelope
		• Design temperature 55/45 ° C, centralized distribution system within the heat transfer encirclement area, inside lines and assigned pipeline, pump according to demand to supply(regulated, constant Δp), hydraulically balanced piping, insulation of piping
		• Heat transfer with not covered heating surfaces, normal arrangement along the external wall, thermostatic valves with proportional range 1 K

8.1.5.1 EnEV Standards

Aspect	Building element/System	Referenceperformance / Value(unit)
VI	Plant for water heating	• central water heating
		• common water heating with heating unit according to aspect V
		• Solar system (combined system with flat plate) according to the requirements of DIN V 4701-10 : 2003-08 oder DIN V 18599-5 : 2007-02
		• storage, be heated indirectly (vertical), the same setting like heat generators, design according to DIN V 4701-10 : 2003-08 oder DIN V 18599-5 : 2007-02 als a.small solar system, A_N < 500 m² (bivalenter Solar-storage) b. latge solar system, A_N > 500 m²
		• Distribution within the heat transfer encirclement area, inner legs pipelines, common installationswall, thermal insulation of pipelines, with a circulation pump according to demand to supply(regulated, constant Δp)
VII	cooling	no requirement
VIII	ventilation	central air exhaust system, with controlled DC fan by demand

A_N Building usable area

8.1.5.1 EnEV Standards

Aspect	**Building type**		**Maximum value of the specific transmission heat loss**
I	Detached Residential	$A_N < 350\ m^2$	$H'_T = 0{,}40\ W/(m^2 \cdot K)$
		$A_N > 350\ m^2$	$H'_T = 0{,}50\ W/(m^2 \cdot K)$
II	semi-detached residential buildings		$H'_T = 0{,}45\ W/(m^2 \cdot K)$
III	other type		$H'_T = 0{,}65\ W/(m^2 \cdot K)$

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Technology / new material	**characters**								
Heating Equipment	**Advantages**					**Disadvanteges**			
Biomass	renewable energy source	eco-friendly				depend on site situation	released CO2	not applicable in urban context	
Solar energy	renewable energy	free of charge	eco-friendly	need no fuel	produces no waste or pollution	expensiv to install	depond on the climate conditions		
HP (Heat pump)	Low cost air-conditioning	high eco-heating	eco-friendly	do not depend on energy preice	low demand of storm	lifetime 14-15 years	produces not high temperatur water	depend on the the site situation	needed additional system to function properly
Distribution	**Advantages**					**Disadvantages**			
Floor (Wall) Heating	lower temperature supply water	more radiant heat	feel more pleasant	dry floor especially in kitchen, bathroom	hygienocal	slow response time	especially where the pipe / cable is embedded in a solid floor		

8.1.5.2 Comparision of new Technology / new material

Technology / new material	**characters**								
Heat-Exchanger (Water)	energy saving	recovering heat				in fact it is sub system to recover heat			
other Techlogy / Material	**Advantages**					**Disadvantages**			
Low-E Glass	Low- E is a new type of glass to reduce the transmission of heat	the heat load of building will reduced approximatley by 15 %	reduce cooling load	reduce the storm need for lighting		relative expensiv	Not much experienced technology		
Heat-Exchanger (Air)	energy saving								
LED-light viagialla.ch / Project HPZ /LED-light	with the exhaust air duct to prevent the room from being warmed up	lower the cooling load	do not radiate into the room	reduce the construction depth of the light fitting	energy saving with the heat-exchanger (air)	relative expensiv	not much experienced technology		

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1.	Heating source/technology	Advantages							Disadvantages					
		availability	ecological	economical	energy efficiency	primary energy factor*	political	inicial investment	availability	ecological	economical	energy efficiency	political	inicial investment
1.1	**Biomass**		eco-friendly,renewable energy source	small price for energy source		fp= 0,2	finacnial support in Germany	Low	Not that much applicable in the Urban arae					
	wood stove (one unit/ one dwelling)	traditional, everywhere	renewable energy	small price for energy source		fp= 0,2	finacnial support in Germany	Low		Destroying the Forest				
	Wood pallet block heating (one settlement): combined heat and power plant		renewable energy	small price for energy source	very efficient; can produce both heat and electricity	fp= 0,0	finacnial support in Germany		only within new big settlements, organisation			depends on length and quality of distribution system		high cost
	Wood pallet block heating plant (one settlement):		renewable energy	small price for energy source	efficient	fp= 0,1						depends on length and quality of distribution system		

1.	Heating source/technology	Advantages							Disadvantages					
		availability	ecological	economical	energy efficiency	primary energy factor*	political	inicial investment	availability	ecological	economical	energy efficiency	political	inicial investment
1.2	**Solar energy**		renewable energy	free of charge,	need no fuel	fp= 0,0	finacnial support in Germany		Depend on climatic conditions					expensiv to install
	passive solar energy (solar gains)		renewable energy	free of charge	proportion of solar gains and heat losses through windows	fp= 0,0			Deponde on the clomatic conditions				no financial support for higher building costs	high costs for windows and vent. with heat exchange
	Photovoltaic (PV)		renewable energy	free of charge		fp= 0,0	financial support in Germany (pay off after 10 years)		Depend on climatic conditions			additional heating system required		high
	Solarthermal		renewable energy	free of charge		fp= 0,0	financial support in Germany (pay off after 10 years)		Depend on climatic conditions			additional heating system required, floor heating system requiered		high
	PVT hybride		renewable energy	free of charge		fp= 0,0	financial support in Germany		Depend on climatic conditions					high

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1.	Heating source/technology	Advantages							Disadvantages					
		availability	ecological	economical	energy efficiency	primary energy factor*	political	inicial investment	availability	ecological	economical	energy efficiency	political	inicial investment
1.3	**heat pump (air/ soil/groundwater)**	air, water, soil are always available	high eco-heating, ecofriendly	do not depend on energy price	low demand of electricity	electricity fp=3,0 (electricity mix)	financial support in Germany		depend on the the site situation		lifetime 14 - 15 years, high maintenance costs	combination with low temperature heating system (floor heating)		high
1.4	**Fossil fuels**	Available , at the moment common energy				fp=1,1 - 1,2		Low	depending on market and political situation	not Enviromental friendly	rising energy prices	high primary energy factor	no support	
	Gasboiler	available technology			relatively high energy efficiency	fp=1,1		Low	depending on gas distribution	not Envirometal friendly	depending on gas prices	high primary energy factor	no support	
	Oil stove	available technology			relatively high energy efficiency	fp=1,1		Low	depending on market	not Enviromental friendly	depending on oil prices	high primary energy factor	no support	
	electric boiler/ electric heater	available technology				fp=3,0		Low			high performance costs	no efficiency at all	no support	

2.	Distribution	Advantages							Disadvantages					
		availability	**ecological**	**economical**	**energy efficiency**	**primary energy factor***	**political**	**inicial investment**	**availability**	**ecological**	**economical**	**energy efficiency**	**political**	**inicial investment**
	Floor/ Wall Heating		hygienocal, feels more pleasant		radiant heat, lower water temperature	-	-		slow response time		high maintenacne costs/ repair costs	-	-	higher initial price because of higher planning and
	hot water radiator	standard solution		low maintenance / repairing costs		-	-	Low				-	-	
	Heat-Exchanger (Water)			lower operation costs	hign efficiency, energy saving	-	-		needs more place			-	-	additional cost
	Warm water storage	standard solution		lower operation costs	hign efficiency, energy saving	-	-		needs more place			-	-	higher initial price
	pipe insulation			cost saving	energy saving	-	-					-	-	higher initial price

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3.	ventilation	Advantages							Disadvantages					
		availability	**ecological**	**economical**	**energy efficiency**	**primary energy factor***	**political**	**inicial investment**	**availability**	**ecological**	**economical**	**energy efficiency**	**political**	**inicial investment**
	natural ventilation			no extra costs			-	no extra inicial price	Depond on climate conditions			high energy ventilation losses	-	
	mechanical ventilation	not depond on climate conditon	less household smells			fp=3,0 (electricity mix)	-					consum electricity	-	higher inicial price
	Heat-Exchanger (Air)			less energy costs	energy saving (low ventilation losses)	fp=3,0 (electricity mix)	-						-	higher inicial price
	air conditioning		best comfort condition			fp=3,0 (electricity mix)				higher heat island effect	high energy costs	high energy need	-	high initial price

4.	lighting	Advantages							Disadvantages					
		availability	ecological	economical	energy efficiency	primary energy factor*	political	inicial investment	availability	ecological	economical	energy efficiency	political	inicial investment
	natural lighting			cheap	no energy consumption	-	-					overheating in summer	-	-
	sun protection outside			lower energy costs in summer	lowers energy consumption for cooling	-	-						-	additional inicial costs
	energy efficient lamp			longer life duration than standard lamp	less internal heat gains, less energy consumption	fp=3,0	mandatory in Europe			not recycable, toxic wasrte			-	additional inicial costs
	LED light			lower energy costs than energy efficient lamp	lower the cooling load, no radiation in the room	fp=3,0	-			not recycable, toxic wasrte			-	additional costs

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8.1.5.3 Analysis of available technolotgies

5.	Windows (material)	Advantages							Disadvantages					
		availability	**ecological**	**economical**	**energy efficiency**	**u-value**	**political**	**inicial investment**	**availability**	**ecological**	**economical**	**energy efficiency**	**political**	**inicial investment**
	triple glazing			lower energy costs	little energy saving	~ 0,8 W/m²K								high costs
	double glazing		less material used			1,0 W/m²K								
	Low- Emissivity Glass			less heating energy needed	less heat gains by reducing incoming light spectrum				not very common	neutral white light inside the building				high price

* According to table C.4.1 of DIN 4701 -10

8.1.6 Out Look and Conclusion

8.1.6.1 Proposal for the regulatory criteria for low energy residential buildings

It should be decided of the amount of normative annual energy consumption, after making analysis of normative regulations of different countries and experimental designs of low energy buildings. Analysis of normative regulations of European countries reveals that, there are only 7 countries where there are normative regulations of low energy buildings: Austria, Czech Republic, Denmark, Finland, France, Germany and United Kingdom. Normative regulations of these countries are shown in Table 26.

Table 26. Normative energy consumption per year regulations of low energy buildings

Country	Annual normative energy consumption kWh/m2 (heating, air conditioning, hot water production, other domestic devices)	Notes
Austria	60 - 40	Bigger value is in private residential sector
Czech Republic	51 - 97	C class
Denmark	35	Without consumption for lightening and domestic devices. Project of normative regulation
Finland		At the moment energy consumption is normalized
France	40 -45	Depending on climate (location). With lightening needs, without needs for domestic devices.
Germany	40 - 60	
United Kingdom	Planned value from 2013- close to passive building value	At the moment building regulations are not compulsory

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It should be mentioned, that European Community has common methodology of evaluating [*ErP Directive 2009/125/E*], and still there are difficulties in result comparison, because of national specificity. The reasons of differences are:

- Internal or external measures evaluating heated area;
- Variations of inner heat additions;
- Differences in parameters of comfort conditions;
- Inclusion of unheated areas in the calculations;
- Differences of climate conditions.
-

Influence of climate conditions based on passive building built in Lithuania is shown in Table 27.

Table 27. Energy consumption of passive building in different climate conditions*)

Country	City	Annual energy consumption for heating, kWh/m2
Germany	Hanover	11.2
Austria	Salzburg	7.4
Switzerland	Bern	8.4
Denmark	Copenhagen	10.4
Ireland	Dublin	3.9
Poland	Warsaw	14.5
Finland	Helsinki	24.3
Lithuania	Vilnius	15

*) data of Kaunas University of Technology Institute of Architecture and Building Construction

Passive one household residential house, in Vilnius (Lithuania) climate conditions, was designed evaluating that annual energy consumption is 15 kWh/m^2. Other data: building gross area - 194.9 m^2, heat transfer coefficient – walls- 0.1 W/m^2 K, roof – 0,07 W/m^2 K; windows – from 0.73 to 0.83 W/m^2K; energy consumption – 107 kWh/m^2 per year; tightness, if there is 50 Pa pressure difference, – 0.4 h^{-1}. Table 2 data reveals, that climate conditions influence is big and differences in energy consumption for heating are radical: varies from 3.9 to 24.3 kWh/m^2 per year. It means that, if energy consumption of energy efficient buildings will be regulated, in different European countries these buildings will be designed using different thermodynamically parameters or different engineering solutions will be used to compensate the heat loss difference because of climate conditions.

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The results of calculations shown in Table 25 presents in that for the operation time the total annual energy demand is about 42 kWh/m^2. This result correlates well with regulatory values of the energy effective building in European countries shown in Table 26.

It seems that the two suggested normative regulatory values for the design of energy efficient building must be enough. It would be valuable to find relations between the two suggested parameters.

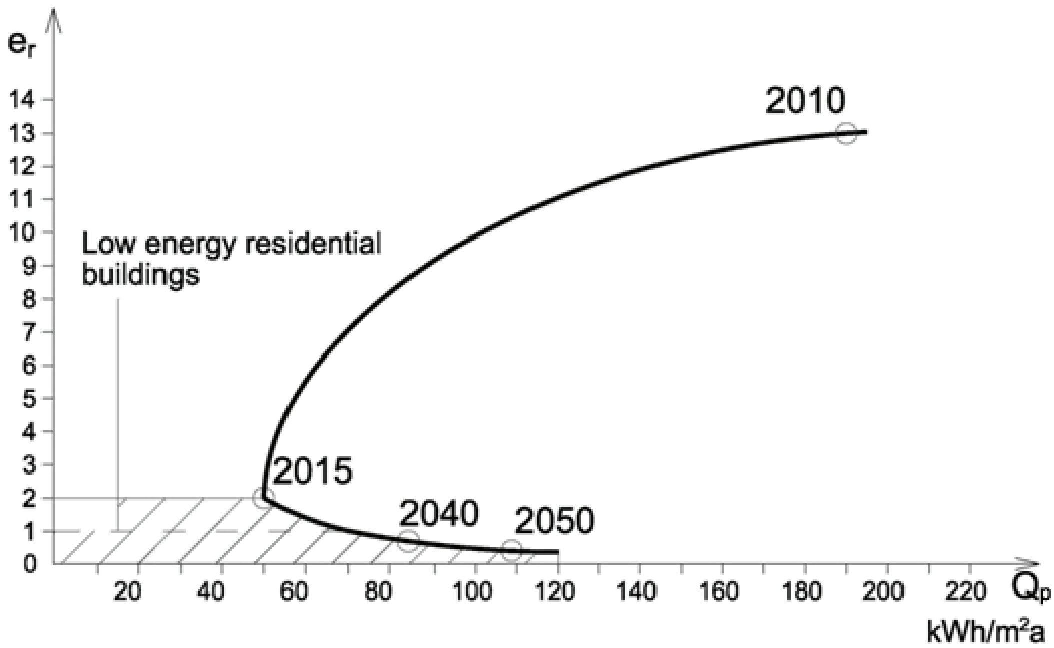

Fig. 11. Hypothetic curve representing annual energy stock ratio $\mathbf{e_r}$ and normative annual energy consumption of residential buildings $\mathbf{Q_p}$

The result of such our attempt is shown in Figure 11, which depicts a hypothetical link between these parameters. Year 2010 reflect the current average situation of European Union countries in the residential sector. For the proposed energy efficient building design in 2015 the regulatory energy stock ratio $\mathbf{e_r}$ = 2 and the overall annual energy demand 50 kWh/m^2 value is suggested. Fig. 11 reveals that there is a field (Fig. 11, drawn in lines) where in the intersection of the two parameters the building falls into the category of low energy. Extension of the curve after the year 2015 in the growth direction of total energy consumption is disputable. It is clear, that effective consumption of energy resources will be topical issue, though total energy saving in the context of increasing renewable energy resources consumption will not be so important. On the other hand societal development reveals inescapable – increasing of energy consumption in the future. That is why hypothetical draft lines of suggested parameters shown in Fig. 11 are yet to be researched.

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8.1.6.2 Conclusions

- Global energy situation forces to increase consumption of renewable energy resources. Normative **e_r** coefficient value of fossil fuel and renewable energy resources for design of low energy residential building should be used and normative regulations of this coefficient should be made.
- In order to save energy resources it is worth to pay attention on their demand for the production, treatment and recycling of building materials as well as their potential to save energy during the operational time of a building.
- Total energy consumption of the house built in year 1973 is more than 2 times larger than houses built post 2000. The majority of losses are determined by insufficient characteristics of external walls, windows and abundance of running thermal bridges.
- Energy losses of new-built houses are mostly influenced by windowing systems and protruded elements of the facades. The mentioned protruded elements of the facades lead to higher energy loss than incompactness of a house.
- Performed comparable calculations have pointed the ability and potential of architectural, planning and structure solutions to influence the saving of energy resources.
- Life cycle low energy residential building should be valued by energy stock ratio **e_r** coefficient value (taking into account periods of resources development, production of elements and structures, construction, operational period, demolition and recycling).
- Calculations made by the pilot project showed that for the design of low energy residential buildings, normative energy stock ratio **e_r** coefficient value should be used and normative regulations of this coefficient should be made. The proposed regulatory criteria **e_r** = 2 value for the year 2015 is suggested.
- From 2015, normative annual total energy consumption of the low energy residential building must be no larger than 50 kWh/m^2 of the gross area. Still later, if the energy stock ratio value have less than 2 for, for the maintenance period of the building, it is obvious that total energy consumption can be more than 50 kWh/m^2.
- It would be valuable to make functional bond of both above-mentioned parameters, though special scientific research is needed.

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8.2 Method of planning, permit and tendering procedures - Guideline for administrative, legal and tendering procedures

8.2.1 Overview

To facilitate the cooperation between the participants the lead partner, Roskilde Municipality developed a questionnaire in the form of a wish list for the 6 main head-lines under this thematic area: Planning, Building requirements, Tendering, Supervision, Inspection and Incentives. The wish list developed by Roskilde could then be commented, added to and marked as something already the present situation or a wish for the future.

Answers were so far received from Denmark, Germany, Poland and Lithuania. The complete wish list with answers, comments, and marks is presented at the end of the chapter. Some of the main findings are presented under the appropriate headlines below.

Germany pointed out that for Germany many of the wishes are already a reality or in intensive discussion (e.g. tax support of renewable energy systems). So, on this basis it is argued that first the other countries need to reach the same high standards (laws, technology, supervision, monitoring, tendering etc.), Also Germany added one point to the list, which can be considered as a wise advice useful for all countries: “check the effect of the existing measures to be able to alter the course when required”.

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8.2.2 Planning

The wish list presented a number of requirements that either could be or had already been implemented in the planning documents. They were requirements:

- of Biofactor in urban areas by vegetation on buildings or plantation in streets and recreational areas.
- for detention of rainwater in urban areas
- for increased outlays for reforestation to capture CO_2 and reduce climate impacts.
- for reducing CO_2 from private transport by reduced parking possibilities and environmental zoning.

- for planning of a certain amount of wind turbines or produced energy based on wind.
- for high building density in the cities together with restrictions on private cars in favor of public transport.

The general impression (except for Germany) from the answers to the questionnaire was that these requirements were not implemented presently, but could be reasonable wishes for the future. In particular requirements for reforestation and rainwater detention were already implemented in Poland.

8.2.3 Building requirements

Also a number of requirements specifically for the buildings were presented to the participants for comments and identification as already implemented or something that could be wished for the future. They were:

- Requirements for energy saving for heating, lighting, cooling, etc. in new buildings.
- Requirements for increased energy savings in existing buildings, implemented over a period of years.
- Requirements on increased energy savings in building components or for the whole building.
- Requirements for total economic design, total CO_2 load design or integrated energy design
- Restrict the use of PV or Heat-pump to achieve Low Energy Class status

- Reduce opportunities for exempting on district heating
- Differentiated requirements for heat loss frame, depending on supply systems (by increased requirements on heat loss in areas heated with gas or oil).
- Requirements on a buildings total CO_2 load (from heating).
- Requirements for energy consumption in air conditioning / refrigeration in new and existing buildings.
- Requirements for increased heat recovery or total energy consumption in ventilation systems.
- Requirements for local production of energy for heating and domestic water in buildings, for instance 50% of the buildings own consumption.
- Requirements for use of rainwater in the building.

Most of these requirements had not been implemented in most of the countries and they were generally accepted as reasonable wishes for implementation in the future.

8.2.4 Tender

For the tendering procedure the Danish team leader had only presented one idea for the “wish list”:

- Requirements in tender of public property for economic life calculations, total CO_2 load-design or integrated energy design.

Denmark and Lithuania identified this as a reasonable requirement to include in the tendering.

8.2.5 Supervision

Two issues concerning the possibility to supervise a project were listed:

- Supervision of the project design to avoid the use of energy consuming technologies.
- Supervision of the execution of construction, especially sustainable components, by blower-door tests, thermographs etc.

Supervision is considered as very important to guarantee an estimated energy performance. All countries agree that this should be stressed in the guidelines.

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8.2.6 Inspection

Inspection can be seen as a follow up measure to the supervision and like that a control mechanism. Three reviews or checks were identified:

- Periodic follow-up review of compliance of requirements to the building and technical facilities and alterations on building and technologies etc.
- Requirements for independent evidence of a construction project energy standard with energy labelling.
- Check the effect of the existing measures to be able to alter the course when required

The first and last were agreed to belong to the wish list for future implementation, whereas the second in a sense is already implemented by the implementation of the EPBD – energy labelling scheme in each country.

8.2.7 Incentives

Economical incentives in the form of taxes or governmental subsidies can be important tools to encourage energy efficient, sustainable construction. 7 measures were identified:

- Tariffs on district heating that reflect and motivate low-energy construction and energy improvements in existing buildings.
- New tax structure on non-CO_2-neutral (fossil) fuels, which motivates to energy savings.
- Tax structure on electricity, which allows for timed power consumption to heat storage when abundant (CO_2-neutral (wind-) based) electricity (Smart grid).
- Subsidy for conversion of CO_2 increasing heating (by oil or gas) to district heating or sustainable energy plants.
- Grants to promote renewable energy solutions such as solar cells or windmills (kWh-support).
- Tariff structure for biogas-based electricity and gas, so it promotes initiatives to establish biogas plants.
- Compensation for increased costs due to increased requirements to reduce energy consumption for heating, lighting, cooling, etc. in new and existing (public) housing.

The general picture is that some of these incentives do exist in the countries – but only to a certain extent and that all could need improvements. The incentives to motivate CO_2-reductions can be ordered in groups: 1. Tariff/price structure, 2. Tax structure, 3. Subsidies and grants.

8.2.8 Conclusions

The wish list and the answers and comments received from the participants show agreement as too which measures could be worked into a guideline for administrative, legal and tendering procedures including a framework to harmonise administrative and legal procedures to be used by administrations and planners.

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8.2.9.1 Tendering and contract law

8.2.9.1 Tendering and contract law															
	Germany			Denmark			Lithuania			Poland			Russia		
Wish list	Proposal/Comment			Proposal/Comment			Proposal/Comment			Proposal/Comment			Proposal/Comment		
		wish	actual possibility		wish	actual possibility		wish	actual possibility		wish	actual possibility		wish	actual possibility
Requirements in tender of public property for economic life calculations, total CO2 load-design or integrated energy design.				No requirements	x			x		No requirements.					
	Check the effect of the existing measures to be able to alter the course when required	x		Check the effect of the existing measures to be able to alter the course when required	x										

8.2.9.2 Supervision rules and procedures															
	Germany			Denmark			Lithuania			Poland			Russia		
Wish list	Proposal/Comment			Proposal/Comment			Proposal/Comment			Proposal/Comment			Proposal/Comment		
		wish	actual possiblity		wish	actual possiblity		wish	actual possiblity		wish	actual possiblity			actual possiblity
Supervision of the projectdesign to avoid energy consuming technologies.				No requirements	x			x		The supervision is not required.	X				
Supervision of the execution of construction, especially sustainable components, by blowerdoortest, thermography etc.				The municipalities have the possibility to require a blower door test to check the airtightness of buildings after construction.	x		The supervision is aplied to the implementation of the project by technical supervisor of construction of a construction works. If sustainable components are mentioned within the project, these are being supervised.	x	x	The supervision is not required.	?				
	Check the effect of the existing measures to be able to alter the course when required	x													

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8.2.9.3 Inspection system

8.2.9.3 Inspection system															
	Germany			**Denmark**			**Lithuania**			**Poland**			**Russia**		
Wish list	**Proposal/ Comment**			**Proposal/Comment**			**Proposal/ Comment**			**Proposal/Comment**			**Proposal/ Comment**		
		wish	**actual possiblity**		**wish**	**actual possiblity**		**wish**	**actual possiblity**		**wish**	**actual possiblity**		**wish**	**actual possiblity**
Periodic follow-up review of compliance of requirements to the building and technical facilities and alterations on buliding and technics etc.				Not presently required and/or conducted.	x		The institution performing the construction works gives the warranty (5 years), no other specific follow-up reviews are required	x		The compliance to the existing requirements is determined during the design process and during subsequent alterations of an existing building.					
Requirements for independent evidence of a construction project energy standard with energy labeling.			x	It is obligatory for every new building to have an Enegy performance certificate		x	It is obligatory for every new building to have an Enegy performance certificate		x	Building energy performance certificate (pot. certified energy) - valid from 1 January 2009 as the implementation of the Directives of the European Parliament and the Council of Europe of 16 December 2002 concerning the quality of buildings. The certificate will be required for completion of construction of the building * new * sales * rental.		x			
Check the effect of the existing measures to be able to alter the course when required		x													

8.2.9.4 Economic aspects for supporting sustainabilty = economical incentives

8.2.9.4 Economic aspects for supporting sustainabilty = economical incentives

	Germany			Denmark			Lithuania			Poland			Russia		
Wish list	Proposal/Comment			Proposal/Comment			Proposal/Comment			Proposal/Comment			Proposal/ Comment		
		wish	actual possiblity		wish	actual possiblity		wish	actual possiblity		wish	actual possiblity		wish	actual possiblity
Tariffs on district heating that reflect and motivate low-energy construction and energy improvements in existing buildings.			x	Currently district heating tarif structure in many cases demotivates introduction of low-energy buildings	x		If the payback is 10 years in lenght and heat prices increase annually .	x		The question is not clear. Does the question concern high energy prices in order to motivate people to construct low-energy buildings?					

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8.2.9.4 Economic aspects for supporting sustainabilty = economical incentives

8.2.9.4 Economic aspects for supporting sustainabilty = economical incentives															
	Germany			Denmark			Lithuania			Poland			Russia		
Wish list	Proposal/Comment			Proposal/Comment			Proposal/Comment			Proposal/Comment			Proposal/ Comment		
		wish	actual possiblity		wish	actual possiblity		wish	actual possiblity		wish	actual possiblity		wish	actual possiblity
New tax structure on non-CO2-neutral (fossil) fuels, which motivates to energy savings.			x	Presently discussed	x		Maybe new tax structure for both and the providers and inhabitants	x		In spite of the fact it is a good idea, in Poland 80% of energy for heating is obtained from fossil fuels. Thus, the issue is complex and it should be discussed. The energy prices in Poland, including the district heating prices, are generally high, what should encourage investors to use low-energy solutions. However in Poland we still have economical problems. Not so many people want to spend more money during initial building for energy saving.					

8.2.9.4 Economic aspects for supporting sustainabilty = economical incentives															
	Germany			Denmark			Lithuania			Poland			Russia		
Wish list	Proposal/Comment			Proposal/Comment			Proposal/Comment			Proposal/Comment			Proposal/ Comment		
		wish	actual possiblity		wish	actual possiblity		wish	actual possiblity		wish	actual possiblity		wish	actual possiblity
Tax structure on electricity, which allows for timed power consumption to heat storage when abundant (CO2-neutral (wind-) based) electricity (Smart grid).			x	Presently discussed	x		No specific requirements	x		Please, explain the question more precisely.					
Subsidy for conversion of CO2 increasing heating (by oil or gas) to district heating or sustainable energiplants.			x	A subsidy for conversion of CO2 increasing heating (by oil or gas) to district heating or sustainable energiplants exist to some degree in Denmark.	x	x	No specific requirements	x		There is a subsidy system (partially provided by EU) which supports the conversion of the old heating system into the more suistainable one. Currently in Poland oil, gas and district heating are considered as sustainable energy sources.		X			

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8.2.9.4 Economic aspects for supporting sustainabilty = economical incentives															
	Germany			Denmark			Lithuania			Poland			Russia		
Wish list	Proposal/Comment			Proposal/Comment			Proposal/Comment			Proposal/Comment			Proposal/ Comment		
		wish	actual possiblity		wish	actual possiblity		wish	actual possiblity		wish	actual possiblity		wish	actual possiblity
Grants to promote renewable energy solutions such as solar cells or windmills (kWh-support).			x	Exist in the form of fixed prices for electricity produced and for small PV-systems the owner can let the meter "run backwards" This subsidy could be further developed.	x	x	The modernisation program gives opportunity to install salternative energy sources on modernised buildings/ EU funds are available	x	x	There is a subsidy system (partially provided by EU) which supports the conversion of the old heating system into the more suistainable one. Currently in Poland oil, gas and district heating are considered as sustainable energy sources. I guess that few people would like to have a large windmills before the house and in order to determine the profitability of investment need to have a much more accurate data about the wind in your location and other economic data.	X				

8.2.9.4 Economic aspects for supporting sustainabilty = economical incentives															
	Germany			Denmark			Lithuania			Poland			Russia		
Wish list	Proposal/Comment			Proposal/Comment			Proposal/Comment			Proposal/Comment			Proposal/ Comment		
		wish	actual possiblity		wish	actual possiblity		wish	actual possiblity		wish	actual possiblity		wish	actual possiblity
Tariff structure for biogas-based electricity and gas, so it promotes initiatives to establish biogas plants.			x	As for wind and PV the tariff structure partly supports this, but there is place for improvements.	x	x	No specific requirements	x		No such tariff structure.	X				
Compensation for increased costs due to increased requirements to reduce energy consumption for heating, lighting, cooling, etc. in new and existing (public) housing.			x	Does not exist at the moment.	x		No specific requirements	x		The question should raised for a discussion.					
	Check the effect of the existing measures to be able to alter the course when required	x			x										

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8.3 Economical and financial basis, industry and quality

8.3.1 Overview

The answers to our questionnaire were multifaceted and reflect again the variety between the different countries of the Baltic Sea Region. Nevertheless we can point out some common characteristics, especially concerning the construction parameters of the pilot project. The „Longlife“-Members of Team 3 consider appropriate a building with 4 storeys and 30-40 dwellings with following distribution:

- 2-room-appartment: about 50 m²
- 3-room-appartment: between 70 and 80 m²
- 4-room-appartment: about 85 and 120 m²

Mostly there is not the need for an elevator.

Whereas Denmark and Germany has legal regulations for the energy standard of new buildings, there are none in Lithuania and Poland. The concept of the „Passive House“ with the yearly primary energy demand of about 40 kWh/m² per year could be a common denominator. As far as we learned, besides Lithuania (and Russia) the partner countries have yet experiences with passive house construction. In all countries are no legal restrictions for maximum CO_2-emission.

With regard to the data of rent prices we have to differ between countries with a stable rent market (Denmark and Germany) and countries with a mainly property market (Lithuania and Poland). But an average value as a basis for the pilot project is as gross rent (incl. operating cost and heating) between 7 and 10 €/m² and as net rent between 7 and 8 €/m².

Maintenance costs are included in the net rent and the data for operating costs ranges from 0,4 €/m² (Lithuania) to 3,00 €/m² (Poland) monthly.

The prices for construction costs show an extraordinary variety between the different countries. While Denmark and Germany are calculating with about 2.500 €/m², Lithuania and Poland name about 500 €/m² of construction costs. The reasons for this amplitude can be among other things different wage levels as well as different prices for building materials and, if we take into account what is said before about the differences in the market structure, different requirements to the equipment.

The property share is between 49 and 482 €/m² but averages around 190 €/m².

No one of the participating countries consider savings or financial allocations to reserves. The payment will mainly be effected form existing liquidity.

STEP 1 to STEP 8: How to combine fixing the construction costs with Longlife-aspects?

	DK	GE	LT	PL	RU
1. Description of common characteristics of the pilot project	ONE pilot project				
2. Description of energy standard suitable for each country					
3. Result: max construction costs => max rent per m² (consider market price level)					
4. Calculating maintenance costs Nr. I and LCC: without extra Longlife-sustainability-aspects (CO_2 footprint of materials, longlasting materials etc.)					
5. Additional costs through Longlife-sustainability-aspects					
6. (Lower?) Maintenance costs Nr. II and (Lower?) LCC: with extra Longlife-sustainability-aspects (CO_2 footprint of materials, long lasting materials etc.)					
7. Needed/possible financial support (for Longlife-sustainability-aspects to assure market price per m² => see Nr. 3)					
8. Max. construction costs of Longlife-pilot-project including Longlife-sustainability-aspects					

Longlife-pilot project → standards harmonized to the requirements of each country

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8.3.2 economical and financial basis, industry and quality (Questionar Continuation)

3.10	**S T E P 1: Description of common characteristics of the pilot project**						
In order to achieve the goal of a comparable pilot project for each country we need a current fixed base for all countries (an equal/common "basis pilot prototype").							
	Question	**Denmark**	**Germany**	**Lithuania**	**Poland**	**Russia**	**Summary/Benchmarks**
	WP4 check list from our Workshop in Roskilde (23.-24.02.2009): - building with 3-4 storeys? - social housing - yes or no? - 8-16 (24-30) apartments? - size of each appartements? - Is an elevator needed?						
3.10.1	How many number of dwellings do you consider appropriate?	- 40-50 dwellings	- 8-16 respectively 24-30 dwellings	-building with 4 storeys; 34 flats in a dwelling	20-30 dwellings	- 12-16 dwellings	They consider **between 20 and 40** dwellings appropriate.
3.10.2	How many levels should the building have?	- 2-4 storeys	- building with 4 storeys - no social housing	-building with 4 storeys; possible social housing	- building with 4 storeys without elevator	- building with 4 storeys without elevator	The building should have **4 storeys**.
3.10.3	How many m² should each of dwellings have? (number of dwelling with m² and rooms including kitchen and bathroom)	- 2, 3 and 4 rooms - youth dwelling, family dwellings and senior dwellings - average size: 90 m²	Possible size of the dwellings: - 2 rooms: approx. 50-55 m² - 3 rooms: approx. 75-80 m² - 4 rooms: approx. 85-100 m² - for singles, families, single parent, couples without childrens, seniors	- 1 room -8 flats; - 2 room -18 flats; - 3 rooms-4 flats; - 4 rooms-4 flats. - Building without lift (elevator) - possible size of house about 1.900 m² - rooms: 1-room-flat -30 m²; - 2-rooms-lat -48 m2²; - 3-rooms-flat -88 m²; - 4-rooms-flat -120 m².	Possible size of the dwellings: - 2 rooms: approx. 46-50 m² - 3 rooms: approx. 55-70 m² - 4 rooms: approx. 75-90 m² One room must be 16 m² with individually kitchen and bathroom. In 4 rooms apartment it should be bathroom and individually toilet.	Possible size of the dwellings: - 1 rooms: approx. 40-50 m² - 2 rooms: approx. 50-55 m² - for singles, families, single parent, couples without childrens, seniors. One room must be 16 m² with individually kitchen and bathroom.	A **2-room**-flat should have about **50 m²**, a **3-room**-flat **between 70 and 80 m²** and a **4-room**-flat should have between **85 and 120 m².**

3.11	S T E P 2: Description of energy standard suitable for each county						
	The energy standard of the pilot project necessarily has to vary between the countries.						
	Question	**Denmark**	**Germany**	**Lithuania**	**Poland**	**Russia**	**Summary/Benchmarks**
3.11.1	What is the highest energy standard of the country for new buildings (by law or technical possibility) **in kWh/m² per year**?	- Energy Class 02 or 01 as target in areas with district heating close to cities - Passive House, where is no possibility for collective connection	First of all, measuring units for "energy efficiency" are: **a)** primary energy demand per year of the house for heating, hot water, airing and air condition **b)** heat insulation of the building envelope (insulation against loss of heat) **1) by law: EnEV 2009 (Energy Saving Ordinance 2009)** - the yearly primary energy demand has to be at most 85 % respectively 70 % of the than calculated "reference building" (concerning the m², shape of the building, window size, heating system etc. you calculate a so called "reference building" - concerning to this maximum energy demand of this "reference building" the investor than have to plan the building (choose high energy saving windows, insulation system etc.) **2) by technical possibility: Passive House** - A passive house provides a comfortable inside temperature without extra heating or air conditioning. - The yearly primary energy demand is about 40 kWh/m² pear year. The heating demand is max. 15 kWh/m² per year (NOT including hot water!).	1) by law: - Energy Law (LR Energetikos įstatymas) - Electricity Energy Law (Elektros energetikos įstatymas) - Natural Gas Law (LR Gamtinių dujų įstatymas) - Heat economy law (LR Šilumos ūkio įstatymas) - Lithuanian Republic Biofuels and biofuel oil law (LR Biokuro, biodegalų ir bioalyvų įstatymas) - Nuclear energy law (LR Branduolinės energijos įstatymas) 2) by Construction Technical Regulations: - „Essential requirements of the building. Energy saving and heat preservation“ - „Building materials and products of thermal-technical dimensions of project value“ - „Construction products. Conformity assessment and CE marking“ - „Energy Performance of Buildings. Certification of Energy Performance of Buildings“ - “Water charge, preparation of water. Main provisions” - “Sewer cleaners. Main provisions” - „Thermal technique of building elements“ - “Water-Supply and Waste Water Treatment. Building Services. Outdoor Engineering Networks” - “Heating, ventilation and air conditioning” - “Thermal Output of Building Heating System. Heat Demand in Heating”	In the case of a traditional building built in accordance with the applicable provisions of the value of energy demand ranges from 90 to 120 kWh / (m2/year).		The highest energy standard is **between 40 and 120 kWh/m²year**.

8.3.2 economical and financial basis, industry and quality (Questionar Continuation)

3.11	S T E P 2: Description of energy standard suitable for each county						
The energy standard of the pilot project necessarily has to vary between the countries.							
	Question	**Denmark**	**Germany**	**Lithuania**	**Poland**	**Russia**	**Summary/Benchmarks**
3.11.2	Short description of the chosen energy standard (energy standard with primary energy demand per year etc.) Please notice: **Primary energy demand** describes the energy, which is available by natural energy sources. The **yearly primary energy** demand indicates how much of the primary energy is used yearly for heating, ventilation and water heating.	- Low Energy Class 02: primary energy use of the buildings must be below 50+1600/A kWh/m² per year - Low Energy Class 01: primary energy use of the buildings must be below 35+1100/A kWh/m² per year	**Passiv house standard** - that means for the pilot project: The yearly primary energy demand is at maxium about 40 kWh/m² pear year. The heating demand is max. 15 kWh/m² per year.		**Passiv house standard** - that means for the pilot project: The yearly primary energy demand is at maxium about 40 kWh/m² pear year. The heating demand is max. 15 kWh/m² per year.		The energy standards are the **passive house** and **the low energy house** with a **yearly primary energy demand** between 40 and 50 kWh/m².
3.11.3	Are there any legal restrictions for maximum CO2-emission or general greenhouse gases?		There are no legal restrictions concerning CO_2 emission for housing projects.		There are no legal restrictions concerning CO_2 emission for housing projects.	In Russia, there is a normative document GOST R ISO 14064-1-2007 "greenhouse gases" which regulates the maximum emissions of CO2 and other greenhouse gases during the design.	There are **no** legal **restrictions** for maximum **CO_2-emission**.

8.3.2 economical and financial basis, industry and quality (Questionar Continuation)

3.12	S T E P 3: Maximum construction costs for the pilot project for each county						
	Considering different energy levels in each country and variation of equipement, the construction cost will be significantly different, too.						
	Question	**Denmark**	**Germany**	**Lithuania**	**Poland**	**Russia**	**Summary/Benchmarks**
3.12.1	What do you consider as maximum rent per m² (considering possible market price level) **a)** gross rent per m² (incl. operating costs and heating) **b)** net rent per m² (without operating costs and heating)	The rent should be seen as the resulting gross rent, i.e. housing rent inclusive cost of maintenance, operation and consumptions etc.	a) approx. 10 €/m² b) approx. 8 €/m² (according to current status for 2010)	rent is not popular in Lithuania.Usually people has the property as their own and can rent. Then the price depends on the location of the building in the city, year of construction (new construction 7 km out of center could be about 7€/m² -without operating costs and heating)	a) approx. 9 €/m² b) approx. 7,8 €/m² (according to current status for 2010 foreign currency)		The maximum **gross rent is between 7 and 10 €/m²** and the **net rent is between 7 and 8 €/m²**.
3.12.2	What do you consider as maximum maintenance/operating costs per m² nowadays realistic/usual (WITHOUT extra sustainability aspects)?	Maintenance costs is covered by the net rent and therefore no extra costs for the tenants : 23 €/m²/p.a - covering roof, facade (incl. windows etc) and tecnical installations.	operating costs: approx. 2,00 €/m² (monthly) maintenance costs: - should be covered by the net rent - no extra payment by the tenant - app. 4,68 €/m² (p.a.) in 2008 over the whole dwelling stock of PRO POTSDAM GmbH (without repair/overhaul) - for new building max. 3,00 €/m² (p.a.)	operating cost without heating costs: 0,4 €/m² (including administration, exploatation expenses, and etc)	operating costs: 2,00 €/m² (monthly) without extra peyment by the tenant. for new building max. 3,00 €/m² (p.a.)		The **maintenance costs** are **included in** the **rent** and the **operating costs** are **between 0,4 and 3 €/m² per month.**

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8.3.2 economical and financial basis, industry and quality (Questionar Continuation)

3.12	S T E P 3: Maximum construction costs for the pilot project for each county						
	Considering different energy levels in each country and variation of equipement, the construction cost will be significantly different, too.						
	Question	Denmark	Germany	Lithuania	Poland	Russia	Summary/Benchmarks
3.12.3	Taking the questions of 8.3.1 into consideration, how much do you estimate the **construction costs** per m² for the choosen standard? **a)** construction costs in € per m² **b)** property share (price for land) in € per m²	a) family dwellings: € 2.239 - € 2.784 b) Senior dwellings: € 2.703 - € 3.456 c) Youth dwellings: € 2.703 - € 3.274 (maximum amount per m² VAT - the span is given by the dependence of the geographic placement: province or capital area)	a) approx. 2.235 €/m² (living space) b) approx. 482 €/m² living space respectively approx. 190 €/m² plot area (see also exposé for the project Johannes-Lepsius-Str. in Potsdam)	In Lithuania we have Estimated construction price Comparative Economic Indicators. According these indicators, approx. price for 1 m³ of dwelling is 539 Lt = 156 €. If we are applying the higher quality requirements for the new building decoration, equipment and floor covering, we have to increase price applying coefficient 1,2.	a) approx. 489€/m² b) approx. 49 €/m² - 250 €/m² price depends on location (according to current status for 2010 foreign currency)		The **construction costs** are **between 489 and 2.235 €/m².** The **property share** is between 49 and 482 €/m² but averages around **190 €/m².**
3.12.4	To what extent do you consider savings or financial allocations to reserves (for example for renovations etc.)?	none, payment will be effected from existing liquidity or by new loans.	None, payment will be effected from existing liquidity according to business plan.	No reserves, only possible for small repairment works, but not for renovation. In this case owners of flats can agree about the amount of money monthly paid for reserves (they can vote for that).	None, payment will be effected from existing liquidity according to business plan.		There are **no savings, reserves or financial allocations** considered for e.g. renovations.
Notice:	*If we observe a building over a period of 30 years we realize that only approx. 18 % of the total costs belong to the construction costs, but approx. 82 % to the maintenance costs. (Werner Sodek, President of the DGNB, German Sustainable Building Council in "Handelsblatt", 01.05.2010)*						

8.3.2 Economical and financial basis, industry and quality (Benchmarks)

3.1	Demographic analysis of housing needs and the target group of population			
	topic / subtopic	Summary	Benchmarks	variation / tolerance
3.1.1	the rate of private-home ownership	Lithuania with 97,2% has the highest private ownership rate. In Denmark the private ownership rate is also remarkable high (97%), but only for detached houses. Germany shows the lowest ownership rate with about 41,6 %.	Allthough the private ownership rate is quite high in all countries, it is a need to figure out, if it is a downward or an upward tendency to private ownership to decide which kind of ownership should be considered in the next work packages.	
3.1.2	general statement about the residential buildings	Denmark differentiates between the amount of rooms of a dwelling: smaller dwellings are normally rented, while dwellings with 4 or more rooms are mostly private. This does not apply to Germany and Lithuania.	Multistorey buildings are represented in all participating countries. In WP5 it should be concentrated on multistorey buildings of 3-5 levels.	
3.1.3	statements of the demographic structure	In comparison to the other countries, Germany is most densely populated (twice as Denmark and four times as Lithuania). Denmark´s habitants demand the biggest living space per person. Allthough the population decreases in all countries, they strive to construct new buildings.	The discrepancy between population decrease and enhanced new building activities need to be considered in WP5.	
3.1.4	statements of the distribution of income	The level of income is significant different in the participating countries. The lowest approx. net income per month shows Lithuania, but compared with the other countries, the amount for rental costs of the net household income is the highest rate.	The amount in % for rental costs of the net household income should not exceed a certain level that has to be defined yet (e.g. 25%). To achieve this certain level it is necessary to consider on building costs, financing and promotion.	
3.1.5	regional distinctions or similarities concerning the climate	There are no significant differences in Denmark and Germany. In Lithuania there are regional distinctions for snow and wind effects.	No significant differences in Denmark and Germany. In Lithuania there are regional distinctions for snow and wind effects. Further consideration in wp5 should have regards for the different climatic conditions in the participating countries.	
3.1.6	Construction, maintenance and operation costs per m², m³	Construction costs are tendentially increasing in all participating countries.	It should be define an approx. building cost per m² for the pilot project, which for example can differ in each country for certain reasons. In addition to that new building technics should be considered or even developed within the project to work against this trend.	

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8.3.2 Economical and financial basis, industry and quality (Benchmarks)

3.2	**Sustainability aspects**			
	topic / subtopic	Summary	Benchmarks	variation / tolerance
3.2.1	financial support for the sustainable construction of residential buildings	Only in Germany it exists a financial support for Energy-Efficient Construction. (Energy saving) Modernisation is supported in Germany and in Lithuania.	Existing financial support models in Germany could be source material to develop promotional programms for all countries. It is figure out whether these programms can be nationally integrated or on EU-basis.	
3.2.2	capital allowances regarding sustainability building practice	Germany offers tax deductions. The other countries have no capital allowances.	We have to check if German regulations are applicable to the partner countries respectively to the EU.	

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8.3.2 Economical and financial basis, industry and quality (Benchmarks)

3.3	**Economical energy supply**			
	topic / subtopic	Summary	Benchmarks	variation / tolerance
3.3.1	the energy consumption per m^2	The energy consumption is differently high: Denmark has an annual average consumption of 120-150 kWh/m², Lithuania has a consumption of 96 to 429 kWh/m² and Germany on average 195 kWh/m².	The term "energy" has to be clearly defined (only heating?). Within the project a maximum requirement/m² and country has to be specified as an aim which should be achieved.	
3.3.2	the development of energy costs for private household (incl. TAX)	While the development of energy prices was quite stable in Denmark, prices rose remarkably in Germany (40% in 10 years) and in Lithuania (66% in 8 years).	Because of the rising prices it is necessary to save energy: on one hand by changing our consumer attitude and on the other hand by building houses with less energy requirement.	
3.3.3	the rate of CO_2 –emission of the used energy resources of residencial buildings		**For the prototype building only energy resources with least CO2-emission should be used. The highest aim of course should be to reduce energy consumption in general, in the best case by using renewable energy.**	

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8.3.2 Economical and financial basis, industry and quality (Benchmarks)

3.4	Evaluation of current maintenance and operating costs			
	topic / subtopic	Summary	Benchmarks	variation / tolerance
3.4.1	the operating costs	There seems to be no uniform definition of operating costs for the participating countries. The amount of operating costs mostly depends on consumer behaviour.	see. 3.4.3	
3.4.2	the statement of available performing benchmarks	Benchmarks only exist in Denmark and in Germany. In both countries we are just at the beginning of collecting data. Data which reach a back long time periode are not available.	Benchmark datas are suited very well for comparison in general. Due to the fact that in DK an LT no dataform for this discussed benchmarks exist by now, it might be considered to initiate/ to trigger an EU-Benchmark database for that, starting with Longlife participating countries.	
3.4.3	the bill of operating costs	The definition of operating costs is different in the participating countries. Special cost groups (e. g. maintenance and administration costs) are partly included and partly excluded.	In connection with 3.4.1 it can be seen that the term "operating costs" is used very differently . In WP 4 it is imperative to find a general, transnational definition (possibly referring to the German Operating Cost Ordinance), especially with regard to profitability calculations that have to be made in the next working steps.	
3.4.4	the development of maintenance and operating costs	Actually, there is no real data available. In Denmark, the development seems to be stable, Germany is only able to supply data according to the construction price index.	Further consideration is not possible due to unavailable data. Maybe it can be considered in WP5 to trigger an EU-Database for that point.	
3.4.5	the costs of maintenance and administration costs	Actual costs may differ from possibly existent standardized values.	A general statement is not possible by now. It is a need to figure out in WP5 if that can be unified with fixing certain standards.	
3.4.6	stability of value and life cycle costs (development)		Life cycle costs and stability of value are criterias to evaluate the sustainability of buildings. How should "Life cycle costs" equally listed in the participating countries? That should be worked on in WP5.	

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8.3.2 Economical and financial basis, industry and quality (Benchmarks)

3.5	Housing development programs of the participating countries			
	topic / subtopic	Summary	Benchmarks	variation / tolerance
3.5.1	the financial support for owners and renters	There is financial support for social housing in every country. Modernisation is supported in Lithuania and in Germany. In addition to that, new building is also promoted in Germany.	It is necessary to check whether the existing kinds of support are applicable to the other countries or to the EU. Additionally, the supporting programs must be analysed if they need to be adapted to actual conditions, needs and trends.	
3.5.2	target group for local supporting programs	Tenants are supported in all countries. Additionally, there are other target groups (owners, constructors) in Germany.	Different supporting programms for different target groups are to be found out.	

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8.3.2 Economical and financial basis, industry and quality (Benchmarks)

3.6	Management models , owner's structures			
	topic / subtopic	Summary	Benchmarks	variation / tolerance
3.6.1	the structure of ownership	Since the private ownership rate is very high in Lithuania, it only can be considered the dwelling stock in Denmark and Germany: Most of the apartments in Denmark are rented by social associations. In Germany, nearly 50% of the dwelling stock belong to enterprises in the form of capital companies and others (banks, funds,...) that are yield-orientated.	It might be necessary to discuss how important the owner structure and therefore the management model are for the developement of sustainable property.	
3.6.2	the procedures of the decision making within owners' associations	Procedures to make decisions are quite uniform in Lithuania (democratic majority decisions) because of the high private ownership rate. In Germany there are different forms of coorperations with different decision makers. In Denmark decisions are made democratically by the organs of the association which seems to be quite similar to Germany.	see 3.6.1.	

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8.3.2 Economical and financial basis, industry and quality (Benchmarks)

3.7	Condition of real estate management			
	topic / subtopic	Summary	Benchmarks	variation / tolerance
3.7.1	national distinctions in the tenancy law	In Denmark and Germany exist a defined tenancy law for the entire country. The tenancy law in Lithuania is not valid anymore. There are existing regulations for special groups (e.g. foreign consulars).	Tenancy law should not have national distinctions. We have to find out, which are the similarities between the law in the partner countries e.g. according to the structure of the rent and possibilities for rent increase.	
3.7.2	the development of the rental prices	Rental prices increased varyingly strong.	These significant differences in rental prices must be considered in the formulation of standards for the prototype.	

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8.3.2 Economical and financial basis, industry and quality (Benchmarks)

3.8	Benefit analyses for owners and investors			
	topic / subtopic	Summary	Benchmarks	variation / tolerance
3.8.1	the models of calculation of profitability	Static and dynamic calculation methods are known in all countries.	In nowadays calculation must follow a dynamic way to take developments (increase and decrease) and variations during the period under review into consideration. This could be price changes, interest changes or rent increase.	

8.3.2 Economical and financial basis, industry and quality (Benchmarks)

3.9		**Financing and funding instruments and mechanism on local/regional/national/ EU level for housing development /such as public privat partnership (PPP)**		
	topic / subtopic	Summary	Benchmarks	variation / tolerance
3.9.1	the financial supporting instruments for house owner and renter	In Denmark special loans and support for social housing are provided. Lithuania offers grants for modernization. Germany has different supporting instruments (loans, grants etc.).	Typical financing instruments are loans and grants. They are known in all countries and easy to handle so that they should be a major part of the financing for the prototype building.	
3.9.2	the procedure of investment decision making		Due to the fact that it is so important for the profitability of a property project how investment decisions are made, in WP 5 should be discussed an implementation on a standardised "investment decision model" for all participating countries.	

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8.3.2 Economical and financial basis, industry and quality (Benchmarks)

3.10	**Description of common characteristics of the pilot project**		
	Topic/Subtopic	Summary/Benchmarks	Variation
3.10.1	Number of dwellings		We consider between 20 and 40 dwellings appropriate.
3.10.2	Number of levels	The building should have 4 storeys.	
3.10.3	Size of each dwelling		A 2-room-flat should have about 50 m², a 3-room-flat between 70 and 80 m² and a 4-room-flat should have between 85 and 120 m².

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8.3.2 Economical and financial basis, industry and quality (Benchmarks)

3.11	**Description of energy standard suitable for each country**		
	Topic/Subtopic	Summary/Benchmarks	Variation
3.11.1	The highest energy standard of the country for new buildings (by law or technical possibility) in kWh/m² per year		The highest energy standard is between 40 and 120 kWh/m²year.
3.11.2	Short description of the chosen energy standard (energy standard with primary energy demand per year etc.)	The energy standards are the passive house and the low energy house with a yearly primary energy demand between 40 and 50 kWh/m².	
3.11.3	Legal restrictions for maximum CO_2-emission or general greenhouse gases	There are no legal restrictions for maximum CO_2-emission.	

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8.3.2 Economical and financial basis, industry and quality (Benchmarks)

3.12	**Maximum construction costs for the pilot project for each country**		
	Question	Summary/Benchmarks	Variation
3.12.1	Maximum rent per m² (considering possible market price level) a) gross rent per m² (incl. operating costs and heating) b) net rent per m² (without operating costs and heating)		The maximum gross rent is between 7 and 10 €/m² and the net rent is between 7 and 8 €/m².
3.12.2	Maximum maintenance/operating costs per m²		The maintenance costs are included in the rent and the operating costs are between 0,4 and 3 €/m² per month.
3.12.3	Construction costs per m² for the choosen standard a) construction costs in € per m² b) property share (price for land) in € per m²		The construction costs are between 489 and 2.235 €/m². The property share is between 49 and 482 €/m² but averages around 190 €/m².
3.12.4	Extent of savings or financial allocations to reserves (for example for renovations etc.)	There are no savings, reserves or financial allocations considered for e.g. renovations.	

9. Comparison of certification systems (DGNB/LEED, BREEAM……)

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9.0 Introduction

The method of evaluation of sustainability and the implementation to the design process are the main intents of this chapter. Therefore eight existing sustainable building certification systems (LEED, BREEAM, DGNB, HQE, Green Star, CASBEE, BCA Green Mark, TERI GRIHA) from America, Europe, Asia and Australia are examined and compared together.

In a first part of research the comparion is based on: the general dates and operating mode of these systems: their existance in years, the number of worldwide certified projects, their ranking systems and the number and names of their different versions according to typology.

In the second part comparison is based on: analysis of eight of the different residential versions according to their thematic fields. Multitresidential versions of BREEAM, Green Star and BCA Green Mark are compared with home or detached house versions of BREEAM, LEED, CASBEE and BCA Green Mark and – in order to include the German system as well – with DGNB office. The comparison always is made in words an in a graphic showing the points, a distinct rating system is giving for a distint topic.

In the last part of the research topic of management in the whole life cycle from design process to cnostruction site, comissioning, metering, and life cycle costs is examined.

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9.1 Engineering and building technology standards

9.1.0 Overview

The main thematic fields differ in some of the certification systems. The comparison is based on the LEED , BREEAM and Green Star system as the titles of their fields are very easy to understand. That makes possible the reorganization of some other systems like DGNB and BCA Green Mark. The chosen thematic fields are as well ordered according to the design process.

The reserach begin with site and transport, which includes all urban connections of the building, followed by architectural definitions like energy, indoor air quality, material, waste and water. The last part talks about management in the whole life cycle from design process to construction site, comissioning, metering, and life cycle costs.

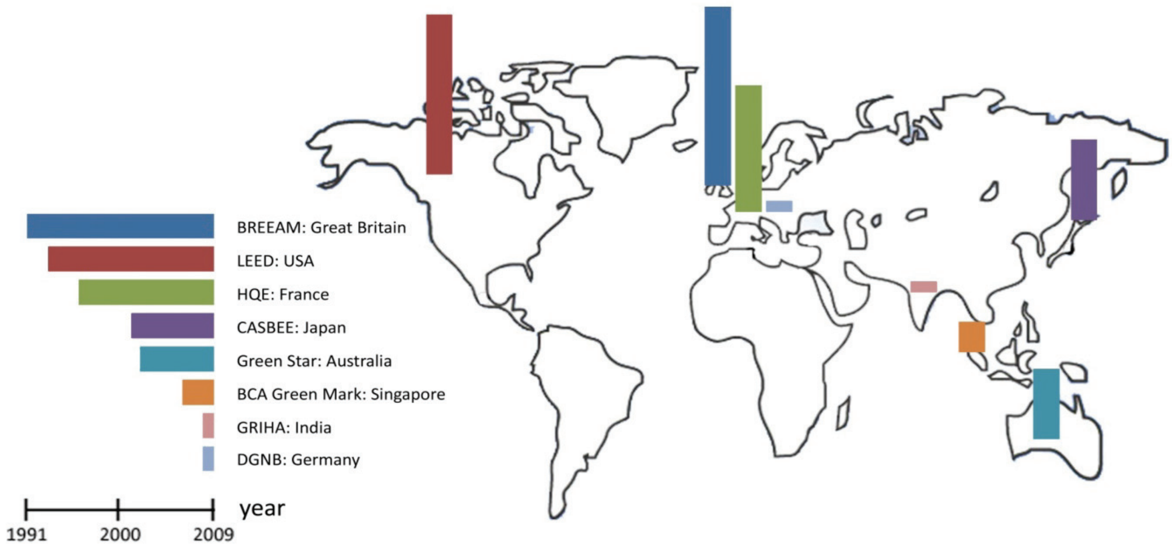

Fig. 1: Worldwide sustainable systems according to their lifetime in 2009

In first step one American certification system called LEED[2] (leadership in energy and environmental design), which is the most common as it already has 5000 internationally certified projects (Fig. 2) is chosen. It was founded in 1998 and based on the U.S. Green Building Council (USGBC)[3] which was founded in 1993. This council gives the adequate national database and information and thus is existing independently from the profit organization for certification. LEED is the only system which is used in South America and in Africa, Europe and Asia it is very important, too. It is though not the oldest and most extensive system. It has only a lifetime of 16 years and until now only 10 differnet versions (Fig. 1, 4).

In Europe, there are three systems which have been examined. The oldest and most extensive is the British system BREEAM4 with its lifetime of 18 years and its 14 different versions (Fig. 1, 4). It is based on the U.K. Green Building Council5 and was founded in 1991. BREEAM is the second system that functions internationally in North America, Africa, Europe and Australia. The certified projects in Britain aren’t part of Fig. 2 because of missing information.

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All other systems until 2009 are only working nationalwide. The Frensh system HQE (haute qualité environmnetale) 6 is also relatively old but doesn't have many versions nor an English web page. And although it is much older than the German DGNB (Deutsches Gütesiegel nachhaltiges Bauen or German certification for sustainable construction)7 that is only one year old the amount of certified projects is almost equal in both systems(Fig. 1, 2, 4). DGNB is based on the information portal for sustainable construction (Informationsportal nachhaltiges Bauen)[8].

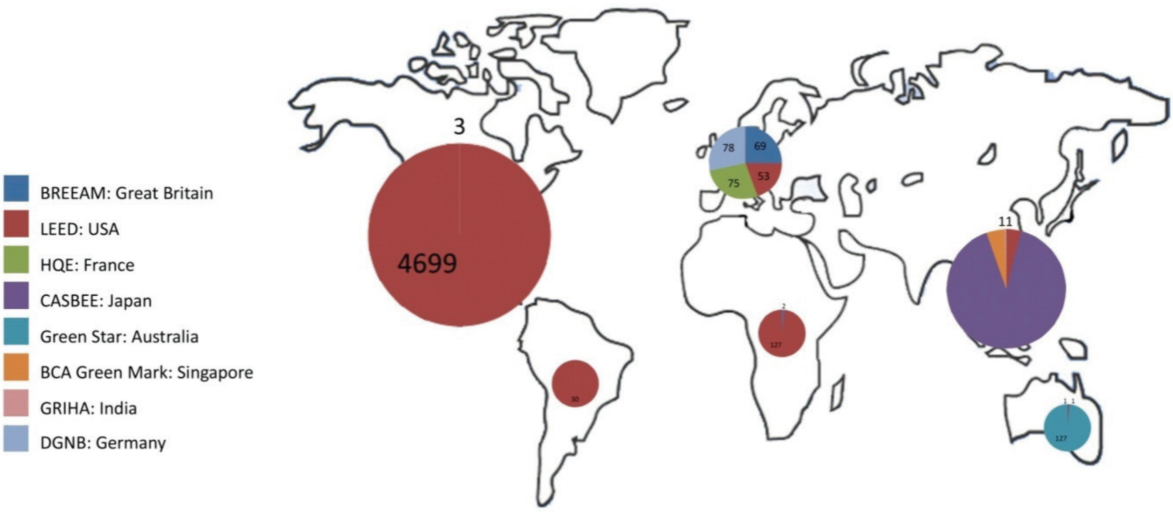

Fig. 2: Worldwide sustainable certified projects according to certification systems in 2009

The Australian system Green Star9 has 127 certified projects in Australia where also exist some BREEAM and LEED projects (Fig. 2). It already is existing seven years and has seven versions (Fig. 1, 4).

On the Asian continent, the Japanese system CASBEE (Comprehensive Assessment System for Building Environmental Efficiency)10 is the leader of the market with its already 2111 projects certified (Fig. 2) and an accordant lifetime as Green Star. The Japanese system is based on the Japan Green Building Council. The other two less imortant Asian systems are BCA Green Mark11 in Singapoore and TERI GRIHA12 in India which has the same age as the German system.

The ranking of all compared systems is working very similar. A number of points (e.g. 100 points) is the total amount a building can reach. Sometimes there are extra points (e.g. 10 points) for innovation. So an excellent sustainable building could reach 110 points as well (LEED, BREEAM in Fig. 3). The next step is the ranking system where platinum, gold, outstanding, world leadership or six stars is the best grade – very similar to the accordant school ranking system. This ranking system defines though the most sutainable building that can be sold better or gives the adequate, sustainable reputation to the inhabiting company. The German DGNB is the only system which doesn't include the certification of the site in the ranking.

Almost all the systems react on the typology of a building and the older a system is the more versions do exist. All these versions can be organised into different typology groups. There are the non residential versions (office, education, health, commercial, industrial, courts, prisons) and the residential (multiresidential buildings, homes, maintenance & operation), there are some versions without typology (new construction, core & shell, existing building, heat island, other buildings)

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and some that function for urban development (communities, neighbourhood development, urban development, urban are, district, infrastructure). Only LEED and BREEAM have versions that are working internatioanlly. BREEAM for example made two new international versions after my comparison for the two differnet climates of Europe and the Gulf region (Fig. 4, Annex 1)

Fig. 3: Ranking of the certification systems in 2009

As already mentioned in the introduction, for the further analysis I choose the multiresidential and home versions (not the maintenacne and operation models) in order to aply it to the prototype design of the project Longlife. As the German system only exists for offices and as Germany is partner of the project Lonlige I involved it as well in my further analysis.

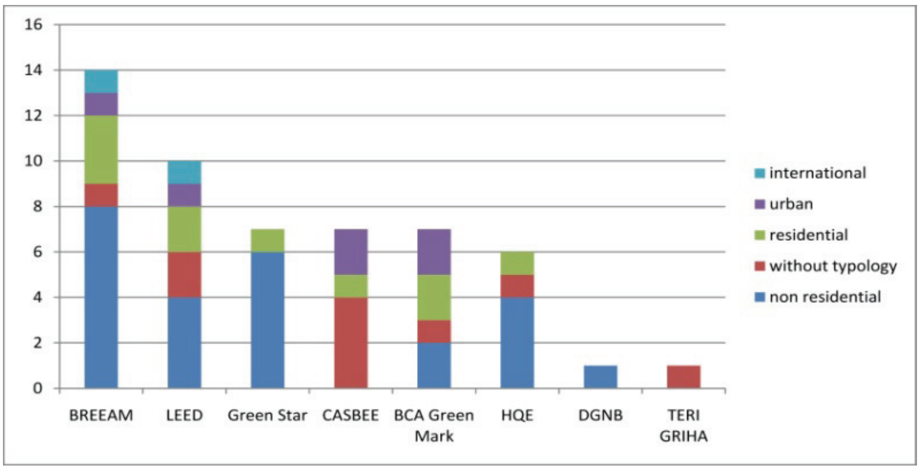

Fig.4 Versions of the certification systems

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All the analysed systems are arranged according to different categories. Each version is based on this arrangement and defines a percentage of points for each category. The persentage in the text below is always taken from the multiresidential or home versions of the systems. BREEAM, LEED, Green Star and BCA Green Mark are arranged very similar meanwhile DGNB and CASBEE differ a lot.

BREEAM multiresidential13 and ecohomes14 are seperated in ten categories: management (12%), health & wellbeing (15%), energy (19%), transport (8%), water (6%), materials (12,5%), waste (7,5%), land use and ecology (10%), pollution (10%) and innovation (10%). In total 110 percent is available. For the following thematic comparison I take two versions of the system, ecohomes and multi – residential.

LEED homes15 has seven categories: sustainable sites (26 points), water efficiency (10 points), energy and atmosphere (35 points), materials and resources (14 points), indoor environmental quality (15 points), innovation and design (6 points) and regional priority (4 points). In total 110 points are available. For the further comparsion, the homes version is taken.

Green Star multi unit residential16 has nine categories: management (18 points), indoor environmental quality (20 points), energy (26 points), transport (14 points), water (12 points), materials (26 points), land use and ecology (11 points), emissions (15 points) and innovation (5 points). In total, 142 points are available. Green Star has one residential version, the multi unit residnetial.

BCA Green Mark residential buildings17 and landed houses18 has five categories: energy efficiency (74 points), water efficiency (8 points), environmental protection (20 points), indoor environmental quality (10 points) and other green features (8 points). The system has two versions, residential new buildings and landed houses.

CASBEE home19 has six categories which all have give the same number of points : comfortable, healthy & safe indoor envirnoment, ensuring a long service life, creating a richer townscape and ecosystem, conserving energy and water, using resources sparingly and reduing waste and last but not least consideration of the global, local and surrounding environment. In total the project has to reach more than 3 points to be rated best. The home (detached house) version is compared below.

DGNB office20 only has an office version that is taken to include my countries system as well. It has six categories but only five of them are rated: Ecological quality (22,5 %), economical quality (22,5 %), social quality (22,5 %), technical quality (22,5 %) and process quality (10 %). The location quality is rated seperately.

HQE and **TERI GRIHA** aren't presented furthermore because of missing information and bacause the Indian system doesn't have a residential version.

In order to compare the above mentioned systems I take the arrangement that occurs most frequently (LEED, BREEAM, Green Star, Green Mark) because it seems very logical and easy to understand. In the next step I sort the topics according to the design process (Fig. 5). The green coloured topics are connected to the first design stage, the urban design that contains schemes like site, landscape design, ecology and transport. In the second blue design stage, architectural and technical design is united with the following schmes: energy and atmosphere, indoor environment, materials, waste and water. The third orange stage is talking about management in the whole life cycle of the project, beginning with the design process, comissioning, operation and life cycle costs.

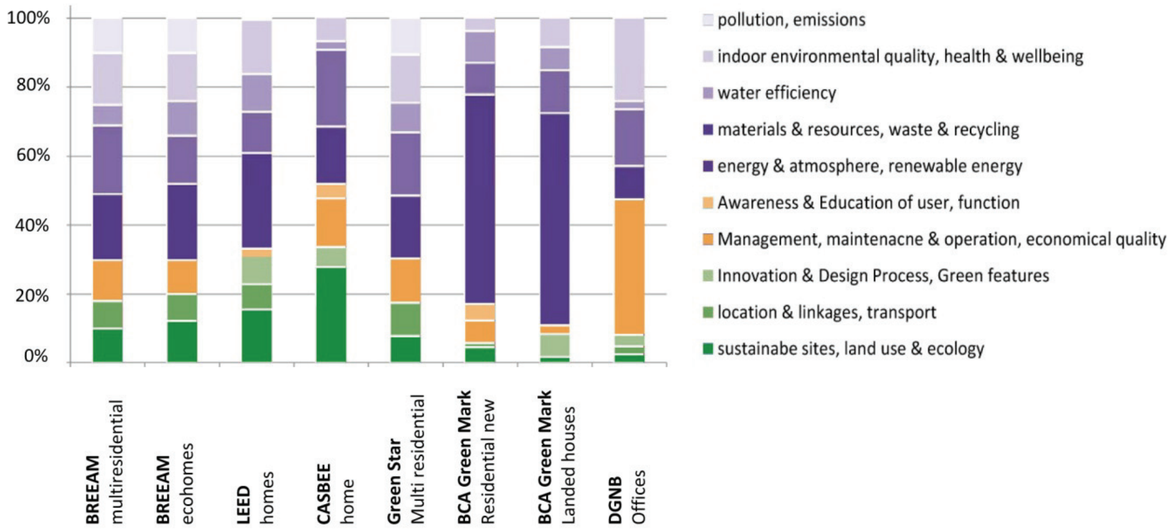

Fig. 5: Thematic comparison of certification systems according to ranking 2009

9.1.1 Site and transport

The importance of the site and transport section differs from 2% up to 27% between the certification system with an average value of 12,5%. It has several subtopics which are the result of a funded comparison that can be seen in annex 2. The topics are mentioned according to the number of systems in which they are included.

Community and private resources for example is part of 7/8 versions. The closeness of amenities like shops, markets, community centres is certified according to the number of all amenities in a distinct distance and a safe route. Facilities on the lot like compost or swimming pool are another point. The distance to water, sewage and IT service is certified as well. As a design stage result, a map of amenities with walking distance to the lot should be presented.

Public transport (6/8 versions) certifies the distance of the main entrance to the public transport station (bus, train, ferry) and the number of rides per weekday or during rush hours. Fig. 6 shows that this is more important for multiresidential versions (BREEAM, BCA Green Mark) than for home versions. The design stage result here is a public transport map and timetables.

Landscape design (6/8 versions) declares benchmarks for the green are which should be 100 % permeable area and is related to the roof water management in order to prevent flooding of the site. Density is another requested point (e.g. 1 dwelling/ 200m²; floor/ footprint ratio ≥ 3,5/1). To lower the heat island effects, material with high solar reflectance and shading plants should be used on the site. The design stage result is a landscape design plan.

Ecological value and biological habitat (6/8 versins) exists to protect the species on the site. The aim is to rise the number of possibel species and habitats or at least their preservation. The restoration of destroyed trees is a good example. At design stage there has to be a plan and fotos of previous and planned biological habitat in a so called landscape and habitat management plan.

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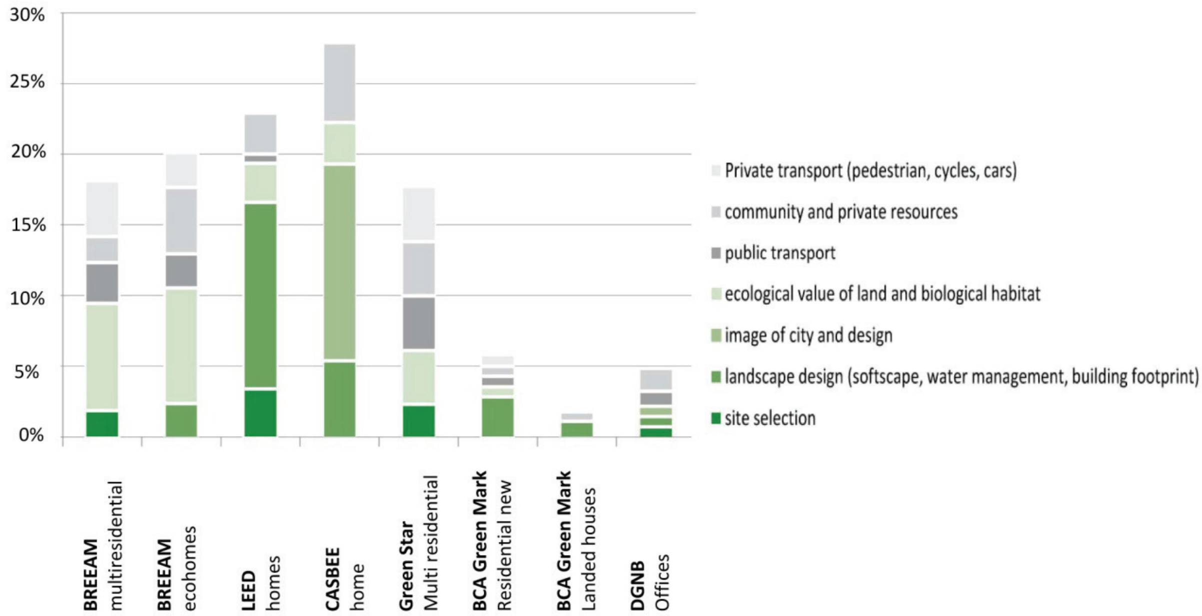

Fig. 6 Site and transport comparison 2009

Private transport is mentioned in only 5/8 versions. Cycle routes and storage, pedestrian routes, external lighting and the lowest possible amount of car parks has to be shown in the urban transport management plan.

In 4/8 versions sustainability already begins with the site selection. Here the use of previously developped or as well contaminated land is favoured over the use of non developped land in order to limit the use of land and though the further destruction of biological habitat. Plan, area and fotos of previous and proposed land use have to be shown at design stage.

The last small topic is the image of the quarter (2/8 versions) where the image of the quarter is described and the use of local landscape and architectural design is claimed.

9.1.2 Energy

The importance of the energy section differs from 10% up to 62% between the certification system with an average value of 30%. The peak is located in Singapoore with BCA Green Mark, the lowest amount can be found in Germany with DGNB. A possible declaration can be the German energy savings ordenance which has to be fullfilled by any new construction apart from a certification system. It seems that in Singapoore there is no such law to save energy and therefore the amount is that high. The subtopics are the result of a funded comparison that can be seen in annex 3. The topics are mentioned according to the number of systems in which they are included.

7/8 versions request the use of low energy domestic products. A++ rated products like washing machines, dish washers, refrigerators and lifts shall be used in the design thus conserving energy. The EU labeling system for example therefor is a good foundation.

Lighting - that means the use of energy efficient internal and external lights - is part of 6/8 versions. Here, the use of 75 – 80% of energy efficient light and a lighting level of 300 lux is required. Other features for the design stage lighting concept are the lighting control and the sunlight penetration in summer and winter.

Renewable energy is also part of 6/8 versions. Its use on the site, near the site or in connection with other sites is certified according to the percentage of renewable annual energy that leads to a reduction of CO_2 emissions and is declared in the renewabel energy concept.

CO_2 emissions during the whole life cycle are part of 5/8 versions. The renewable and non renewable energy is mentioned as well and though part of the design stage energy concept and CO2 calculations. The benchmarks here are defined in very different ways: The German DGNB gives the most points for a demand of 203kWh/m² nia *a (nia = net internal area) of primary energy, other systems require 0kg CO_2 equivalent/m²*a or a saving of 42% of energy costs.

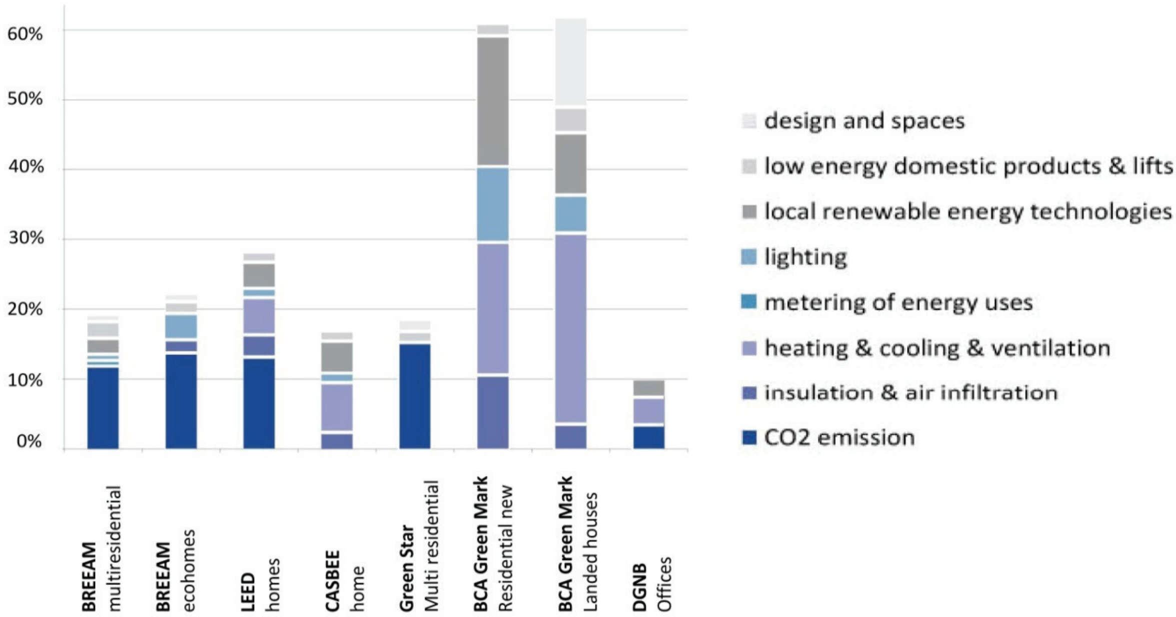

Fig. 7 Energy comparison 2009

Insulation and air infiltration (5/8 versions) talks about the insulation using the u-value and a low heat loss parameter that is defined through the air tightness of a building that can be tested with the blower door tes.The wall to floor ratio – or the compactness of the design of the building and the solar reflectance are other important points for this topic.

Heating, cooling and ventilation (5/8 versions) wants to minimize thermal bridges and requires an energy efficient heating, cooling and ventilation system. Shading, solar gains and relative humidity are also involved to the energy efficiency in W/m²K. At design stage, a thermal and ventilation concept has to be designed.

Design and spaces (4/8 versions) gives points for an adequately located drying space for all building users, an occupancy control in all jointly used rooms, an orientation of the dwelling southwards for solar gains, solar reflectance and a green roof.

Metering of energy uses is mentioned here in 1/8 versions but appears in other sections as well. The submetering is necessary to be able to improve the energy performance of a building in the first years of operation.

9.1.3 Indoor environment

In comparison to the energy section where the total energy demand and related energy efficient technics is important, indoor environment covers more the perception of the user of the building. The imporance of the indoor environmental section lies between 3% and 22% with an average importance of 12%. The subtopics are the result of a funded comparison that can be seen in annex 4. The topics are mentioned according to the number of systems in which they are included (Fig. 8).

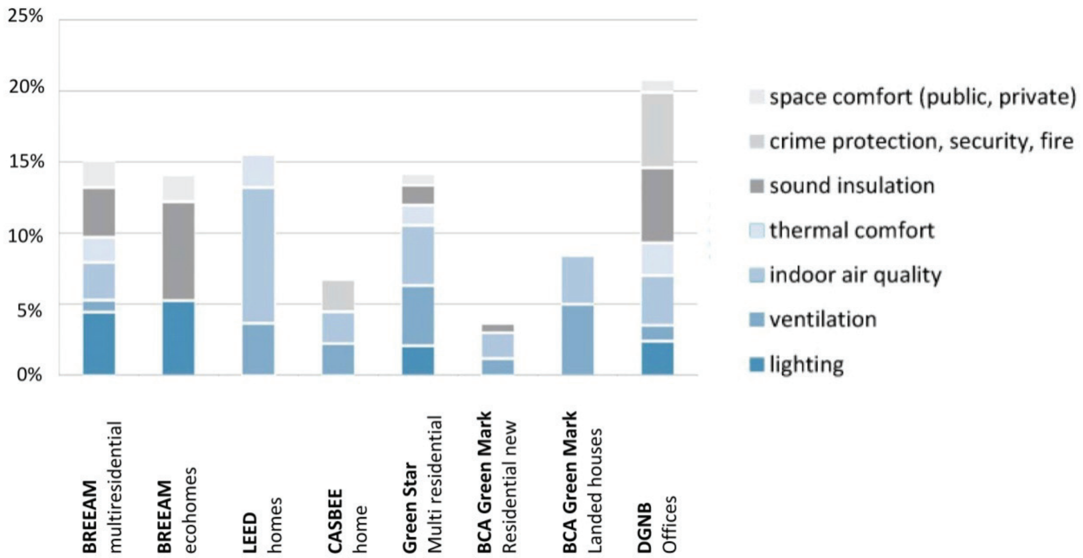

Fig. 8 Indoor environment comparison 2009.

Ventilation is mentioned in 7/8 versions. The amount of natural ventilation shall be high as it doesn't consume energy. If mechanical ventilation is used it has to be energy efficient. But the most important topic is the user control, so that individual ventilation is possible to reach the adequate air change rate. The design output is a ventilation concept including the user control and the location of the air entrance in order to prevent high pollution of air.

Indoor air quality exist in 7/8 versions, too. Here the entrance of air is important and the use of non – hazardous materials to prevent VOC and other emissions. The air change between the end of construction and the beginning of operation is one possibility to prevent health risks. At design stage, environmental product declarations are a possibility to show the amount of hazardous materials in a product.

Sound insulation (5/8 verions) tries to force the airborne and floor sound protection and insulation. 55dB at day and 45 dB at night are possible benchmarks for dwellings. A possibility to envolve local codes is to ask for a 8dB higher insulation than required in the code. At design stage, a sound concept has to be produced.

Another possibility to improve the wellbeing of the user is the space comfort (5/8 versions). Private space with adequate IT service or garden is as important as public space on roof or inside the building. Common and private areas have to be defined during design process.

Lighting and view (4/8 versions) gives information about the daylight conditions (75% - 90% adequately daylit, daylight factor) and lighting level (300 lux in 90cm above floor). Shading devices and glare control, light colour and external view are all part of the designes lighting concept. A possible way to calculate the daylight conditions in each part of the world is the software ecotect.

Thermal comfort is men tioned by 4/8 versions. The thermal comfort level is defined on the one hand by the thermal envelope and on the other by the user controlled heating and cooling device.

Local codes define the conditions that have to be integrated to the thermal concept in the design process.

The crime protection (1/8 versions) defines lighting, security and clearly arranged escape ways.

9.1.4 Material and waste

Material and waste is presented in all system in very equal amounts from 9% to 22% with an average of 14%. The subtopics are the result of a funded comparison that can be seen in annex 5. The topics are mentioned according to the number of systems in which they are included (Fig. 9).

The sustainable construction element rating is one of two parts that is included in 8/8 versions. Here architectural and landscape design materials or construction elements like walls or are rated according to different factors like Global Warming Potencial (GWP in Germany: 39kg CO_2-equivalent/ m² NEA*a), ozone depletion potencial (ODP in Germany: 0,0000035kg R11-equivalents/ m²NEA*a), photochemical ozone creation potential (POCP in Germany: 0,0105kg C2H4 – equivalent/ m²NEA*a), eutrophication potencial (EP in Germany: 0,0147 kg PO4 – equivalent/m²NEA*a) and acid potencial (AP in Germany: 0,2170 kg SO2 equivalent/m²NEA*a). In Germany these benchmarks numbers are available for free on the web page of the information portal sustainable construction, LEED refers to another database that rates the construction elements with an A+ similar to the EU product declaration system. Other certification systems make a statement to distinct materials: the use of bamboo or wood or the reduction of concrete usage. At design stage a software called legep is available for the German system that not only gives environmental data but as well construction and operation and maintenance costs.

Life cycle waste management is part of 7/8 versions. The reuse and recycling of construction and operation waste and a low amount of non hazardous construction and waste is required. The allocation of waste and recycling bins during construction and operation has to be planned in design stage.

Recycling is part of 6/8 versions. The use of recycled materials and recycled concrete aggregates are demanded and has to be shown in the recycling concept.

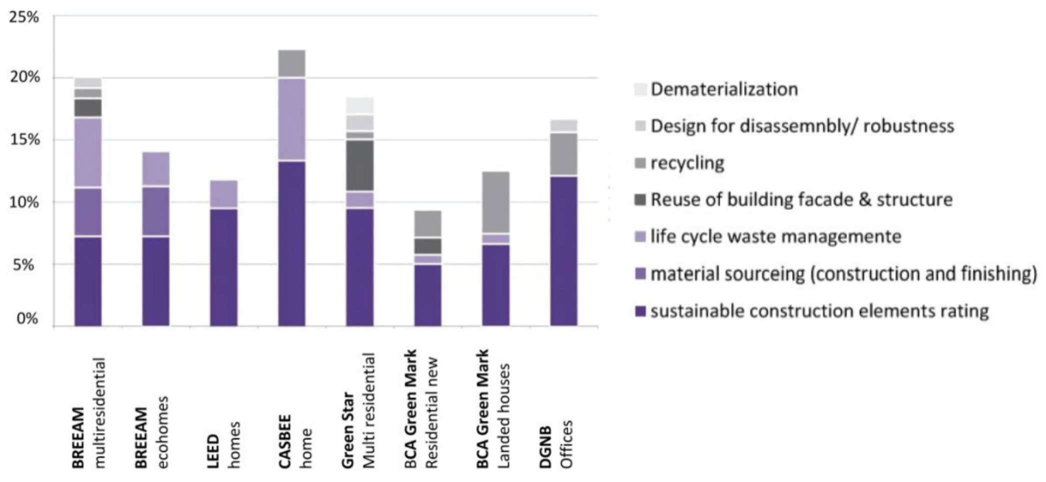

Fig. 9 Material and waste comparison 2009

The reuse of building elements is a possibility to include new construction and renovation in the same version (3/8 versions). The reuse of 50% of existing building façade and 80% of building structure has to be shown in a plan with existing and new building parts.

Disassambly and robustness (3/8 versions) relates on the one hand to the use of dissassambable construction elements in façade and framework and on the other hand to especially durable building parts to save money in tearing and maintenance.

Material sourcing (2/8 versions) contains the use of regional construction materials in order to save energy on transportation. Therefore 80% of the material has to be sourced and 100% legal timber has to be used in construction.

Dematerialization (1/8 versions) aims in the use of less material.

9.1.5 Water

The water section has different importance from 2,5% to 11% with an average of 7%, It is lower than all the other sections and very dependent of the climate. In Germany for example there is enaugh water available for consumption meanwhile huge parts in the USA have a dryer climate. The subtopics are the result of a funded comparison that can be seen in annex 6. The topics are mentioned according to the number of systems in which they are included (Fig. 10).

The main indicator for this section is the minimization of water consumption (8/8 versions) by the use of fittings, urinals and WCs. The reuse of greywater for toilets and the infiltration of rainwater are other important parts that have to be presented in a water concept. Ine possible benchmark is the use of ≤ 32m³/ bedspace*a.

6/8 versions mention a water efficient irrigation system that includes the use of rainwater. The integration of metering and leak detection system is mentioned in 3/8 systems and rainwater harvesting for the use in toilets and irrigation system is part of 2/8 versions.

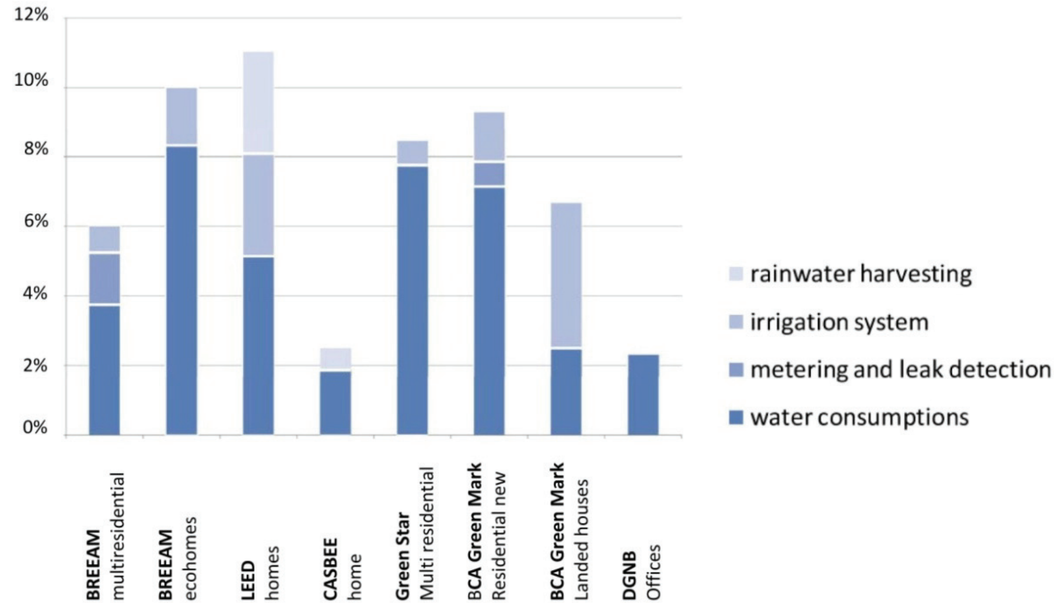

Fig. 10 Water comparison 2009

9.2 Method of planning, permit and tendering procedures - management

Legal aspects build the base for certain calculations in certification systems. Their fullfillment aren't part of the system because the systems go beyond these values. Anyhow if one widens the legal aspects to the whole field of social aspects there are a lot of different aspects involved. Costs are involved in this chapter but will be mentioned more deeply in the next one.

The management section shows a big difference between the different systems. Meanwhile LEED only gives 2 % of the points, the DGNB gives 38 %. The average value is 13 %. One reason for the difference surely is the one between multiresidential with a high grade of organization and homes which normally have one owner and though a lower degree of organization. DGNB with its focus on management and life cycle costs is surely a different system, but as well it is an office version and not a dwelling like the other versions. The subtopics are the result of a funded comparison that can be seen in annex 7. The topics are mentioned according to life cycle of the building (Fig. 11).

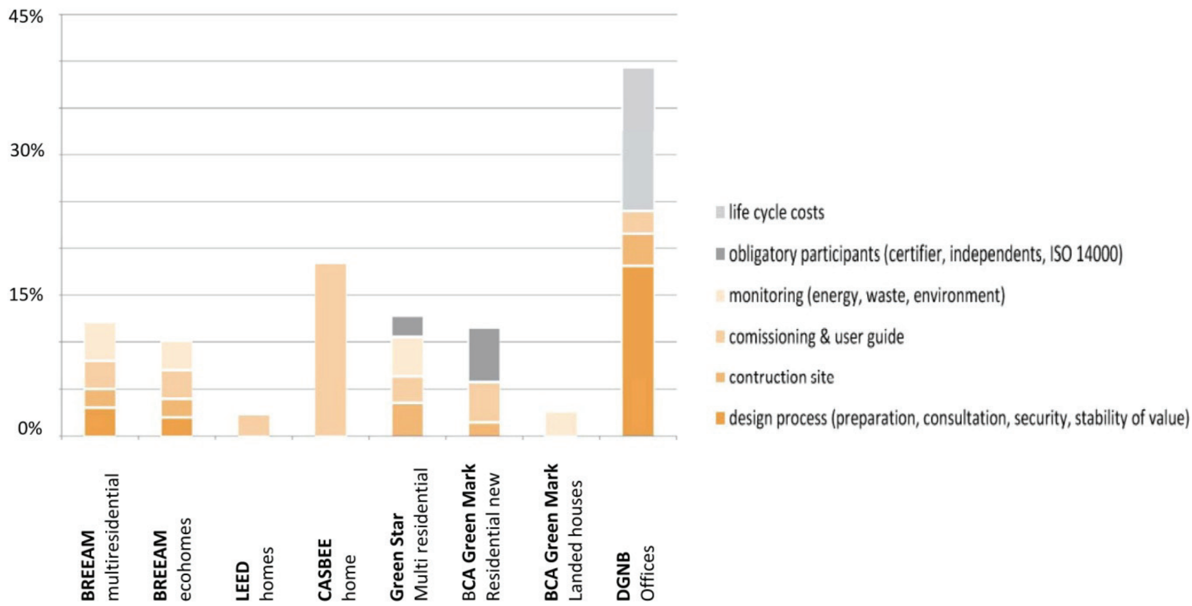

Fig. 11 Management comparison 2009

A sustainable **design process** (3/8 versions) is defined by the production of different already mentioned sustainable concepts, integral planning (integration of all stakeholders in the design process) and the possibility of conversion of future building use, where the number and kind of integrated groups are one possible benchmark.

The **construction site** (5/8 versions) has to be managed by a site management plan that organizes the environmental management, waste management and recycling (80% of construction waste has to be recycled).

Comissioning and user guide (7/8 versions) refers to the moment between construction and operation. The comission has to be monitored and a home user guide and inspection with the future building users have to be made integrating operation, maintenance and cleaning. The most important output is an understandabel user guide.

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Monitoring of CO_2 emissions, energy, water and pollutions should be part of the first year of operation to be able to react on possible debilities of the building.

Obligatory participants have to be part in 2/8 versions. Professional certifiers, independent comisioning agents, ISO 14000 vertified planners and stakeholders of the building are only some of the possible participants.

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9.3 Economical and financial basis, industry and quality

9.3.1 Management

The management section shows a big difference between the different systems. Meanwhile LEED only gives 2 % of the points, the DGNB gives 38 %. The average value is 13 %. One reason for the difference surely is the one between multiresidential with a high grade of organization and homes which normally have one owner and though a lower degree of organization. DGNB with its focus on management and life cycle costs is surely a differnet system, but as well it is an office version and not a dwelling like the other versions. The subtopics are the result of a funded comparison that can be seen in annex 7. The topics are mentioned according to life cycle of the building (Fig. 11).

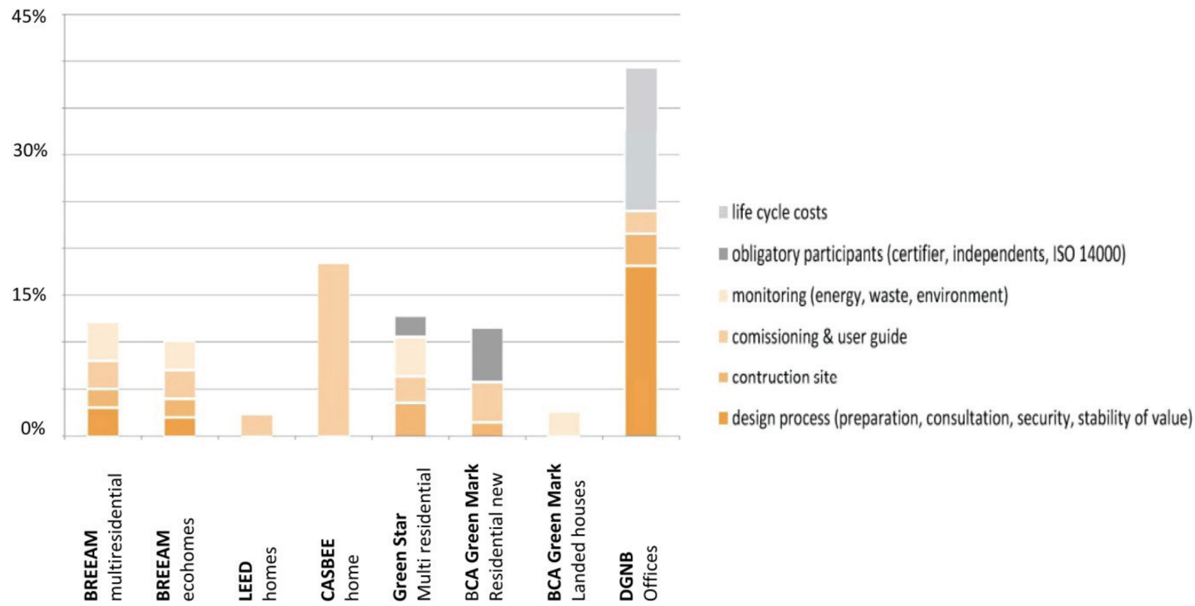

Fig. 11 Management comparison 2009

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Obligatory participants have to be part in 2/8 versions. Professional certifiers, independent comissioning agents, ISO 14000 vertified planners and stakeholders of the building are only some of the possible participants.

The **life cycle costs** from construction to maintenance or as well to demolition is only part of the German system DGNB. With the software legep, the net - construction costs can be estimated in €/m² GEA

9.3.2 Economical and financial basis, industry and quality

The aspects mentioned in the previous chapter are arranged according to the life cycle. The **life cycle costs** from construction to maintenance or as well to demolition however are only part of the German system DGNB. Economical sustainability for buildings means that the life cycle investment should be as efficient as possible therefore the life cycle costs are a good indicator. The problem is that there are no precise measurements by now and therefore the costs will always be approximated.

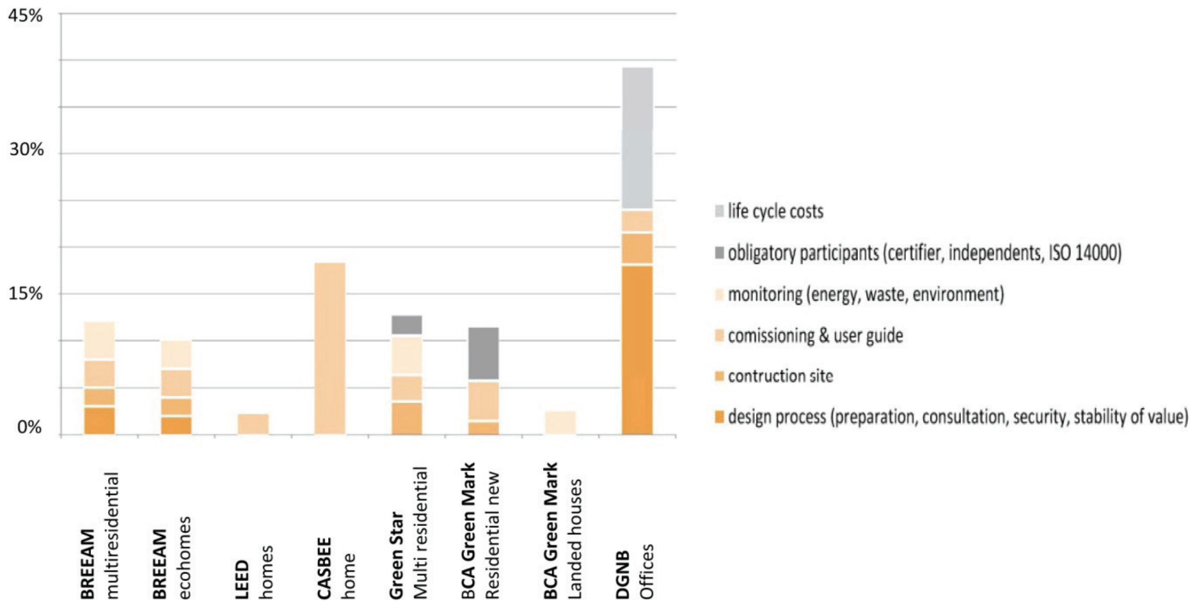

Fig. 12 Management comparison 2009

The general accepted definition of sustainability, as developed by the World Commission on Environment and Development in 1987, is as follows:

“Sustainability is a development that meets the needs of the present without compromising the ability of future generations to meet their own needs.”

The ISO 15392:2008 gives information about general principles of sustainability in building construction. According to this the concept of sustainability contains three aspects: ecological, social and economical.

The goal of our questionnaire was to find out what kind of measure instruments for the three aspects of sustainability exist in the different countries to find a general level and to see where we stand.

In general, the definition for ecological sustainability is to save resources for future generations and minimize the energy demand. Measurements are e.g. the energy consumption, the EP-factor and the proportion of gains from the usage to the demand of resources.

Social sustainability mainly means that the social and cultural impact of planned projects is considered in some ways like the integration of urban planning into landscaping areas or monument preservations. But so far, there are no real measure instruments just some guidelines and certificates e.g. in Germany there is a green building certificate (DGNB).

The main statement says that economical sustainability for buildings means that the investment should be as efficient as possible e.g. the life cycle costs are a good indicator but there are no precise measurements by now.

Until now there are no real instruments to measure the different types of sustainability for housing projects in the different countries except for the ecological part. That shows that the theory of sustainability is not really internalized till now and that we stand just at the beginning of the development of sustainable housing.

The Technische Universität Berlin charged the Leibniz Institute of Ecological and Regional Development to develop a “Longlife”-certificate framework which will be used as a measurement of sustainability and life cycle costs as well as quality management. Other certification programs like LEED or DGNB will be consulted as cross check.

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10.Results from external expertises

10.0 Introduction

In this chapter research and analysis resulted from the external expertise would be examined.

Following the main structure of the report, this chapter is also consisted of three sub chapters.

In the sub chapter of Engineering and building technology standards; result of research of related expertise “Leibniz Institute of Ecological and Regional Development of Dresden” is presented under the three topics of:

- Evaluation of existing assessment schemes and outline of a transnational communication and evaluation framework for residential construction towards sustainability
- Comparison concerning indicator catalogues, methods of weighting & scoring, institutional and procedural concept, and communicational instruments of the assessment schemes
- Outline of a framework for a Longlife certification scheme

In the sub chapter of Method of planning, permit and tendering procedures; result of the research and analysis prepared by related expertise” Gleiss Lutz in Association with Herbert Smith and Stibbe” under the title of “ Legal sustainability requirements and building permit procedures” is presented.

In the sub chapter of “Economical and Financial Basis, Industry and Quality”, resulte of the research and analysis done by related expertise” ………………………..” under the title of 2 Energy efficiency in the Residential Building Sector: market barriers and Policy Responses” are presented.

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10.1 Engineering and building technology standards

10.1.1 Report .1 Evaluation of existing assessment schemes and outline of a transnational communication and evaluation framework for residential construction towards sustainability; Identification and documentation of existing relevant assessment schemes

10.1.1.1 Abstract

This report at hand concludes step one of the longlife expertise “Evaluation of existing assessment schemes and outline of a transnational communication and evaluation framework for residential construction towards sustainability”. It provides an overview and summary of the most relevant assessment schemes in use in the partner countries, and considers the most renowned international rating tools as well.

The importance of sustainable building as a contribution to a low-carbon economy is discussed in the introduction, and the basic principles of assessment schemes such as its objectives are dealt with thereafter. The situation of sustainable building in the partner countries including some remarks concerning the debate on assessment schemes as well as the existence of Green Builing Councils is examined based on an inquiry conducted from the project partners.

Then profiles of existing assessment schemes in the partner countries and in international context are presented first, and then compared concerning the topics, issues and indicators they regard for assessment. Furthermore, there are some remarks on the procedural concepts and the weighting and scoring principles applied in the various schemes.

Table Short Info (template)

For all assessment schemes presented in the main part of this report a table with short information on the most important characteristics of the method are presented in an overview at the page the system is described. For more comprehensive information see the tools descriptions in the appendix. There are three assessment schemes appearing in the annex which are not discussed in detail in the main part: Green Mark (Singapore), Miljoklassad (Sweden) and MINERGIE®-ECO (Switzerland).

First of all, the logo of the assessment scheme or of the providing institution is indicated. Then, the dimensions of sustainability that are covered through the assessment are shown by full blocks, while in case of non-consideration the small box is not filled. For the rest of the characteristics it works the same with the exception of lifetime, where the number of years the system is defined for is indicated, if it is available or sensible.

Logo	Dimensions	Lifecycle	Building Lifetime	Elements
	■ ecology ■ economy ☐ society ■ technology	☐ planning ■ construction ■ operation ■ demolition	No. of years	☐ building ■ environment ■ site ■ infrastructure
Development Type	**Typical Purpose**	**Main Users**	**Planning Stage**	**Required Resources**
☐ universal ■ new development ■ refurbishment ☐ demolition ☐ maintenance	☐ universal ☐ fast screening ■ def. of quality ☐ consensus build. ■ award./benchm. ☐ decision support ■ controlling	☐ universal ■ planner/designer ☐ municipality ☐ consultant ☐ researcher ☐ jury ☐ management ■ client/owner	☐ unspecific ■ scoping ■ concept ■ implementation ☐ monitoring/mgmt.	☐ high ■ medium ☐ low ☐ flexible

10.1.1.2 Overview

In the course of the discussion on climate change, the relevance of the building sector for environmental impacts and resource use has been considered to an increasing degree. Roughly 40% of the CO_2 emissions for example can be accounted to building and habitation including the activities related to this area. Sustainable or green buildings are more and more attractive for planners, developers, real estate companies and common house owners. The improved energy efficiency associated with such types of construction directly translates into cost savings in the operation phase, and results in a growing importance of sustainable building principles. However, sustainable building involves more than merely energy-efficiency. Topics such as indoor air quality, health and well-being, water management, and building materials are part of the consideration as well.

Assessment schemes for sustainable buildings aim to provide a holistic analysis of the building in terms of its resource utilisation, its energy demand and its environmental impacts. The conceptual and procedural design of the schemes varies as well as the selection of topics, issues and indicators differ from scheme to scheme. In the following chapters the discussion on assessment schemes regarding theoretical, conceptual and practical aspects is summarised, the situation of sustainable building in the countries of the project partners is highlighted, a selection of existing assessment schemes is analysed and compared and finally the results for this part of the expertise are presented.

10.1.1.3 Sustainable Building & Assessment Schemes

In this section a short summary of the current discussion on sustainable building in general, and the development and use of assessment schemes regarding theoretical, conceptual and practical aspects is presented.

Sustainable Building practices make up a growing proportion of the construction market. Main driver of this development is definitely energy and the ability to save energy and costs simultaneously. Nevertheless, an integrative approach covering all dimensions of sustainability is desirable as economic and social aspects are important as well and generate positive benefits in the end. In addition, sustainable and green building concepts also often are considered as

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supporting healthy indoor climates for the users which is not only important in the housing sector but also is gaining importance for example in office buildings.

Assessment schemes for sustainable building are developed to achieve comprehensible and marketable certifications that give evidence of the greenness of the examined building. There are numerous types of assessment schemes available. According to the IEA Annex 31[1] the assessment schemes considered in this report can be classified as Environmental Assessment Frameworks and Rating Systems [see Dirlich 2010]. Among these one can differentiate into quantitative and qualitative systems. Quantitative methods such as Life Cycle Analysis, Life Cycle Costs, Eco-Balances etc. all result in quantifiable and verifiable (aggregated) data to assess sustainability or ecological aspects of a building. These are only taken into account to complete the picture, but are not part of the analysis. Usually such methods focus on a particular topic such as the energy demand of a building. Qualitative assessment schemes yet introduce scoring systems on certain scales (0 to 5 or 0 to 100% for example) to assess the various issues and the result can be interpreted as the degree of compliance with the optimum.

The number of qualitative assessment schemes has been rising within the recent decades. In international context the British system BREEAM (Building Research Establishment Environmental Assessment Method) was the first to be introduced in 1990 already. The most famous scheme beside the British is probably the LEED rating system (Leadership in Energy and Environmental Design) designed by the USGBC, the Green Building Council of the United States.

Nevertheless, the benefits of assessment schemes are in debate. Many critics state that the expenses in terms of time and money required to undergo a certification do not pay back at the end of the day. The advantages which the critics admit to exist simply do not justify the efforts beforehand in their opinion. [see e.g. Olgyay and Herdt 2004, Haapio and Viettaniemi 2008, Beul 2010]

The following section presents some aspects why a certification may be sensible regardless of that.

10.1.1.3.1 Objectives of Certification

Why may it be useful for house owners, real estate companies or other stakeholder to undergo an assessment of their building concerning its sustainable aspects? There are a number of benefits associated with the execution of an assessment, and despite the efforts and costs for the certification it seems to be useful for many development projects. The rationale behind can be roughly divided into three groups: marketing reasons, market reasons, and planning-related reasons.

Marketing reasons lead to an improvement of the image of the building owner:

- The efforts of the owner and/or planner in executing a sustainable development and the high building quality are credibly visualised by a certification.
- A certification, however, must put added value to the development project. The additional efforts which are necessary in planning and construction of the development must pay back somehow. This payback may consist in an improved image due to the visible green building or due to decreased operational costs.

Market reasons result in better marketable buildings/apartments:

[1] Annex 31 classifies various types of methods assessing the environmental performance and impacts of buildings. The website (http://www.annex31.org/) is no longer available.

- The assessment can be regarded as a proof of the overall greenness of the building.
- Additionally, a successful assessment proves the (potential) lower operating costs of the building.
- The certification will also improve the possibilities to sell the building on the real estate market (competitiveness).

Further benefits relate to the planning of the development project:

- From the very beginning such a scheme makes sure that the targeted quality of the completed building can be realised.
- An assessment scheme can function as a guideline for sustainable building, and supports involved actors (planners, architects, clients) to reflect upon quality issues that go beyond existing standards. Following this procedure consistently from the beginning, even a cost reduction can likely be put into practice compared to “add-on-solutions” in a later stage.

Nevertheless, assessment schemes for sustainable building still involve a number of problems which is examined roughly in the following section.

10.1.1.3.2 Involved Problems

Though the assessment schemes have been evolving within the recent years, there are still several problems awaiting their termination. At least one should know about the difficulties and inconsistencies that still exist.

Scientific Basis

The backbone of all assessment schemes, the scientific basis they rely on, is crucial for the acceptance and value of the certification. The indicators are all measured or assessed on the basis of a scoring system. These scores, however, may either be derived from objective information such as the demand of primary non-renewable energy, or from estimations of experts as it is when the ecological value of a site is in question. In order to optimise the procedure of measuring reality has to be simplified; however, the question remains to which degree simplification is allowed to ensure a minimum level of a realistic assessment.

Information deficit

Due to the complexity of buildings as a system and the construction process in general and with the aim of sustainable building in particular a potential information deficit must be considered. Furthermore, the innovative character of building green/sustainable contributes to the fact that involved actors are not always fully familiar with the possibilities and challenges involved. On the one hand an assessment scheme can be helpful in this respect, especially one that is designed to function as a guideline as well. On the other hand it may also intensify the problem due to the increased requirements to get the construction process started. Every assessment scheme therefore has to find the balance between the information requirements resulting from the building as a complex system and the problem of information overload on the side of involved actors.

Additional efforts

The integration of principles of sustainable building into the planning and construction procedure adds further efforts. Performing a certification in addition to that may increase the management requirements in a way that overburdens the average planner and/or house owner.

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Additional costs

The integration of principles of sustainable building into the planning procedure does not only increase the complexity of the development project, but supposedly simultaneously leads to additional costs2. These refer to activities in the construction phase as well as in the planning phase. When the building is in addition also scheduled for an assessment and certification further costs have to be added. These costs on top may be unbearable for many (potential) house owners in the countries examined. However, understanding the certification process also as a structured way to come to a holistic definition of quality may also lead to a shift in priorities and thus to savings on the one hand that can be used to finance higher quality on the other.

Simplification

Assessment schemes aim to depict the reality of sustainable building in a score, label etc., and doing so reality is simplified. Nevertheless, most of the systems are developed in a way to minimise the discrepancy between the real characteristics of the building and the assessment results. The user must, however, be aware of the fact that the transformation process necessarily leads to results that do not fully mirror reality in terms of a one to one relation.

The following chapter approaches the practical implementation of sustainable building into the building and construction activities in the partner countries including Green Building Councils and the development of assessment schemes in general.

10.1.1.4 Sustainable Building Practices & National Green Building Councils

The establishment of a national Green Building Council (GBC) signals that there is a certain level of public consciousness for sustainable building in a country. However, it does not at all necessarily mean that principles of sustainable building are not considered in a country without a GBC.

In the following the current situation in the partner countries is summarized focusing on the general situation of sustainable building and GBCs. The information given is based on an inquiry conducted in April 2010 [see Annex 1] among the project partners.

10.1.1.4.1 Denmark

Historically speaking, the first sustainable buildings in Denmark were erected on the countryside as buildings independent from technical infrastructure, but, nowadays, the development also takes place in urban context [see Elle 2007]. Sustainable building in Denmark is characterised by a focus on the user and his/her needs. Elle [2007] states: “The first sustainable buildings were built by their users, and the user-building interaction still plays a decisive role for the performance of the present sustainable buildings. The users have to understand how the building functions”. A growing interest in building green can be stated for Denmark, and the topics perpetuating the discussion most are “Energy”, “Materials”, and “Water”. Stakeholders are both interested in sustainable building practices and in the implementation of assessment schemes for sustainable building.

So far, there is no GBC established in Denmark. However, there are a lot of activities fostering the growth of sustainability in the construction sector. Under the auspices of the Danish Building Research Institute affiliated to the University of Aalborg a lot of research activities have been performed up to date.

[2] Though the majority of stakeholders involved in sustainable building agree upon substantially higher costs for building green several authors do not coincide with this opinion such as van Hal 2007 or Kats 2003.

There are a number of assessment schemes which result from these activities. Others are developed in the framework of projects funded by the European Union. Internationally renowned systems are not often used. However, stakeholders interested in sustainable building often show interest in an assessment as well.

10.1.1.4.2 Germany

Sustainable building is an important issue in architecture and urban planning since more than two decades in Germany. However, and although other topics other aspects such as the selection of environmentally sound materials or water efficiency are at stake, energy efficiency plays a major role also in Germany. Many innovative architectural concepts such as low-energy houses and passive houses in particular were developed here.

In Germany the national GBC – DGNB (Deutsche Gesellschaft für Nachhaltiges Bauen) – was established in 2008. Many stakeholders of the building sector such as architects, manufacturers of building materials, real estate companies, research institutions etc. are members of the council and foster the development of sustainable building.

Beside several assessment schemes having been in place as results of scientific work or efforts of authorities (e.g. of the Ministry of Transport, Building and Urban Development and its subordinate institutions) the DGNB compiled a new assessment scheme in cooperation with the mentioned Ministry. The DGNB label (called Gütesiegel) is operational since the beginning of 2009, and due to marketing efforts of the GBC this scheme is becoming more and more popular

[3]. Other rating systems available and in use in Germany are LEED or BREEAM. Furthermore, a lot of activities take place in federal states, municipalities, and in organisations dealing with the real estate and building sector. Examples are the “Green House Number” in Saarland, “Building Typology” in Schleswig-Holstein, or “ImmoPass” developed by DEKRA.

10.1.1.4.3 Lithuania

Sustainable building is of growing interest in the country, and the main topics discussed among stakeholders are “energy”, “material” and “costs”. The costs, however, are an immense hindrance for the development of sustainable building practices in Lithuania, and the government does not offer any financial support yet. Nevertheless, some stakeholders express their willingness to build sustainably.

In the moment there is no national GBC established in Lithuania.

Concerning assessment schemes for sustainable building the information available in Lithuania is very limited. As far as it can be gathered from online research and the inquiry of the project partners, assessment schemes are neither in use in the moment, nor in the status of being implemented in the near future.

10.1.1.4.4 Poland

[3] According to a study among 274 clients and interested persons of *Drees & Sommer* Group conducted in the framework of a Master’s Thesis [Weisser 2009] 66% of the respondents know the DGNB label while 46% respectively 22% are acquainted with LEED or BREEAM.

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Sustainable building practices are not common in Poland. There is a starting discussion on green building issues which came up with rising energy prices. So far, the interest of stakeholders such as planners, real estate companies or housing societies is limited. For all of them the costs in the construction phase is the main criterion concerning new developments. The operation costs are usually not considered in this context.

The Polish GBC (PLGBC) was founded in 2006 by two architects with interest in green building practices.

There are activities based on the efforts of PLGBC to adapt the international assessment schemes BREEAM and LEED to the standards and requirements in Poland. Apart from an academic consideration of assessment schemes, the issue is not on the agenda in Poland’s building sector.

10.1.1.4.5 Russia

Sustainable building is a topic of growing importance in Russia, which is indicated by intensifying discussions at universities, but also among practitioners. Main issues are “Energy & Energy-Efficiency”, “Materials” and “Ecological Planning”. Planners, real estate companies and other stakeholders become more and more interested in building sustainably.

The Russian GBC (RuGBC) was established in 2009, and is official member of the World Green Building Council (WGBC). Russia was one of the eight countries attending the first meeting of the WGBC in 1999, but the last of the major developed countries to have a national GBC.

Assessment schemes are, however, not a big topic in Russia so far. There are some activities by the RuGBC to implement BREEAM/LEED, but as far as it was to be detected there is no system developed yet that is used by planners, owners or consultants.

10.1.1.4.6 Summary

Sustainable building is on the agenda in all partner countries, however, the degree of consciousness of the stakeholders as well as the real market penetration differs considerably.

In Germany the development began relatively early, and many innovative green building technologies had been invented there. Denmark is on the forefront of the development as well and adapts sustainable building practices in the construction sector as well as it produces innovative technologies.

The countries in the East actually face major problems in implementing sustainable building practices due to assumed higher initial investment costs. Surely, house owners, planners and developers know that the total life cycle costs are lower in general as a result of energy and cost savings over the whole lifetime of green buildings. But, they argue that at the start of a development project the initial investment must be financed, and this is much more difficult in economies and construction sectors not as strong as the Western ones.

Table 1: Green Building Councils in the Partner Countries

	Denmark	Germany	Lithuania	Poland	Russia
Name of national GBC	No national GBC	DGNB Deutsche Gesellschaft für Nachhaltiges Bauen	No national GBC	PLGBC Polish Green Building Council	RuGBC Russian Green Building Council
Year of establishment	-	2008	-	2006	2009
Number of members (April 2010)	-	> 800	-	47	41
Website http://www.	-	dgnb.de/	-	plgbc.org/	rugbc.org/

National GBCs are established in three of the project partner countries (see Table 1): Germany, Poland and Russia. Considering the number of members the German GBC is the leading association. Furthermore, the DGNB is so far the only council among the mentioned having introduced an own (national) assessment scheme. Poland's and Russia's seem to be in the preparation process and adapt LEED and/or BREEAM to the country-specific requirements and standards in the construction sector.

In the following chapter existing assessment schemes in the partner countries are presented in a short review including the information overview mentioned before.

10.1.1.5 Assessment Schemes in the Partner Countries

The schemes in use in a country may be developed by a ministry, a national Green Building Council, a public authority or research institutions. Many assessment systems were developed in the context of a research project dedicated to sustainable building in general.

The short description of the schemes can be found in the next sections while a longer profile of two pages each for all schemes is available in Annex 2. In the headline refering to the short description of the scheme the name of the method is indicated as well as the providing institution, the bibliographic reference, and the link to the respective online resource. The short profiles provide a table indicating the targeted dimensions of sustainablity, details on the system boundaries, and specific information such as the type of development the scheme can be used for or the required resources.

10.1.1.5.1 Denmark

In Denmark the Building Research Institute at the University Aalborg is actively supporting the development of sustainable building. In the course of several projects (many of them funded by the European Union) assessment schemes were developed and implemented.

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ASCOT[4]

Logo	Dimensions	Lifecycle	Building Lifetime	Elements
ASCOT	[■ ecology] ■ economy [■ society] ☐ technology	■ planning ■ construction ■ operation ■ demolition	adjustable	■ building ☐ environment ☐ site ☐ infrastructure
Development Type	**Typical Purpose**	**Main Users**	**Planning Stage**	**Required Resources**
☐ universal ■ new development ■ refurbishment ☐ demolition ☐ maintenance	☐ universal ■ fast screening ■ def. of quality ☐ consensus build. ☐ award./benchm. ☐ decision support ☐ controlling	☐ universal ■ planner/designer ☐ municipality ■ consultant ☐ researcher ☐ jury ☐ management ☐ client/owner	☐ unspecific ■ scoping ■ concept ☐ implementation ☐ monitoring/mgmt.	■ low ☐ medium ☐ high ☐ flexible

The ASCOT tool [see ASCOT_v2_10.xls - Excel Tool] is provided by Cenergia, a consulting company dealing with energy efficiency and sustainable building in Denmark who compiled the tool with partner institutions in the framework of two EU projects.

The purpose of the ASCOT tool is to assist the user in evaluating and, thereby, optimising the economic costs of a building renovation project in relation to sustainable development issues. The system was developed first in the context of the HQE2R-project in 2003, and received an improvement during the ENPIRE-project in 2007. The ASCOT model allows a comparison between a traditional (reference) building renovation and different sustainable concepts for the renovation of the building. This comparison will take into account usage savings during the total lifetime of the building and the frequency of future replacing of building components and systems. The tool is primarily intended for use in the early stage of the design process. It can be used for both new constructions and renovation projects.

Opti Build[5]

Logo	Dimensions	Lifecycle	Building Lifetime	Elements
	■ ecology ■ economy ☐ society ☐ technology	■ planning ■ construction ■ operation ■ demolition	30 years	■ building ☐ environment ☐ site ☐ infrastructure
Development Type	**Typical Purpose**	**Main Users**	**Planning Stage**	**Required Resources**
☐ universal ■ new development ■ refurbishment ☐ demolition ☐ maintenance	☐ universal ☐ fast screening ■ def. of quality ☐ consensus build. ☐ award./benchm. ■ decision support ■ controlling	☐ universal ■ planner/designer ☐ municipality ■ consultant ☐ researcher ☐ jury ☐ management ☐ client/owner	☐ unspecific ■ scoping ■ concept ■ implementation ■ monitoring/mgmt.	☐ low ■ medium ☐ high ☐ flexible

[4] http://www.enpire.eu/
[5] http://www.ecobuilding.dk/

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The topics touched by the assessment are energy and costs, thus, the system covers ecological as well as the economic aspects of sustainability.

The ASCOT tool calculations are based on international standards for energy calculation. Thermal performance of buildings – Calculation of energy use for space heating and cooling (ISO/DIS 13790), Heating systems in buildings – Method for calculation of system energy requirements and system efficiencies: Heat generation system, thermal solar systems.

The focus of Opti Build [see Pedersen n.d.] is on energy efficiency. The software tool also offered by Cenergia calculates life cycle costs (LCC) of various energy saving measures that could be executed at the building, and can be used as a decision-support-system. Basis for the calculation is the European standard PrEN 832 "Thermal performance of buildings". With a database of investment costs the tool produces a list of energy saving measures ordered by their LCC. Depending on the LCC the user decides which of the possible measures are to be conducted.

Considered topics are **Energy** (improved insulation of building envelope, improved windows, heat recovery of ventilation air, solar heating system for domestic hot water, solar heating system of the ventilation air) and **Water** (water savings, improvement of the distribution system and the furnace).

There is no scoring, but LCCs for the different measures are the results of the assessment. The tool functions as a decision-support-system and no award is assigned. The life cycle costs are calculated as a self-assessment without external supervision.

Green Diploma

Logo	Dimensions	Lifecycle	Building Lifetime	Elements
	■ ecology ■ economy ■ society ■ technology	☐ planning ■ construction ■ operation ☐ demolition	-	■ building ☐ environment ☐ site ☐ infrastructure
Development Type	**Typical Purpose**	**Main Users**	**Planning Stage**	**Required Resources**
☐ universal ■ new development ■ refurbishment ☐ demolition ☐ maintenance	☐ universal ☐ fast screening ■ def. of quality ☐ consensus build. ☐ award./benchm. ■ decision support ■ controlling	☐ universal ■ planner/designer ☐ municipality ■ consultant ☐ researcher ☐ jury ☐ management ■ client/owner	☐ unspecific ■ scoping ■ concept ■ implementation ■ monitoring/mgmt.	☐ low ☐ medium ■ high ☐ flexible

The Green Diploma [see Pedersen et al. 2007] is provided by the National Organisation of Housing Associations. It was developed in cooperation with two consulting companies, and intends to lower the CO_2 and other hazardous emissions, to minimise the operation costs due to reduced energy bills, and to offer an improved comfort and a healthier indoor air climate. The award is given to housing associations for their efforts in reducing environmental impacts and increasing energy efficiency. As new improvements of the method, now also private house owners as well as housing cooperatives are able to use the system.

The system considers the "Requirements of Energy Perfomance of Buildings Directive (Low Energy Class 2)" [European Parliament and Council of the European Community 2002] by indicators such as base, floor slab, basement, renewable energy, energy quality control, quality control, environmental requirements etc. and the "Improved Environmental Conditions" which are more or less the same, but request a higher level.

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As the main focus of the method is to minimise the operational costs for the housing associations energy for heating, hot water and electricity is most important. The reporting is organised by the tenants' committee or as part of the general reporting of the housing association on basis of a self-assessment. The reporting can be executed online. The Green Diploma is awarded for one year, and can be renewed in case all requirements are met. The Green Diploma is awarded when the minimum requirements, the requirements set by the Building Directive (low energy class 2), and 15 issues of the list of improved environmental conditions elaborated by the developers of the system are fulfilled.

Green Build[6]

Logo	Dimensions	Lifecycle	Building Lifetime	Elements
	■ ecology ■ economy ■ society ■ technology	☐ planning ■ construction ■ operation ☐ demolition	-	■ building ■ environment ■ site ■ infrastructure
Development Type	**Typical Purpose**	**Main Users**	**Planning Stage**	**Required Resources**
☐ universal ■ new development ■ refurbishment ☐ demolition ☐ maintenance	☐ universal ☐ fast screening ■ def. of quality ☐ consensus build. ☐ award./benchm. ■ decision support ■ controlling	☐ universal ■ planner/designer ■ municipality ■ consultant ☐ researcher ☐ jury ☐ management ■ client/owner	☐ unspecific ■ scoping ■ concept ■ implementation ■ monitoring/mgmt.	☐ low ■ medium ☐ high ☐ flexible

"Green Build" [see SolarVent n.d.] provided by SolarVent in cooperation with Cenergiy is an energy and environmental rating system for urban development areas and buildings with focus on use of healthy and sustainable building materials and optimisation of heat, electricity and water consumption, energy supply, indoor climate and waste treatment. The questionnaire can be used to document sustainability of buildings.

The topics considered by the scheme are "Building Urban Development Area & Methods for Sustainable Development & Sustainable Urban Management", "Waste", "Materials & Construction", "Energy", "Indoor Air Climate", and "Water, Rainwater, Sewage". The system is overarching and covers all three dimensions of sustainability plus technical aspects.

The Green Build questionnaire is used by municipalities to gather information on the mentioned areas (categories) of sustainability from (potential) house owners. These are requested to fill in the questionnaire, and submit these to the municipality. The Green Build tool shall make it possible to asses and compare European municipalities, buildings and developments with each other concerning the individual environmental performance. The tool is used to measure the performance of urban developments, and produce comparable results.

Points are attached to the criteria of the questionnaire in self-assessment, the achieved score shows the level of sustainability (from A to M) compared to the local standard. It is not fully clear whether there is a real certificate, but probably the owners receive a documented proof of a building's sustainability.

[6] http://www.greenglobal21.com

Further Schemes

There are more assessment schemes available such as BEAT 2002 and Environmental Indicators for Buildings (both developed under the patronage of the Danish Building Research Institute) which will be analysed in the second report to complete the picture.

10.1.1.5.2 Germany

In 2009 DGNB (Deutsche Gesellschaft für Nachhaltiges Bauen = German Sustainable Building Council) with support from the German Building Ministry published an assessment scheme, called DGNB label, which covers six different “qualities“ (which can be interpreted as “topics”): ecological, economic, socio-cultural, functional, process and site quality. The scheme draws an overarching picture of a building’s sustainability being one of the few taking all three dimensions into account: ecology, economy and society. Nevertheless, there are further methods available on the market including the international versions of BREEAM and LEED, or other schemes developed in Germany such as the Guideline Sustainable Building, Green House No., ImmoPass or BNB.

DGNB Label[7]

Logo	Dimensions	Lifecycle	Building Lifetime	Elements
DGNB	■ ecology ■ economy ■ society ■ technology	■ planning ■ construction ■ operation ■ demolition	50 years	■ building ■ environment [■ site] ■ infrastructure
Development Type	**Typical Purpose**	**Main Users**	**Planning Stage**	**Required Resources**
☐ universal ■ new development ☐ refurbishment ☐ demolition ☐ maintenance	☐ universal ☐ fast screening ■ def. of quality ☐ consensus build. ■ award./benchm. ☐ decision support ■ controlling	☐ universal ■ planner/designer ☐ municipality ■ consultant ☐ researcher ☐ jury ☐ management ☐ client/owner	☐ unspecific ■ scoping ■ concept ■ implementation ☐ monitoring/mgmt.	☐ low ☐ medium ■ high ☐ flexible

The DGNB label [DGNB 2009] offered by the German GBC provides an overarching approach to assess the sustainability of a building with 49 indicators in 6 categories/qualities.

The label covers six so called qualities: Ecological Quality (12 indicators): impact on global environment, resource consumption, Economical Quality (2 indicators): life cycle costs , property value growth, Socio-cultural & Functional Quality (15 indicators): health wellbeing, & user satisfaction, functionality, assurance of design quality, Technical Quality (5 indicators): quality of technical construction, Process Quality (9 indicators): quality of planning, quality of construction work, Quality of Location (6 indicators, not part of the overall grade): characteristics of the location.

The first step in the procedure to obtain the certificate is to register the project at DGNB. Then, the goals for characteristics of the building according to gold, silver, or bronze are defined. The issued

[7] http://www.dgnb.de/

pre-certificate can be used for marketing reasons. Assessors at DGNB check the planning and construction documentation. In case of compliance with the requirements the final certificate is issued and can be used for marketing. The assessment is carried out by an assessor accredited by DGNB.

Each individual indicator can receive a maximum of 10 points. Each indicator is weighted with a factor from 0 to 3 due to its relevance. The results of the individual topics (such as ecological quality) are derived from the indicators' percentages. The overall result (degree of compliance) is calculated by computing the mean value of all six qualities [see Figure 1]. The award is assigned in four levels: Passed – bronze – silver – gold.

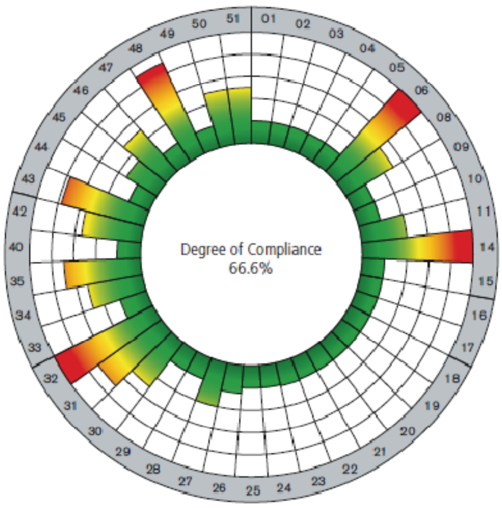

Figure 1: Radar Chart Depicting the results of an Assessment According to Gütesiegel [Source: DGNB 2009, p.10]

Guideline Sustainable Building[8]

Logo	Dimensions	Lifecycle	Building Lifetime	Elements
Federal Ministry of Transport, Building and Urban Development	■ ecology ■ economy ■ society ■ technology	■ planning ■ construction ■ operation ■ demolition	50 to 100 years	■ building ■ environment ■ site ■ infrastructure
Development Type	**Typical Purpose**	**Main Users**	**Planning Stage**	**Required Resources**
■ universal ☐ new development ☐ refurbishment ☐ demolition ☐ maintenance	☐ universal ☐ fast screening ☐ def. of quality ■ consensus build. ☐ award./benchm. ☐ decision support ■ controlling	☐ universal ■ planner/designer ☐ municipality ☐ consultant ☐ researcher ☐ jury ■ management ☐ client/owner	■unspecific ☐ scoping ☐ concept ☐ implementation ☐ monitoring/mgmt.	☐ low ☐ medium ■ high ☐ flexible

[8] http://www.bmvbs.de/Bauwesen/Arbeitshilfen_-Leitfaeden_-Ric/Leitfaeden-,3016.4165/Leitfaden-Nachhaltiges-Bauen.htm

The Guideline Sustainable Building [see BBR 2001] provided by the Federal Ministry of Transport, Building and Urban Development focuses on governmental buildings and serves as a guideline for green building practices.

The assessment scheme recognises ecological, economic and socio-cultural aspects.
The topic "Ecology" is divided into demand for new developments, sustainable use of land and natural resources, durability and universal usability of the building, easy dismantling utilisation of environmental and health sound materials, requirements during operation, minimisation of further operational requirements. "Economy" covers expenses in development phase (DIN 276) and expenses in operation phase. "Socio-cultural" topics consist in requirements exceeding the usual integration into environment etc. such as special requirements for accessibility for handicapped, heritage protection etc.

The scheme can be used as a guideline, and the focus is on the planning stage though all phases of the lifecycle are considered.

In the decision-making process the guideline can be used to determine whether a new development is necessary, or the re-use of existing buildings is a better alternative in terms of sustainability. The user can consult the guideline in the different planning stages concerning appropriate solutions to ensure the execution of the building in line with the requirements in the three dimensions of sustainability: ecology, economy and society. Upon completion a building passport is issued which can be regarded as a building manual providing information about relevant characteristics of the building and operating instructions.

The assessment is performed during the planning process and the construction phase as a "self-assessment" by following the suggestions and/or requirements stipulated in the checklists of the guideline. The final document issued is the so called "building passport".

Assessment Scheme for Federal Administration Buildings[9]
(Bewertungsystem Nachhaltiges Bauen = BNB)

Logo	Dimensions	Lifecycle	Building Lifetime	Elements
Federal Ministry of Transport, Building and Urban Development	■ ecology ■ economy ■ society ■ technology	■ planning ■ construction ■ operation ■ demolition	50 years	■ building ■ environment [■ site] ■ infrastructure
Development Type	**Typical Purpose**	**Main Users**	**Planning Stage**	**Required Resources**
☐ universal ■ new development ☐ refurbishment ☐ demolition ☐ maintenance	☐ universal ☐ fast screening ■ def. of quality ☐ consensus build. ■ award./benchm. ☐ decision support ■ controlling	☐ universal ■ planner/designer ☐ municipality ■ consultant ☐ researcher ☐ jury ☐ management ☐ client/owner	☐ unspecific ■ scoping ■ concept ■ implementation ☐ monitoring/mgmt.	☐ low ☐ medium ■ high ☐ flexible

[9] http://www.nachhaltigesbauen.de

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The system [see BMVBS 2009] focuses on new governmental buildings and is based on the DGNB label as well as on the aformentioned Guideline Sustainable Building. There are slight differences concerning the selected indicators, but in principal both schemes are virtually identical.

Covered topics: Ecological Quality (11 indicators): e.g. global warming potential, ozone depletion potential, photochemical ozone creation potential, acidification potential etc., Economical Quality

(2 indicators): building-related life cycle costs, value stability, Socio-cultural & Functional Quality (15 indicators): e.g. thermal comfort in the winter, thermal comfort in the summer, indoor hygiene, acoustical comfort, etc., Technical Quality (3 indicators): noise protection, energetic and moisture proofing quality of the building's shell, ease of cleaning and maintenance of the structure, Process Quality (9 indicators): e.g.: quality of the project's preparation, integral planning, optimization and complexity of the planning approach, evidence of sustainability considerations during bid invitation and awarding, etc., Quality of Location (6 indicators, not part of the overall grade): e.g.: risks at the micro location, circumstances at the micro location, characteristics of the quarter, connection to transportation, etc.

The procedure is not indicated in the documents explaining the scheme. However, due to the affinity to the DGNB scheme the approach to certification should be similar. That means, the building must be registered, and the relevant documentation must be submitted. After a check by the assessors the certificate can be issued.

Each individual indicator can receive a maximum of 100 points. Each indicator is weighted with a factor from 1 to 3 due to its relevance. The calculation of the overall result (degree of compliance) is published in the document “BNB_Berechnungsregel“10 at the information portal.

ImmoPass[11]

Logo	Dimensions	Lifecycle	Building Lifetime	Elements
	■ ecology ■ economy ☐ society ■ technology	■ planning ■ construction ☐ operation ☐ demolition	n.a.	■ building ■ environment ☐ site ■ infrastructure
Development Type	**Typical Purpose**	**Main Users**	**Planning Stage**	**Required Resources**
☐ universal ■ new development ■ refurbishment ☐ demolition ☐ maintenance	☐ universal ☐ fast screening ■ def. of quality ☐ consensus build. ■ award./benchm. ☐ decision support ■ controlling	☐ universal ■ planner/designer ☐ municipality ☐ consultant ☐ researcher ☐ jury ☐ management ■ client/owner	☐ unspecific ■ scoping ■ concept ■ implementation ☐ monitoring/mgmt.	☐ low ☐ medium ☐ high ■ flexible

The ImmoPass method [see DEKRA 2002] is provided by DEKRA, an engineering and consulting company who developed the scheme in cooperation with the bank HypoVereinsbank. In total there

[10] At the time of compilation of the report, the document has not yet been available at the website (http://www.nachhaltigesbauen.de/)

[11] http://www.dekra-immopass.de/

are roughly 130 different criteria (see Annex for a more comprehensive description) which are assessed during the check. Single criteria among the 6 categories may be fulfilled or not, and accordingly receive a credit or not. The credits are summed up, and a minimum of 100% in each category is required for being awarded the ImmoPass.

Topics considered for the assessment are: building, open space, health & wellbeing, environment, domestic technology (HVACR), and construction work.

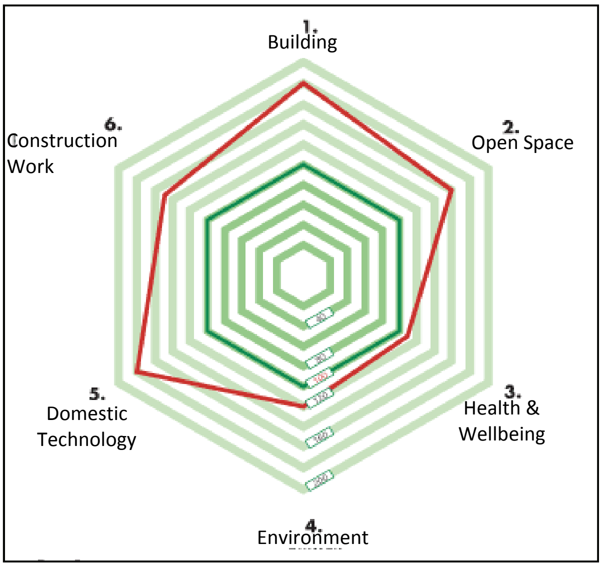

Figure 2: Radar Chart of ImmoPass
[Source: DEKRA 2010]

At the start the customer receives information on the procedure, signs a contract with the assessing organisation (DEKRA REE), and has to send the relevant documents. In the first stage DEKRA conducts two planning checks and sends the result to the customer. In the second stage DEKRA performs three audits at the construction site; the last one includes the measuring of hazardous substances. If the assessment is successful, the ImmoPass certificate is submitted to the customer including photographical documentation and minutes. For refurbishments the procedure is slightly different: Analysis of the current state → refurbishment planning including condition assessment → planning check. The assessment is executed by assessors from DEKRA.

The percentages assigned in all six categories are depicted in a radar chart called “ImmoPass Spider” [see Figure 2]. The customer is awarded the ImmoPass.

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Green House Number Saarland[12]

Logo	Dimensions	Lifecycle	Building Lifetime	Elements
Saarland Ministerium für Umwelt	■ ecology □ economy □ society ■ technology	■ planning ■ construction ■ operation ■ demolition	-	■ building ■ environment □ site □ infrastructure
Development Type	**Typical Purpose**	**Main Users**	**Planning Stage**	**Required Resources**
■ universal □ new development □ refurbishment □ demolition □ maintenance	□ universal □ fast screening □ def. of quality □ consensus build. ■ award./benchm. □ decision support □ controlling	□ universal ■ planner/designer □ municipality □ consultant □ researcher □ jury □ management ■ client/owner	■unspecific □ scoping □ concept □ implementation □ monitoring/mgmt.	□ low ■ medium □ high □ flexible

The assessment scheme [SMU 2009] is provided by the Ministry of Environment of the Federal State Saarland, and aims to reward the efforts of house owners in improving the environmental performance of their house by awarding the so called "Green House Number".

Topics covered by the system are Natural Materials, Solar Architecture, Modern Heating Technology, Water Efficiency, Nature Conservation at the Building, Environmental Protection in Daily Use, Domestic Technology, Passive House characteristics (10-15 kWh/m²·a), Bonus for Buildings for Non-Residential Purposes, Energy Facilities.

The building owner applies for the award at the Ministry of Environment by filling in a questionnaire. In there the relevant indicators are listed and the owner assigns points in case his building complies with the requirements stated. After completion of the questionnaire the application is sent to the Ministry where it is verified. In case of doubts or questions the owner will be asked to clarify, therefore it is recommended to keep the documentation relevant for the construction of the building. The administrators in the Ministry assign the award if the building receives a minimum score of 100 points.

Figure 3: Green House Number Plaque
[Source: SMU 2009a, p.1]

12 http://www.saarland.de/4172.htm

Each indicator has a certain maximum of points (between 2 and 50) depending on the relevance. In case of compliance points can be received for that individual indicator.

The assessment is performed by the house owner him-/herself using the questionnaire. The Green House Number (a plaque bearing the slogan “only for exemplary environmental-sound buildings”, see Figure 3) is handed over on occasion of a publicity effective event in which several Green House Numbers are awarded, thus promoting best practice examples.

Building Letter AKOEH[13]

Logo	Dimensions	Lifecycle	Building Lifetime	Elements
AKÖH	■ ecology ☐ economy ☐ society ☐ technology	■ planning ■ construction ■ operation ■ demolition	-	■ building ☐ environment ☐ site ☐ infrastructure
Development Type	**Typical Purpose**	**Main Users**	**Planning Stage**	**Required Resources**
☐ universal ■ new development ■refurbishment ☐ demolition ☐ maintenance	■ universal ☐ fast screening ☐ def. of quality ☐ consensus build. ☐ award./benchm. ☐ decision support ☐ controlling	☐ universal ■ planner/designer ☐ municipality ■ consultant ☐ researcher ☐ jury ☐ management ■ client/owner	☐ unspecific ☐ scoping ■ concept ☐ implementation ☐ monitoring/mgmt.	■ low ☐ medium ☐ high ☐ flexible

The building letter [AKOEH n.d.] issued by AKOEH, an association to foster the development of environmental sound wooden houses, ensures certain standards (set by AKOEH) such as exclusion of chemical wood protection, excellent thermal protection, avoidance of damages through condensate, etc.

The categories are not used by the provider, but in order to allow comparability the indicators are categorised as follows: **Energy** (compact architecture, passive utilisation of solar radiation, thermal protection (30% below the requirements of EnEV 2002), proof of air tightness through blower-door-test, thermal solar plant recommended, heating system: condensing boiler technology, district heating (CHP), wood pellet boiler and/or furnace recommended), **Materials** (materials selected concerning their environmental impact following the positive list of AKOEH, non recyclable are only allowed in case the demounting can be proved (thermal recycling is not acceptable)), **Indoor Air Quality** (impregnation of wood with chemical wood preservatives is not allowed, prevention of mould, prevention of damages through condensate, automated ventilation with **mechanical ventilation facility** (preferable with re-use of heat energy).

The planning documents are assessed by AKOEH before the start of the construction. During the erection and after completion accredited assessors check the quality of the construction and put an

[13] http://www.akoeh.de/6_1_kriterien.php

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emphasis on energy efficiency. The building letter is issued after the completion of construction works. The assessors who are responsible for the certification process are accredited by AKOEH.

There is no scoring in that sense, but houses built according to the criteria of AKOEH have to fulfil them. The approach offers a documentation of used materials, exact calculation of energy demand (using a method developed by the Institute Habitation and Environment) and actual energy consumption, and technical details of the (wooden) building. The building letter provides therefore a “full declaration” of the building.

The certificate awarded is the AKOEH building letter.

Dwelling Value-Barometer[14]

Logo	Dimensions	Lifecycle	Building Lifetime	Elements
	■ ecology ■ economy ■ society ■ technology	■ planning ■ construction ■ operation ■ demolition	-	■ building ■ environment ■ site ■ infrastructure
Development Type	**Typical Purpose**	**Main Users**	**Planning Stage**	**Required Resources**
☐ universal ■ new development ■refurbishment ☐ demolition ☐ maintenance	☐ universal ☐ fast screening ■ def. of quality ☐ consensus build. ■ award./benchm. ☐ decision support ■ controlling	☐ universal ■ planner/designer ☐ municipality ■ consultant ☐ researcher ☐ jury ☐ management ■ client/owner	■ unspecific ☐ scoping ☐ concept ☐ implementation ☐ monitoring/mgmt.	☐ low ☐ medium ■ high ☐ flexible

The Dwelling Value Barometer [Hegger (ed.) 2010] developed by TU Darmstadt provides an assessment in respect of all sustainability dimensions for existing multi-storey residential buildings. The indicators are not only grouped thematically, but also belong to so called activity radii (apartment, building and residential environment, environment, and process). The purpose is to focus on tenants’ needs by considering their different areas of activities.

Issues the barometer includes are: comfort, flexibility and social diversity, spatial and design quality, functional quality, owner costs and benefits, user costs, resource demand building, overall impact of the building, procedural quality, accessibility and site quality & amenities.

[14] http://www.wohnwert-barometer.de/

The planner/operator uses an Excel tool and the assessment manual to conduct the assessment. The manual includes all relevant information and descriptions of indicators and assessment levels. First, the indicators referring to the activity radius “location”, then the indicators concerning the activity radius “building”, and then the indicators of the individual apartments shall be assessed. Finally, the indicators dealing with processes shall be elaborated.

For each indicator a maximum of 5 points is available – this is e.g. the case when existing buildings reach the energy-efficiency of new built houses. However, if it is even better, bonus points can be attained. For extremely unsound solutions (e.g. health endangering substances) the indicator receives the minimum score of 1 point, and it is possible to lower the points of the whole topic due to this risk. The results for each topic are summarised and graphically displayed as a radar chart. So far, the assessment is executed by the owners and/or planners, but for future versions of the tool an external assessment will be an optional part.

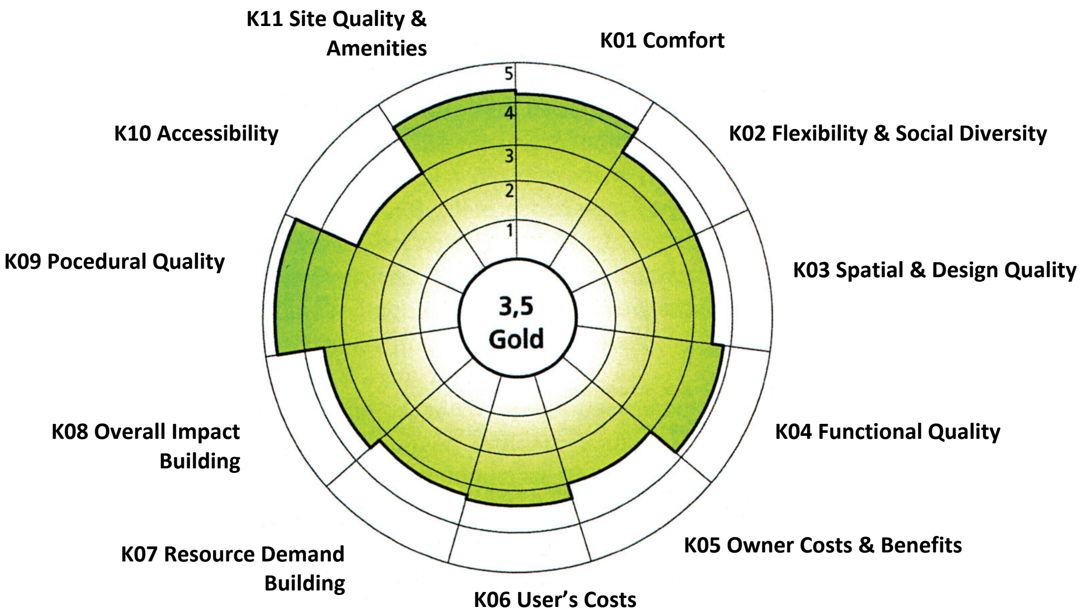

Figure 4: Radar Chart of the Dwelling Value Barometer Results
[Source: Hegger 2010, p.106]

The certificate is a sheet of paper indicating basic information of the building as well as the results of the assessment in a radar chart [see Figure 4] including the classification (bronze – silver – gold).

Further Schemes

In Germany there are also more schemes for sustainable building in use, but their approaches are sometimes very different, or the practical implementation of the developed method and/or importance is not evident. In the upcoming report the selection will be extended, and also include other and some less known methods.

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10.1.1.5.3 Lithuania

Only buildings' energy performance is recognised in legislation (STR 2.01.09: 2005 "Energy performance of buildings. Certification of energy performance of buildings"), while there is no broader assessment scheme available in the moment. Neither one of the renowned international methods nor a national system is used so far. The attitude of actors in the building sector towards assessment schemes in general is unknown, but in the opinion of the inquired partners the majority is sceptical due to the associated higher costs for a certification. Again the missing support from government is lamented.

10.1.1.5.4 Poland

PLGBC initiated to adapt the international assessment schemes BREEAM and LEED to the requirements and the standards in Poland. So far this process is going on, therefore in the moment there is no country-specific method available.

10.1.1.5.5 Russia

The situation in Russia is comparable to the one in Poland. The national GBC is working on an adaption of the BREEAM and LEED system as to be seen from the website of RuGBC. The inquiry with the project partners resulted in the statement, that it is unknown whether a scheme is in preparation.

10.1.1.5.6 International Assessment Schemes

The number of qualitative assessment schemes in many countries of the world has been rising in the recent years. Many countries developed their own systems, while others implemented existing schemes by integrating national specifications.

BREEAM[15]

Logo	Dimensions	Lifecycle	Building Lifetime	Elements
breeam	■ ecology ☐ economy ☐ society ☐ technology	☐ planning ■ construction ■ operation ☐ demolition	-	■ building ■ environment ■ site ■ infrastructure
Development Type	**Typical Purpose**	**Main Users**	**Planning Stage**	**Required Resources**
■ universal ☐ new development ☐refurbishment ☐ demolition ☐ maintenance	☐ universal ☐ fast screening ■ def. of quality ☐ consensus build. ■ award./benchm. ☐ decision support ■ controlling	☐ universal ■ planner/designer ☐ municipality ■ consultant ☐ researcher ☐ jury ☐ management ■ client/owner	■ unspecific ☐ scoping ☐ concept ☐ implementation ☐ monitoring/mgmt.	☐ low ■ medium ☐ high ☐ flexible

The Building Research Establishment Environmental Assessment Method (BREEAM) [see BRE 2009] is a mature assessment system for green building with a focus on environmental topics developed in the United Kingdom and provided by the Building Research Establishment (BRE). The BREEAM scheme exists for several different building types. Analysed here ist the "Code for Sustainable Homes" which is available since April 2007. In May 2008 the scheme became mandatory for all new developments.

Energy & CO_2 emissions, water, materials, surface water run-off, waste, pollution, health & wellbeing, management, and ecology are the topics considered in the assessment. Social and economic aspects are not considered.

The project must be registered with a service provider who provides licensed and trained assessors before detailed designs are finished. The assessment process for the two stages (design stage – post construction stage) is very similar. Evidence is supplied and used as the basis for the assessor to determine how many credits are to be awarded for each issue. A summary report is submitted to the Code service provider for quality assurance and certification. The assessment can be executed by an auditor licensed by BREEAM.

The indicators are assigned typically between 1 and 6 credits. In case of the dwelling emission rate and the environmental impact of materials it can be up to 15. According to the total points an award is assigned in six levels (Level 1 – minimum 36 points up to Level 6 – minimum 90 points).

[15] http://www.breeam.org/

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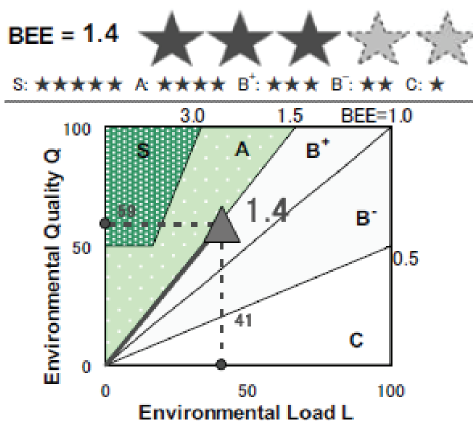
CASBEE[16]

Logo	Dimensions	Lifecycle	Building Lifetime	Elements
CASBEE	■ ecology ☐ economy ☐ society ■ technology	■ planning ■ construction ■ operation ■ demolition	-	■ building ■ environment ■ site ■ infrastructure
Development Type	**Typical Purpose**	**Main Users**	**Planning Stage**	**Required Resources**
☐ universal ■ new development ■ refurbishment ☐ demolition ■ maintenance	☐ universal ☐ fast screening ☐ def. of quality ■ consensus build. ■ award./benchm. ☐ decision support ■ controlling	☐ universal ■ planner/designer ☐ municipality ■ consultant ☐ researcher ☐ jury ☐ management ■ client/owner	■ unspecific ☐ scoping ☐ concept ☐ implementation ☐ monitoring/mgmt.	☐ low ☐ medium ■ high ☐ flexible

The Japanese tool CASBEE [see JSBC 2008] provided by the Japan Sustainable Building Consortium can be used as a guideline for architects/developers as well as an environmental labelling tool. The CASBEE system approach is to sum up both the environmental performance of a building and the environmental load, and divide these by each other. The resulting grade is higher, the more environmentally friendly a building is and the lower the environmental impacts are.

The assessment can be executed at three stages of the building development: at preliminary design, execution design or construction phase. If necessary the design can be adjusted to the needs in order to meet the targeted specifications concerning environmental performance and impacts. The method can be executed by a self-assessment, but third-party experts can be involved as well.



[16] http://ibec.or.jp/CASBEE/english/index.htm

Figure: Chart Depicting the Results of a CASBEE Assessment
[Source: JSBC 2008, p.31]

The points for the individual indicators are calculated according to the respective performance/impact. The overall grade (BEE = building environmental efficiency) is computed by dividing the environmental performance Q by the environmental load L. The CASBEE award is divided into four stages: S: BEE ≥3.0 – A: BEE ≥1.5 – B+: BEE ≥1.0 – B-: BEE ≥0.5 – C: BEE ≤0.5. S is the best level, while C is the worst (see Figure).

Green Star[17]

Logo	Dimensions	Lifecycle	Building Lifetime	Elements
	■ ecology ☐ economy ☐ society ☐ technology	☐ planning ■ construction ■ operation ☐ demolition	-	■ building ■ environment ■ site ☐ infrastructure
Development Type	**Typical Purpose**	**Main Users**	**Planning Stage**	**Required Resources**
☐ universal ■ new development ■ refurbishment ☐ demolition ☐ maintenance	☐ universal ☐ fast screening ☐ def. of quality ■ consensus build. ■ award./benchm. ☐ decision support ☐ controlling	☐ universal ■ planner/designer ☐ municipality ■ consultant ☐ researcher ☐ jury ☐ management ■ client/owner	■ unspecific ☐ scoping ☐ concept ☐ implementation ☐ monitoring/mgmt.	☐ low ■ medium ☐ high ☐ flexible

The Australian Green Star rating tool [see GBCA 2010] focuses on the ecology, and is no holistic approach to assess the sustainability of buildings. Provider of the tool is the Green BuildingCouncil Australia (GBCA).

The Green Star system includes the following issues: management, indoor environmental quality, energy, transport, water, materials, land use & ecology, emissions, and innovation.

The project can be self-assessed using the rating tool as a guideline. In case the Green Star achievements are to be promoted /marketed a formal assessment is required. Firstly, the eligibility of the project has to be verified by the applicant. If so, project registration follows secondly. Third step is the submission of the project's documentation by the applicant. The GBCA then assesses the project and informs the applicant about the results. When the rating is achieved the certificate can be awarded. If not, a second round is necessary, in which the applicant hands in improved documentation. Another assessment is executed, and again depending on the results the rating is achieved or not [see Figure 5]. The assessment can be performed by owner, but in order to verify the assessment and to decide about the rating third-party assessors commissioned by GBCA are required.

[17] http://www.gbca.org.au/

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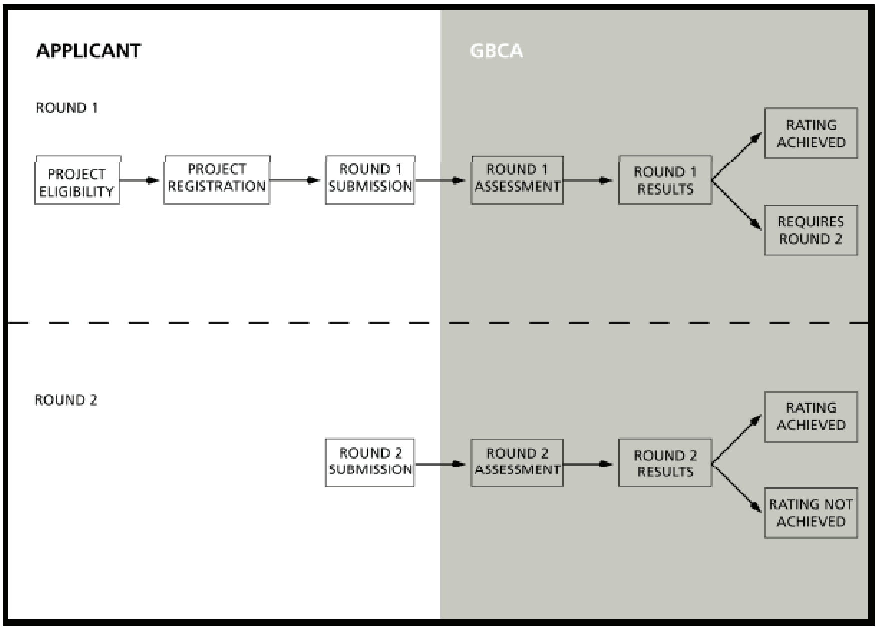

Figure 5: Green Star Certification Procedure
[Source: GBCA 2009, p.1]

The user enters the predicted number of points in each category. Calculators are provided for a number of the tool's credits. Points that may be achieved but need to be confirmed must be entered in the 'Points to be confirmed' column. The predicted rating is shown in the Summary worksheet. More detail on point scores (both achieved and those to be confirmed) are shown in the Credit Summary and Graphical Summary worksheets at the end of the tool. After the certification up to 6 green stars are awarded.

LEED[18]

Logo	Dimensions	Lifecycle	Building Lifetime	Elements
	■ ecology ☐ economy ☐ society ☐ technology	■ planning ■ construction ■ operation ■ demolition	-	■ building ■ environment ■ site ☐ infrastructure
Development Type	**Typical Purpose**	**Main Users**	**Planning Stage**	**Required Resources**
☐ universal ■ new development ■ refurbishment ☐ demolition ☐ maintenance	☐ universal ☐ fast screening ■ def. of quality ☐ consensus build. ■ award./benchm. ☐ decision support ■ controlling	☐ universal ■ planner/designer ☐ municipality ■ consultant ☐ researcher ☐ jury ☐ management ■ client/owner	■ unspecific ☐ scoping ☐ concept ☐ implementation ☐ monitoring/mgmt.	☐ low ■ medium ☐ high ☐ flexible

[18] http://usgbc.org/

The Leadership in Energy and Environmental Design (LEED) approach [see USGBC 2009] is highly professional, but focuses only on the environmental performance of buildings, and so does not deliver a really holistic sustainable view. The GBC of the United States is the providing institution.

Issues covered by the LEED approach: indoor environmental quality, materials & resources, energy & atmosphere, water efficiency, sustainable sites, innovation & design, and regional priorities.

The applying project team has to register with GBCI (Green Building Certification Institute). The application including the documentation for all credits chosen to pursue has to be submitted online. The application is reviewed either in a combined or split design & construction review depending on the applicant's preference. In the preliminary review GBCI professionals check for completeness and compliance of the application, designate "anticipated", "pending" or "denied" to the prerequisites and credits, and approve the project information or not. The applicant may accept this review or submit a response after which the final review is executed. As a result prerequisites and credits are finally awarded or denied, and the project information is approved or not. The result including technical advice is sent to the project team. The method is performed as self-assessment supervised by GBCI experts. (The project earns a further credit when at least one LEED accredited assessor is part of the project team).

There are prerequisites (up to 3) in each category that must be fulfilled in order to receive certification. For each credit (indicator) the development can be assigned one or more points depending on the available points and the performance of the building in the referring indicator. In total up to 115 points can be reached. Levels of the award are "certified" (40-49 points) – "silver" (50-59) – "gold" (60-79) – "platinum" (80+).

LEnSE[19]

Logo	Dimensions	Lifecycle	Building Lifetime	Elements
LEnSE	■ ecology ☐ economy ☐ society ☐ technology	■ planning ■ construction ■ operation ■ demolition	-	■ building ■ environment ■ site ☐ infrastructure
Development Type	**Typical Purpose**	**Main Users**	**Planning Stage**	**Required Resources**
☐ universal ■ new development ■ refurbishment ☐ demolition ☐ maintenance	☐ universal ☐ fast screening ■ def. of quality ☐ consensus build. ■ award./benchm. ☐ decision support ■ controlling	☐ universal ■ planner/designer ☐ municipality ■ consultant ☐ researcher ☐ jury ☐ management ■ client/owner	■ unspecific ☐ scoping ☐ concept ☐ implementation ☐ monitoring/mgmt.	☐ low ■ medium ☐ high ☐ flexible

The LEnSE (Label for Environmental, Social and Economic Buildings) method [see LEnSE Partners 2007] was developed as an initative of an international EU project under the auspices of the Belgian Building Research Institute. The main goal of LEnSE is to provide a methodology for assessing existing, new and renovated buildings concerning their sustainability. Thereby acceptability of the scheme for the European stakeholders involved in sustainable construction was of great importance.

[19] http://www.lensebuildings.com

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The topics covered by this method incorporate all three dimensions of sustainability: climate change, biodiversity, resource use & waste, environmental management & geophysical risk (ecology), occupant wellbeing, accessibility, security, social & cultural value (society), financing & management, whole life values, externalities (economy).

The procedure is not fully clear as none of the documents dealing with the LEnSE method discusses the actual procedure of receiving certification. In addition the scheme is not yet operational and tested only for some pilot building projects.

The assessed building can achieve points in the various categories. The rating (A-B-C) for the categories is based on the degree of compliance and summarised for the three dimensions of sustainability, and, finally, for the building. The methodology is designed to fit into various countries, whereas the weighting of the categories is adjusted to the specific needs in the country.

LEnSE rating:	B
Total achieved points:	820,7
Total available points:	970 *

Environmental performance:	B
Social performance:	B
Economic performance:	B

	Category	Rating	Points achieved	Available points
Enviromental	Climate change	B	163	190
	Biodiversity	A	164	175
	Resource use	C	99	125
	Env. & Geophysical risk	A	25	25
Social	Occupant wellbeing	B	127	150
	Accessibility	B	44	50
	Security	B	22	25
	Social and cultural value	D	67	100
onomic	Financing and management	B	21	25
	Whole life value	B	73,7	90

Figure 6: LEnSE Rating
[Source: LEnSE Partners 2007, p.6]

The method is applied through a self-assessment based on an Excel tool. The rating result is classified in four stages: A, B, C or D [see Figure 6].

SBTool[20]

Logo	Dimensions	Lifecycle	Building Lifetime	Elements
iiSBE	■ ecology ■ economy ■ society ■ technology	■ planning ■ construction ■ operation ■ demolition	75	■ building ■ environment ■ site ■ infrastructure
Development Type	**Typical Purpose**	**Main Users**	**Planning Stage**	**Required Resources**
■ universal □ new development □ refurbishment □ demolition □ maintenance	□ universal □ fast screening ■ def. of quality □ consensus build. ■ award./benchm. □ decision support ■ controlling	■ universal □ planner/designer □ municipality □ consultant □ researcher □ jury □ management □ client/owner	□ unspecific ■ scoping ■ concept ■ implementation ■ monitoring/mgmt.	□ low □ medium ■ high □ flexible

The SB Tool [see IISBE 2007] is provided by the Initiative for a Sustainable Built Environment and can be seen as the successor of the GB Tool and as such a result of the Green Building Challenges – between 1998 and 2005. It is a thorough system with a focus on new developments that requires enormous efforts for the assessor and the owner. The tool is a rating framework that needs to be calibrated to local/regional/national conditions to function as a rating tool.

Covered issues: site selection, project planning & development, energy & resource consumption, environmental loadings, indoor environmental quality, service quality, social & economic aspects, cultural & perceptual aspects.

The procedure to receive the certification starts with the definition of scope, context weights and benchmarks in the first step. The design team defines the basic and detailed project characteristics (second step of the tool). The design team enters the performance targets and official self-assessment values (step 3). Then an independent assessor reviews the self-assessment. This report is verified by the local iiSBE, and in case of compliance the certification is successfully completed.

There are three levels of parameters; Issues, Categories and Criteria; Criteria score according to the following scale: -1 = deficient, 0 = minimum acceptable performance, +3 = good practice, +5 = best practice. Criteria scores are weighted and category scores are the total of weighted criteria scores. Issue scores are the total of weighted category scores. The certification encompasses a performance profile, a performance explanation, and an eco-label.

Many of the existing methods presented here have similarities in the selected topics/issues or in the procedural conception of the certification process. The next chapter gives a first comparison of the schemes with respect to several important aspects.

[20] http://www.iisbe.org/sbtool

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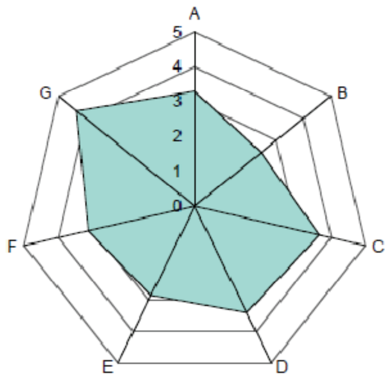

Figure 7: Resulting Chart of a SB Tool Assessment
[Source: IISBE 2007, p.12]

10.1.1.5.7 Summary

Though there are differences between the asessment schemes presented in this review the general structure of the systems is relatively similar, and the main topics considered for the assessment are nearly the same. The more specialised methods provide some particular characteristics such as the consideration of aspects which can not be found in the other systems.

In the next chapter the schemes are compared with each other focussing on the topics consider for the assessment.

10.1.1.6 Comparison of Assessment Schemes

In this report a first comparative analysis is performed in which the schemes are examined concerning the topics covered in the individual assessment. Additionally, there are some remarks on the procedure of the certification as well as a short overview over the scoring and weighting principles applied in the systems.

In literature, in guidelines, and in manuals etc. dealing with schemes for sustainable building (and in measuring sustainability in general) there is the problem of dividing the different levels of categories. Themes, categories, sectors, topics, issues, criteria, aspects, indicators, etc. can all be used to fulfil this task. For this project the structure depicted in Figure 8 will be applied.

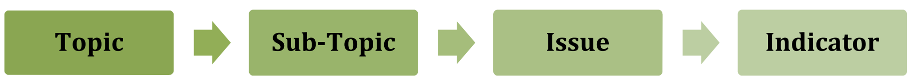

Figure 8: Division of categories and criteria applied in the expertise
[Source: author]

Topics are the top-level categorisation, and incorporate in particular the three dimensions or pillars of sustainability: Ecology, Economy and Society. In some cases there are slightly differing denominations such as ecological quality. Additionally, in several assessment schemes other topics are integrated such as process quality or service quality. As they appear on the top-level as well these are also considered as “topics” though they are actually no pillars of sustainability.

These topics may consist of a number of sectors which form the second level. Examples of such are “indoor environment” or “energy”.

Sub-topics on their part compose of issues. For example, the aforementioned sector “indoor environment” is divided into the issues “noise & acoustics”, “thermal comfort”, “lighting & illumination” and “air quality”.

Finally, these issues are made up of indicators. Indicators can be regarded as measurable parameters giving evidence of at least a part of the referring issue. The issue “thermal comfort” for example is indicated by three indicators, namely “room temperature control”, “humidity control” and “type of air conditioning system”. Depending on the assessment scheme’s method and the indicator in question either a real value (e.g. 20 °C) is required or points are assigned referring to the building’s degree of compliance in this aspect.

It should be noted that not all assessment schemes are divided into this four-level system. Some lack sectors, others do not include issues, few only consists of topics and indicators.

So far 20 assessment schemes have been examined concerning the criteria involved and considered in the certification process. Table **2** depicts the results from the analysis. A full box represents full consideration of the topic in the assessment procedure (4 points), while an unfilled box means that the topic lacks single aspects (3 points). A full circle stands for consideration of the topic as an indicator only (2 points), and an unfilled circle shows that only single aspects of the topic are integrated as an indicator (1 point). Finally, a dash signifies that the topic is not at all considered in the assessment method.

If the points assigned to the topics are added, the top 5 considered in the assessment schemes are “Energy & Atmosphere”, “Water Efficiency”, “Materials & Resources”, “Renewable Energy” and “Pollution & Emissions”. This emphasises the results from the inquiry among the project partners that the most remarkable sustainable building topics in the examined countries are energy and materials. Energy and its efficient use are considered in all systems, while questions of the material selection are missing in some specific methods such as Opti Build or ASCOT. Water efficiency, however, is even more recognized than materials. A possible explanation for this may be the relevance of water consumption for the operation costs.

With reference to the assessment schemes and their examination regarding the involved scope of

topics, the following methods are ranked on top: SB Tool, DGNB label, Assessment Scheme for Federal Administration Buildings (BNB), Dwelling Value Barometer (DVB) and LEnSE. It should be stated here that the filing as top 5 does not necessarily make them a good method. It only indicates that the mentioned systems are holistic in the sense that they incorporate most of the topics generally appearing in context with sustainability. In the midfield the international systems such as Green Star, BREEAM, CASBEE, LEED, etc. follow representing a type of system that covers most and especially the most important topics of sustainability, but simultaneously not considering aspects beyond the mere ecological approach. The number of points gained for socio-culture or economic aspects are less than with the aforementioned top 5 systems. Those assessment schemes like AKOEH Building Letter or ASCOT which are more focused are as a matter of course not able to gain many points in total from the whole range of topics just because of their specialisation.

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Table 2: Sectors Covered by the Analysed Assessment Schemes

■ fully considered as a topics □ partly considered as a topics

● fully considered as an indicator ○ partly considered as an indicator

– not considered

Scheme	Energy & Atmosphere	Water Efficiency	Materials & Resources	Renewable Energy	Pollution & Emissions	Indoor Environ-mental Quality	Health & Wellbeing	Economic Quality	Landuse & Ecology	Sustainable Sites	Waste & Recycling	Transport/Location & Linkages	Maintenance/Operation	Management	Socio-Cultural Aspects	Function	User Awareness/Education	Innovation/Design Process	Score Scheme
SB Tool	■	■	■	■	■	■	–	■	■	■	■	●	■	●	■	■	●	–	58
DGNB label	■	■	■	■	■	–	■	■	–	□	■	■	■	■	■	■	–	–	55
BNB	■	■	■	■	■	–	■	■	–	□	■	■	■	■	■	■	–	–	55
DVB	□	□	■	●	●	□	□	■	●	●	■	■	●	■	■	■	■	–	54
LEnSE	□	●	■	■	■	●	■	■	■	■	■	■	●	–	■	–	–	–	49
Green Build	■	■	■	□	–	■	–	●	●	●	■	–	□	□	□	●	●	–	42
Green Star	■	■	■	–	■	■	●	–	■	–	–	■	–	■	–	–	□	■	41
GSB	□	□	○	■	●	–	–	■	■	■	■	●	■	–	■	–	–	–	39
BREEAM	■	■	■	–	■	–	■	–	■	–	■	●	–	■	–	–	■	–	38
CASBEE	■	■	■	■	■	■	–	–	■	□	–	–	□	–	–	■	–	–	38
LEED	■	■	■	●	●	■	□	–	–	■	●	□	–	●	–	–	–	■	38
Green Diploma	■	■	■	■	□	■	□	●	○	–	○	○	○	–	○	●	○	–	36
ImmoPass	■	■	■	■	●	○	■	–	□	■	–	–	○	○	–	–	–	○	33
Green House No.	■	■	■	■	□	–	–	–	■	■	–	–	–	–	–	–	□	–	30
Green Mark	■	■	●	●	–	■	●	–	●	–	●	●	–	●	–	–	●	–	28
MINERGIE®-ECO	■	■	■	–	–	■	■	□	□	–	–	–	–	–	–	–	–	–	26
AKOEH Build. L.	■	–	□	■	■	■	■	–	–	–	–	–	–	–	–	–	–	–	23
Miljöklassad	■	■	–	□	□	■	□	–	–	–	–	–	–	–	–	–	–	–	21
Opti Build	■	■	–	–	–	–	–	□	–	–	–	–	□	–	–	–	–	–	14
ASCOT	■	–	–	–	–	–	–	■	–	–	–	–	–	–	–	–	–	–	8
Score Topic	81	68	62	52	49	48	44	42	41	37	37	32	31	30	28	24	21	9	

The general procedure is relatively similar under most of the schemes. The user (planner or house owner) applies for the certification with the providing institution. Usually, the required documentation has to be sent already at this stage. The actual assessment can be performed either by an assessor or the user himself as a self-assessment using the checklist, questionnaire or software tool provided by the assessing organisation. A comparison considering the procedural conception in-depth will be provided in the second report.

Most of the schemes rely on a "scoring board" system. Depending on the degree of compliance points are assigned for the individual indicators based on a scale ranging for example from 0 to 10 or 0 to 100%. A certificate usually is awarded in case the building complies with the general minimum requirements (if these are requested) and receives the minimum required score. Most of the schemes offer different levels or classes of their certificate. Typically, but not necessarily, there are four of them: a buildig complying with the minimum requirements/score receive a "passed" or "certified", while the better ones are certified as "bronze", "silver" or "gold" for example. The question of scoring and weighting of the topics/sub-topics within the different schemes are touched again in the second report as well.

In the final chapter the results gathered from this first analysis are addressed and an outlook for the future research needs is given.

10.1.1.7 **Results & Outlook**

The results are presented summarising the situation of sustainable building including the establishment of GBCs in the five countries. Also, the results of the comparison of the assessment schemes are presented.

Results

The situation in the five countries involved in the LONGLIFE project differs substantially.

With regard to national GBCs only Germany, Poland and Russia can be mentioned having established a formal institution dealing with sustainable building issues. Astonishingly, the German GBC was only founded in 2008, though the topic of sustainability in the building sector had been on the agenda since more than two decades. The conclusion to be drawn from this fact: there is no correlation between the existence of a GBC in a country and the market penetration of sustainable building. It becomes even more evident in Poland and Russia where GBCs are established in the meanwhile, but the relevance of sustainable building is much poorer than in Denmark for example where no GBC exists, but sustainable building practices are common in the construction sector.

While in Denmark and Germany a vast number of assessments schemes are available, countries such as Poland, Russia or Lithuania just seem to start a discussion on sustainable building issues and certification respectively. In the cases of Poland and Russia the members of the national GBCs seem to pursue a strategy to implement the internationally renowned rating systems BREEAM and LEED (eventually also the DGNB system) into the country.

Regarding the assessment schemes the situation is characterised by an immense range of available methods. Some methods aim to provide the user with a guideline to sustainable building rather than functioning as a certification system. Though it is possible to receive a certification at the end of the day, the focus of such systems is to act as a manual for the planner or house owner, assist him or her in defining targets for a building, and check whether these targets have been met after completion of the development project.

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Outlook

For the upcoming report the comparison of the assessment schemes will be extended to further more procedural and conceptual aspects. A more detailed analysis of the structure of the systems and how the certification is actually performed will give important hints on the design of an adapted assessment scheme. The scientific background of the individual schemes will be examined as well as the procedure of producing the scores and overall results will be analysed in detail.

Nevertheless, some principal requirements for a user-accepted assessment scheme based on Blum, Hofmann, Deilmann (2001, p.67) can be given at this stage already:

Without the **definition of clear goals** for the issues and indicators it is not imaginable to develop a usable and accepted assessment scheme. This also extends to the target groups which should be identified beforehand to compile a system that includes the specific needs and requirements of the real users.

Construction procedures in general can be characterised as relatively complex, and they become even more complex with the integration of sustainable building principles. In order to increase the house owners aptitude to decide for an assessment of their development it is crucial **to keep the procedure as simple** as possible without actually endangering the plausibility and validity of the assessment results.

As a voluntary instrument the assessment scheme **must be designed to serve the needs of the user**; again simply in order to ensure the acceptability of it and at the same time providing all relevant information. Otherwise the risk is at hand that another intelligent instrument is only compiled for the folder or drawer, and will not be used in reality.

The **continual updating** is a requirement comparable to the common procedure required for quality management or environmental management systems. It refers to monitoring the performance of the building with regard to its demand of energy, water and other resources during operation, but as well to the consideration of further, stricter indicators within certain periods of time.

Additionally, for the framework to be developed under the umbrella of Longlife, the experience, opinions and remarks of the involved project partners and other stakeholders in the partner countries will be invaluably important.

10.1.2 Report 2

Comparison concerning indicator catalogues, methods of weighting 6 scoring, institutional and procedural concept, and communicational instruments of the assessment schemes

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List of Assessment Schemes Examined

In the table below the assessment and certification schemes taken into account for the analysis are indicated including the abbreviation used in this report (where necessary), the country and the bibliographic reference the information used in this report originates from.

Table 3 List of examined certification schemes (names, abbreviations, countries and references)

Name – *Original Name*	Abbr.	Country	Reference
Assessment of Sustainable Construction and Technologies Cost	ASCOT	International/ Denmark	Morck 2004
Assessment Scheme for Federal Administration Buildings – *Bewertungssystem Nachhaltiges Bauen für Bundesgebäude*	BNB	Germany	BMVBS 2009
Building Research Establishment Environmental Assessment Scheme: Code for Sustainable Homes	BREEAM-CSH	UK	BRE 2009
Building Letter AKOEH – *Gebäudebrief AKOEH*	AKOEH	Germany	AKOEH n.d.
Comprehensive Assessment System Building Environmental Efficiency	CASBEE	Japan	JSBC 2008
German Sustainable Building Certification – *Deutsches Gütesiegel Nachhaltiges Bauen*	DGNB	Germany	DGNB 2009
Dwelling Value Barometer – *Wohnwert-Barometer*	DVB	Germany	Hegger 2010
Green Build		Denmark	SolarVent n.d.
Green Diploma		Denmark	Pedersen 2007
Green House No. Saarland – *Grüne Hausnummer Saarland*		Germany	SMU 2009
Green Mark		Singapore	BCA 2008
Green Star		Australia	GBCA 2009
Guideline Sustainable Building – *Leitfaden Nachhaltiges Bauen*	GSB	Germany	BBR 2001
ImmoPass		Germany	DEKRA 2002
Leadership in Environmental and Energy Design	LEED	US	USGBC 2009
Label for Environmental, Social and Economic Buildings	LEnSE	International	LEnSE Partners 2007
MINERGIE®-ECO		Switzerland	MINERGIE 2008
Environmental Classification – *Miljöklassad*		Sweden	ByggaBoDialogen n.d.
Opti Build		Denmark	Pedersen n.d.
Sustainable Building Tool	SB Tool	International	IISBE 2007

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10.1.2.1 Abstract

This report provides an in-depth analysis of existing assessment and certification schemes for sustainable building based on the first comparison for the Longlife project [Dirlich 2010]. The schemes are compared regarding the catalogues of indicators, the methods of scoring and weighting, the organisational and procedural concepts and the communicational instruments these systems apply. In consideration of the requirements for an adapted certification scheme for Longlife the most appropriate elements of the systems are identified and an outlook to the next steps that need to be taken for the development of a conceptual framework is presented.

10.1.2.2 Introduction

Based on the first comparison of assessment and certification schemes which dealt mainly with the topics, issues and criteria covered for the evaluation this report extends the analysis to further and more complex aspects.

The comparison of the selected indicators, the weighting & scoring principals, the procedural concept and the communicational instruments in this report is conducted through an in-depth analysis of the documents describing the methodology, concept and procedure of the assessment schemes.

Before the results of the further analysis are presented in chapter 4 some theoretical considerations on certification and communication of sustainability in general as an instrument to transcend the asymmetric information supply of producers and consumers and for sustainable building in particular introduce the reader to the theme of assessing buildings concerning their sustainability performance.

10.1.2.3 Theoretical Considerations Concerning Sustainability Certification and Communication

The quality of products is important for the producer as well as for the consumer. The first is interested in convincing the user by his product's high quality to either recommend his product to others or buying the same product again to satisfy his needs. The latter is interested in high quality in order to be sure about the desired characteristics of the product, e.g. the functionality, as well as about associated characteristics, e.g. the health safety.

Not all qualities of products are, however, easily perceivable for consumers. Therefore, an information deficit between the provider of the product and the consumer can be stated. This information deficit highly depends on the type of product, and in case of buildings it can be assumed as being considerable high as the complexity of a building and the construction process contribute largely to the information misbalance. From the microeconomic perspective this information deficit may lead to an **adverse selection** due to the insufficient or asymmetric information respectively between the stakeholders: Because consumers can not be sure to purchase adequate quality they choose the cheaper product with the result, that high quality products do not succeed on the market as they are supposed to do. There are two alternatives to keep markets functioning in which adverse selection occurs. The provider of goods can signal his product's quality to the user by appropriate means (**signalling**) or the user can screen the product in order to retrieve the missing information in quantitatively and qualitatively sufficient amount and manner (**screening**) [cf. for example Gabler Encyclopedia of the Economy].

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Theoretically, product attributes that can be regarded to make an appropriate decision to buy/use or not to buy/use a certain product can be differentiated into three categories [see Karl, Orwat 1999, p.114].

Search attributes can easily be detected by consumers through a simple inspection of the product. The effort of diminishing the information deficit is therefore relatively low.

Experience attributes in contrast are only perceivable for the consumer after he has experienced the product and its characteristics through using it. The information asymmetry can be reduced at the costs of higher efforts, and the need to purchase the product at least once.

Credence attributes, finally, are the last category and relate to product characteristics the consumer can neither identify before nor after the purchase. “They are a matter of faith in the supplier”, as Blum [2001, p.2] states.

In order to prevent this information deficit especially for credence attributes, certification labels for an immense range of products and characteristics exist, signalling the specific quality of a product for the consumer, thus transforming credence attributes into search attributes. Examples of such labels are GS label[21] or TÜV label[22]. Due to consumers’ increasing awareness of ecological issues since the 1980ies so called eco labels have been developed to overcome the misbalanced information through supposedly transparent and justified labelling processes conducted by independent institutions. According to the norm series ISO 14020 there are three different types of eco labelling: certified eco labels (type I – ISO 14024), self-declarations (type II – ISO 14021), and product declarations (type III – ISO/TR 14025). A certification of the product through external assessors and the improved environmental performance compared to competing products are characteristics of the certified labels as well as their emphasis on the improved communication with consumers. “Blue Angel” (Germany), EU Ecolabel (Europe), or Nordic Ecolabel (Scandinavia) are prominent examples of these environmental labels belonging to type I.

With regard to the building industry the phenomenon of asymmetric allocation of product information becomes even more relevant especially due to the complexity of the whole construction product and process, in particular when it comes to construction for sustainability. Not only the environmental quality of the building, but even more general qualities of the building must to a large extend be trusted by the purchaser or owner as the means to verify the builder’s or seller’s statements concerning the building quality are limited. Additionally, experiencing the characteristics of the building and as a result making better choices in future is no realistic option as a building is typically purchased for a longer period of time – in case of housing often only once in a lifetime. In this situation, certified labels for building quality have the potential to give a first orientation.

A certified label for building quality could also be attractive from the perspective of the building supplier as he or she can document in a transparent and reliable way that the building in question possesses high quality characteristics and thus increase competitiveness of the building.

Basis requirements on certification schemes for sustainable building can be derived from the mentioned eco labels as well as from experiences with the existing green or sustainable building rating tools. In general, the main function of such a certification process is to balance the information level of suppliers and consumers, and support the communication among the stakeholders. Figure 9 introduces the basic pillars of a certification and communication scheme for quality in construction.

[21] GS: *Geprüfte Sicherheit* = certified safety
[22] TÜV: *Technischer Überwachungsverein* = technical supervisory association

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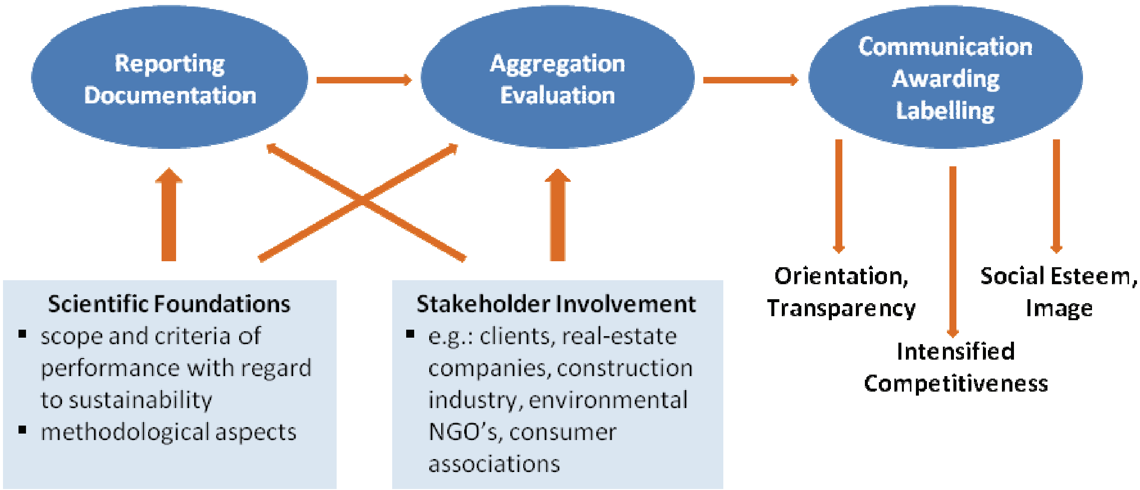

Figure 9 Main elements of a certification and communication scheme for sustainability issues of buildings
[Source: Blum et al. 1998, slightly modified]

The first element of a certification scheme (see Figure 9 – column 1) is the input side consisting of reporting and documentation. This means the compilation of relevant information on the building and the building process. Relevant in this context are those aspects of a building that relate to the three dimensions of sustainability: ecology, economy and society. The concept of the label should be based on justified and socially accepted scientific foundations and ensure that it is ready for future modifications and revisions due to changing aims and/or further insights into the dynamics of sustainability and its evaluation with regard to buildings.

The second element (see Figure 9 – column 2) refers to the method of performing the actual assessment and the way the gathered results of the assessment are embraced in a figure pointing out the building's overall performance in terms of sustainability. The involvement of as many stakeholders as possible from relevant groups such as clients, real-estate companies, environmental NGO's etc. in this process is desirable or even crucial for the success of the assessment scheme and facilitates a maximum of commitment to the certification system from the very beginning.

The final element (see Figure 9 – column 3) is the communication of the building quality as an external presentation of the certification which signals the excellence of the building at least concerning the examined aspects. One of the functions of the certification is the provision of an orientation for the owner, user and/or buyer of such a building as it makes rather independent information on the examined characteristics of the building available in a transparent way. Another function which mainly applies to the owner of the building is the increase of the building's competitiveness on the real estate and tenancy market. Finally, a successful assessment and awarded label may increase the image and social esteem of the building owner.

One additional important function of an assessment scheme – beside assessing and certifying building quality – is to work as a communication instrument which allows and supports the stakeholders to discuss and agree upon the specific characteristics and qualities of the building on planning stage. This is of particular relevance when sustainable building practices are concerned as it complicates the building process even more, and increases the choices (e.g. the variety of materials and techniques) and accordingly the numbers of decisions that must be taken in agreement between planner and client.

The different functions of the scheme depend among other things on its structural design.

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The following chapter presents the comparison of the assessment schemes concerning the catalogue of indicators, the weighting and scoring methodology, the institutional basis and the communicational instruments used by the different systems.

10.1.2.4 Comparison of Assessment and Certification Schemes

Completing the comparison of the first report the assessment schemes are analysed concerning further and more ambitious issues. The target of this comparison is to identify those elements of the existing schemes offering reasonable and appropriate solutions on which the concept of the adapted LONGLIFE certification can be based on.

The catalogues of indicators as the backbone of the assessment and certification are the first aspect discussed in the following section.

10.1.2.4.1 Indicator Catalogues

The layout and compilation of indicators is crucial for the user acceptance of the assessment scheme. The selection must balance at least two factors: first, the realistic depiction of sustainability characteristics and second, the user's comprehensibility. The consideration of both factors varies among the systems.

The topics considered in the assessment have been analysed in the first report already. The number of examined topics totalled 18 in the first comparison taken from the assessment schemes themselves. As some topics cover rather similar aspects it seems to be reasonable to decrease the number of topics by merging some of them. For example the topic "Health & Wellbeing" used in some of the schemes mainly assesses comfort aspects of the indoor environment and, therefore, there are only slight differences to the topic of "Indoor Environmental Quality". Further topics can be merged accordingly due to the same reason and, hence, it is possible to reduce the number topics to 12 (see Figure 10). Several originally used topics, however, can be classified into different topics, and consistently appear in two or three merged topics. For example "pollution & emissions" form an individual group used in the comparison, but at the same time some indicators of this topic are part of the (merged) topic "energy" and others belong to "indoor environmental quality as well.

The most important aspects in the schemes identified in the course of the first examination are "Energy", "Materials" and "Water". Concluding the results from an inquiry among the project partners the same interest can be stated for the stakeholders in the project partner countries. Therefore, these three topics are dealt with to a larger extent and in detail while only the most important features of the remaining topics are stated briefly.

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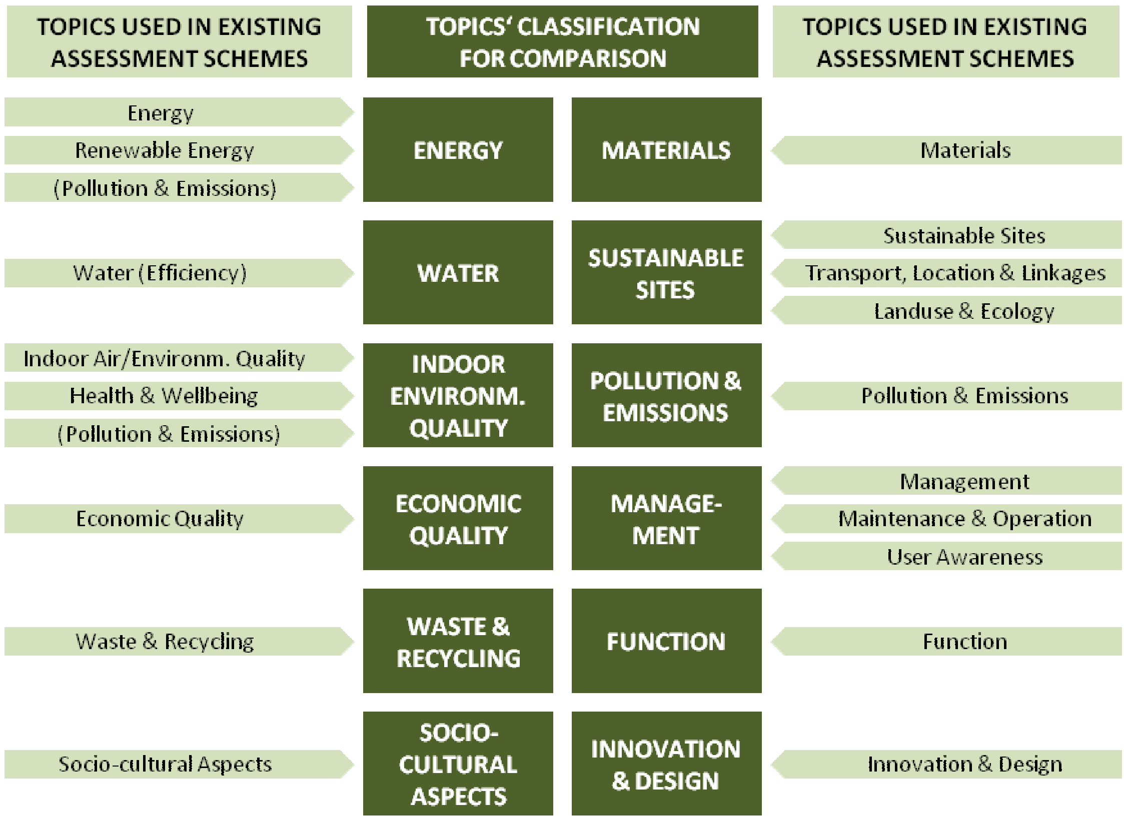

Figure 10 Merged topics considered in this comparison, derived from topics in existing assessment schemes
[Source: author]

The analysis in this section covers the indicators taken into account under the umbrella of the topics or sub-topics respectively. Even though the principal direction of the systems towards measuring the sustainability of buildings is similar or comparable, there are, nevertheless, considerable differences in the design and selection of the indicators. For example, the topic of “Water Efficiency” of the LEED rating system is differentiated into the indicators “water use reduction”, “water efficient landscaping”, “innovative waste water technology” and “further water use reduction”, while “Water” is only assessed as one indicator of the sub-topic “resource consumption” in the DGNB scheme: potable water consumption and sewage generation. The mere quantitative consideration of indicators, however, is not appropriate, as qualitative aspects of the indicators are more significant for the assessment. In the mentioned example of “Water Efficiency”, however, the differences are not that big at the end of the day. The LEED system approaches the topic through measuring (mainly) the reduction of water use (in the house and for irrigation) while the indicator under the DGNB summarises potable water and sewage water in a single value. The more important aspect is the methodology to retrieve the indicator (on a justified basis) as well as the approach to sum up the values of the topics and calculate the overall result. These questions are dealt with in the next section.

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Energy

The most prominent topic for an assessment concerning sustainability is definitely energy. This is reflected in the schemes amongst others by the number of indicators dealing with energy.

Three of the systems request a huge number of different criteria for assessing the energetic performance of the building. The energy topic of Green Diploma consists of no less than 80 indicators, while Green Build provides 43 indicators and Green House No. 20. The main reason for the immense number of indicators analysed in the **Green Diploma** scheme is the perspective of the system that is based on the building element; as such the energetic performance in its various values (e.g. G-value, U-value, ψ-value) is examined for all elements such as walls, windows, building envelope, etc. In the case of **Green Build** the high number derives from the very detailed consideration of possible energy-efficient measures relating to a building. The same is true for the **Green House No**. where many energy efficient solutions are listed. Both systems can be regarded as well as guidelines in the sense that they give the planner or house owner ideas for possible practices that could or even should be implemented.

Still a detailed consideration of the energy topic offer **ASCOT**, **BREEAM, Green Mark**, **GSB**, **ImmoPass** and **LEED** with a range of 8 to 11 indicators. The emphasis of ASCOT is on the share of renewable energy, insulation, windows ventilation, air tightness and the cooling and heating supply. Under the **BREEAM** system the emission rate of the dwelling, internal and external lighting, the building fabric, the existence of a drying space, energy labelled white goods, the use of low/zero carbon technology, and facilities for cycle storage are taken into regard. With **Green Mark** the building envelope, ventilation, lighting, energy-efficiency, and the utilisation of renewable energy are assessed. The **GSB** system requests aspects such as the compactness of the architecture, the compliance with low energy standards, the natural ventilation, the utilisation of daylight and passive solar radiation, the natural thermal protection in summer, the utilisation of renewable energy, and the connection to public transfer system. ImmoPass refers to the orientation of the building, the energy demand for heating, the utilisation of energy-saving bulbs, and the use of renewable energy. The topic of energy is dealt with under the **LEED** scheme by considering the commissioning of the energy system, the energetic performance, the refrigerant management, the utilisation of renewable energy, and measurements/verification.

Assessment and certification schemes in which the energy topic is incorporated with a medium number of indicators between 4 and 6 are **BNB, Building Letter AKOEH**, **CASBEE**, **DGNB**, **DVB**, **Green Star**, **Miljöklassad**, **Opti** Build and **SB** Tool. The indicators commonly consider the energy consumption of the building, and the share of renewable energy. Particular aspects taken into account are for example the energy embodied in materials (SB Tool), energy used for mobility (DVB), reduction of peak electrical energy demand (Green Star), insulation (Opti Build), compact architecture (building letter AKOEH), and building thermal load (CASBEE).

MINERGIE®-ECO and **LEnSE** only refer to few indicators from the energy sector. The three indicators considered in the LEnSE method are the depletion of non-renewable energy for building and transport and the use of renewable energy, while **MINERGIE®-ECO** concentrates on a single indicator, the so called weighted energy performance value, but requires as a pre-requisite the installation of an automatic ventilation.

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Materials

In two examined assessment schemes materials are not explicitly dealt with: **Opti Build** and **ASCOT**. Due to the specific character of these systems the topic is not relevant for the assessment as they simply focus on energy efficiency (and its economic feasibility).

There are three schemes with a very detailed perspective on the topic. **Green Build** covers the topic with 23 indicators such as the exclusion of CFC, HCFC and PVC in building materials and components (in total 4 indicators), the selection of natural materials (for flooring, insulation, walls), the use of recycling materials, and the lifetime optimisation of the materials for façade and roof. **Green House No**. verifies the sustainability of the used materials on the basis of 12 indicators. In the questionnaire the house owners are inquired for example concerning the use of wood for different purposes (construction, façade, doors, windows, stairs, flooring), the use of insulation material from renewable or recycled resources, covering and finishing materials on interior walls from natural and/or renewable materials, and the re-use of used materials and elements. Green **Diploma** approaches the topic with 11 different indicators. Despite the fewer number of indicators the touched aspects are more or less the same as in Green Build: exclusion of CFC, HCFC and PVC, the use of natural, recyclable and/or renewable materials, and the lifetime optimisation of the roof. The avoidance of toxic materials as well as the consideration of materials that support a healthy indoor air climate supplement the topic.

A pronounced detailed reflection of the topic is applied in five certification systems. **SB Tool** covers 10 indicators ranging from the re-use of existing building structures to the design for disassembly. Other aspects dealt with are the use of durable materials, the use of recyclable materials or products that are so called “bio-based”. Furthermore, this scheme considers a minimisation of the use of finishing and of virgin materials, and rewards the (partly) replacement of cement for concrete. **MINERGIE®-ECO** is differentiated into 9 indicators that can be allocated to materials. The durability of the materials, the covering of the façade, the materials for the roof, the façade and the finishing, the flooring material and the abandonment of finishing material for walls and ceilings are aspects touched in the course of the assessment. **CASBEE** system’s consideration of material consists of 8 indicators: the use of materials, the re-use of existing skeleton, the use of recycling material, sustainable timber, the re-usability of components and material, the avoidance of CFC and HCFC, and the use of materials without harmful substances. ImmoPass takes into account 8 indicators as well which deal with the maintenance of the building structure, the selection of eco-materials, the avoidance of halogen in electrical installation materials, the simple restoration and the manufacturing of the construction.

Assessment schemes providing a medium number of indicators to describe “materials” are DVB, Green Star and GSB. **Dwelling Value Barometer** regards hazardous substances in materials, revitalisation of the existing building fabric, the sustainable handling of materials, the durability of the selected materials, and the easy separation of layers and recyclability. **GSB** system distinguishes between the indicators dismantling opportunities, re-usability of elements and materials, recyclability of elements and materials, and whether the construction concept is modular and makes use of pre-fabricated elements. With **Green Star** the topic “materials” is tackled in 4 indicators: flooring, joinery, internal walls, and universal design.

Few aspects are touched by LEnSE, BREEAM, Building Letter AKOEH, Green Mark, DGNB, and BNB. **LEnSE** covers the depletion and use of renewable and non renewable resources, a responsible sourcing of materials, and the exclusion of specific materials and substances. **BREEAM Code for Sustainable Home** approaches the topic with 3 indicators: the environmental impact of materials, a responsible sourcing of materials which is divided into basic building elements and finishing elements. **AKOEH**’s Building Letter provides 3 indicators as well. The selection of material concerning the environmental impact (according to the “Positive List” of **AKOEH**), the ban of an impregnation of wood with chemicals, and the exclusion of non recyclables which are not able to be demounted. Once more 3 indicators are considered in the **Miljöklassad** system. It requests an inventory of specific substances, a documentation of the building components, and a documentation of especially dangerous substances for elimination. Green Mark approaches the topic with a single, but very broad indicator that deals with the sustainability of the construction. **DGNB** targets materials also with one indicator: the ease of deconstruction, recycling and dismantling, while the “sister system” **BNB** embraces the sustainable exploitation of resources and timber.

Water

This topic belonging to the top 3 is not considered at all in two of the examined schemes: **Building Letter AKOEH** and **ASCOT**. The reason is very simple: all of these systems have a specific approach in which water is irrelevant. The first deals with the building quality of timber houses, and the latter focuses on the economic evaluation of building renovation projects.

There are certification schemes which consider “water” and “water efficiency” in a very detailed manner with a lot of different indicators. **Green Build** and **Green Diploma** are relatively similar and both include 11 indicators for this topic which deal with water saving, the use of rain water, the use of grey water and the installation of individual meters for the apartments.

The approach of **the Green Star** system is relatively detailed with 6 considered indicators. The indicators relate to the type of water use (such as fire water, heat rejection water or irrigation water) and the overall water efficiency. The consideration of fire water, heat rejection water and the swimming pool efficiency must be interpreted as a response to the regional climatic conditions in Australia.

Assessment schemes which take into account a medium number of indicators are Guideline Sustainable Buildings (GSB), LEED, Green House No. and Green Mark. The **GSB** method targets the topic in 4 indicators: ground water protection, rain water utilisation, water demand and waste water. The **LEED** system covers 4 indicators and deals with water saving measures, water efficient landscaping and innovative technologies for waste water. Green Mark splits the topic into 3 indicators which relate to water saving and the efficient irrigation of the landscape. Finally, **Green House No**. also uses 3 indicators to cover water: use of rainwater, rain water infiltration and water consumption.

The majority of the examined assessment schemes pursue the approach to summarise the topic of water in one single indicator or two indicators at the most: **SB Tool**, **DGNB**, **BNB**, **DVB**, **BREEAM**, **LEnSE**, **CASBEE**, **ImmoPass**, **MINERGIE®-ECO**, **Opti Build**, and **Miljöklassad**. The indicators predominantly deal with water efficiency and/or consider the consumption of (potable) water (and the generation of waste water). Particular perspectives offers the DVB method in which the establishing of water cycles (as a water-saving means by re-using grey water) are regarded beside water saving measures as well as the Swedish Miljöklassad system where the protection against legionella through a certain minimum temperature of the drinking water is targeted.

The following section sheds a light on the other topics presenting remarkable characteristics and particular solutions.

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Further Aspects

With regard to the topic **pollution & emission** it should be stated that still some of the indicators, though the topics are partly merged, as well could be – and actually are – allocated to other topics such as energy (in case of global warming potential for example) or indoor air quality (hazardous substances that could be emitted from the materials used indoor). Therefore, several indicators belong to more than one topic, but as these indicators touch two or even more topics, it makes sense to proceed like that. Nevertheless, five assessment schemes do not consider this topic at all: Green House No., Building Letter, and the two systems with a focus on energy-saving measures and its economic assessment (Opti Build and ASCOT). Most schemes (SB Tool, DGNB, BNB, DVB, Green-Star, LEnSE) mainly address aspects with a general acceptance in environmental sciences such as the global warming potential (GWP), ozone depletion potential (ODP), acidification potential, eutrophication potential, etc. Other systems (LEED, ImmoPass, Green Mark, Miljöklassad, etc.) focus on criteria only relevant for emissions or pollution of the interior such as the use of sealants or adhesives – aspects which could rather be allocated to indoor air quality.

Indoor environmental quality is an important topic considered in all schemes with the exception of the two aforementioned systems focussing on energy-saving measures (ASCOT, OptiBuild), and Green House No. Some of the methods cover the topic very detailed (SB Tool, MINERGIE®-ECO, ImmoPass, LEED), the others use less indicators, but still the main areas are thermal, acoustic and visual comfort, and pollutants in indoor air.

The **economic quality** is dealt with only in approximately half of the assessment schemes – even renowned systems such as BREEAM, CASBEE, LEED and others do not reflect this aspect of sustainability. Main criterion considered in most of the schemes integrating economic aspects (SB Tool, DGNB, DVB, BNB, LEnSE, Green Build, Green Diploma, GSB, Opti Build, ASCOT) are life cycle costs. Minor relevance have rather “indirect” economic criteria such as the adaptability of the building and its dwelling units, the maintenance of the building, and the stability of the building’s value.

The topic of **sustainable sites** is targeted in 16 of the examined assessment schemes. SB Tool, DVB, and ImmoPass consider the topic in a very detailed manner, while the other schemes take a less detailed, but still sufficient view at the topic. The topic relates to sustainability aspects in connection with the location such as the ecological value of the site, the provision of open space (used for common purposes), mobility or the amenities available for the tenants. DGNB as well as the BNB scheme do not take the rating of the site quality into account for the aggregation of the overall result though it is actually assessed in the course of the certification23.

Waste & recycling is not touched in four assessment schemes (BNB, MINERGIE®-ECO, Miljöklassad, Opti Build and ASCOT). Green Build and LEED approach the topic in detail covering all aspects ranging from the use of recycling and recyclable material to the reduction of waste and its separate collection.

Aspects that relate to the **management** of the development are taken into regard in 17 of the examined schemes. The most detailed consideration is found in SB Tool and Green Star, both approaching the topic with 7 indicators. LEnSE, BREAM, CASBEE and Green Diploma cover managerial aspects with a medium number of indicators (3 or 4), while the topic consists of few indicators in DGNB, BNB, Green Build, GSB, ImmoPass, and Green Mark. Main indicators that are touched are measures supporting the maintenance of the building and building elements, applied

[23] The developers of the schemes decided not to include the “site quality” for the rating as it can hardly be influenced through the building process.

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environmental management (systems), the existence of user manuals/guides, and operation plans/procedures.

Socio-cultural aspects as another dimension of sustainability are considered in only eight systems. The most detailed perspective provides SB Tool with 10 indicators dealing with social aspects, followed by LEnSE (6 indicators). DVB, DGNB, and BNB take a medium number of aspects into account, while Green Build, GSB and Green Diploma just consider a single indicator each. Thematically, the spectrum ranges from barrier-free access, design for elderly, integration into the local architecture/urban development up to art within the architecture, and the inclusion of working conditions during the construction phase.

The **functionality** of the building is concerned in one third of the schemes only. In some methods, however, the relationship between the topic and the chosen indicators is not fully clear. In CASBEE the indicator is called “functionality & usability” and consists of the sub-indicators “provision of space & storage”, “use of advanced information system”, and “barrier-free-planning”. Other systems like SB Too, DGNB, and BNB integrate similar criteria, while Green Build and Green Diploma only target an “easy access to technical installations”. The topic “functional quality” of DVB comprises of indicators such as “quality of HVAC installation” or “state of the building”. Obviously, this topic allows the developers of the schemes to consider a broad range of indicators, and the decision for a certain selection is based on the developing teams’ preferences.

The theme **of innovation & design** is only targeted in LEED and Green Star. Green Star differentiates into “innovative strategies & technologies”, “exceeding green star benchmarks” and “environmental design initiatives”, while LEED considers “innovation in design” and the execution of the assessment of the development team by a “LEED accredited professional”.

Discussion

In the end, the different schemes are not that far away from each other. Taking water as an example, it can be stated that under this topic water saving measures or water efficiency is the most important aspect in all schemes. Whether the way to reach this target is explicitly indicated in a system’s detailed approach or implicitly considered by the use of a “summarising” indicator is only a matter of the conceptual layout of the topic. The overall goal of decreasing the amount of consumed water and produced waste water is reflected in both ways. The same is true for the other examined topics. Some approaches are very detailed, and guide the user concerning the implementation of green features in the development project. This is, on the one hand, reasonable for inexperienced planners or house owners. On the other hand, such a method may also result in the fixation on very narrow solutions. Hence, a target-driven approach seems to be much more appropriate since the way of reaching the target is within the discretion of the user or planner.

With respect to the number of indicators chosen to assess the building concerning a certain topic, it seems to be more practical concentrating on rather few indicators in order to minimise the efforts necessary to conduct the assessment. However, such indicators often consist of aggregated sub-indicators, thus, the derivation of the indicator must be seen in the individual case to decide whether it is easy manageable for the user to determine the indicator or not. A possible agreement with respect to the LONGLIFE certification scheme could be to consider a medium number of indicators under each topic which represent values aggregated to an average extent.

The relevance of indicators highly depends on the specific structure and purpose of the certification scheme. Nevertheless, after the analysis of the existing schemes certain aspects have proven to be more relevant than others. Examples from the three major topics are listed in the following table:

Table 4 Examples for indicators covered by the three major topics of certification and assessment schemes
[Source: author]

Topic	Indicators
Energy	Primary energy demand
	Share of renewable energy
	Energy efficient appliances
	Air tightness of building envelope
	Energy monitoring
Materials	Environmental impact of materials
	Ecological hazard-free materials
	Use of recycled/re-used materials
	Durability of materials
	Ease of deconstruction, recycling and dismantling
Water	Water demand
	Sewage generation
	Water saving measures
	Utilisation of rain water
	Infiltration of rain water on site

Additionally, a full declaration of the materials used for the construction is an interesting aspect as it improves the security of the owners and/or tenants especially from the viewpoint of their health and wellbeing. The assessment of the degree to which a building considers health issues in a certification scheme is difficult due to various reasons. This applies both to the methodology of actual measurements and the standards used in evaluation along with the fact that well-being and health cannot be separated from individual user-specific requirements and sensitivities. Against this backdrop a declaration of materials used in the building offers valuable information about potential health risks for sensitive users gained at reasonable efforts. In addition a declaration of materials also can be of significant support in cases of refurbishment, reconstruction or demolition of a building, because it decreases analytical efforts.

In general, the indicators can be differentiated into those performing the assessment towards an absolute value, and those being valued relatively. The first requires the compliance with a defined target value (say an annual primary energy demand of 45 $kWh/m^2 \cdot a$), while the latter asks for more subjective values such as an energy performance which is 20% better than a reference building. Moreover, indicators can be based on a quantitative or qualitative assessment. The first does actually not differ too much from the absolute value as mentioned before, and again targets a quantifiable value. The latter, however, requests an assessment based on a judgement of the assessing instance (user, assessor, etc.). An example for a qualitative assessment is the indicator “ease of deconstruction” which to a certain degree depends on the assessor’s personal estimation concerning the opportunities to easily disassemble (part of) the structures of a building. Also, “art within architecture” requires a personal (and somehow subjective) judgement to assess a building concerning this indicator.

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Furthermore, it could be questioned whether the number of topics selected for the assessment could have a certain influence on the indicators. The classification depends on the preferences of the developers of the method, and as stated before some indicators could be assigned to different topics. As the denomination of the topics (though there are definitely similarities among the systems) are in the discretion of the designer of the scheme, the analysis shows, that the topics itself only play minor role for the indicator catalogues.

The next chapter presents the results of the comparison concerning the weighting and scoring.

10.1.2.4.2 Weighting & Scoring

Indicators receive a certain score during the assessment procedure depending on the building's performance. Usually, this score is not transferred one-to-one to the overall rating, but is weighted on indicators' level, but also at the level of issues and topics. This weighting shall reflect the different importance and relevance of indicators/issues/topics and is subject to agreement. Compared to the differences in the selection of topics, issues and indicators, the number of points single indicators can receive as well as their weight24 within the topic they belong to varies considerably between the different schemes. The process of determining the weightings are based on the one hand on an objective and traceable scientific rationale, and on the other hand on political decisions taken by the different stakeholders under consideration of the scientific opinion. This stakeholder involvement is definitely important for the commitment of the user groups during the certification. The decision how much weight is assigned to the different topics is one of the first to be taken and a lot of subjectivity and reflection of political targets is contained in the allocation of the weights. Moreover, many assessment schemes allow to adjust the weighting in respond to the local conditions the scheme is used in. For example the SB Tool suggests country-specific weights for the topics which relate to different climatic conditions and varying legislative frameworks in the building sector.

In the following sections selected assessment schemes are described in their way of evaluating the various indicators and summarising the assigned points. Based on the first comparison and the results gathered from the analysis of the topics/issues/indicators the schemes being selected to be analysed more in detail are BREEAM, CASBEE, DGNB, DVB, Green Build, LEED, LEnSE, and SB Tool due to their international relevance and popularity and/or their well-designed transformation of sustainability into an assessment methodology.

BREAAM – Code for Sustainable Homes

The British assessment scheme operates with nine topics covering the most relevant environmental issues, but excluding the social and economic dimension of sustainability. The maximum score for each indicator varies from 1 to 15 points with a typical variation from 1 to 6. 15 points are only available as the maximum for the indicators "dwelling emission rate" and "environmental impact of materials". The biggest share constituting more than 36% is assigned to the topic "energy & carbon dioxide emissions". "Health & wellbeing" accounts for 14%, while "water" only has a share of 9%, and "material" roughly 7%. Therefore, the Code for Sustainable Homes is a bit different from

[24] Weight in this sense means the percentage of the topic for the overall rating for a building as well as the percentage of the individual indicator for the rating of the topic.

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the average system where “health & wellbeing” is not one of the main three topics. For the definition of topics, issues and indicators a stakeholder involvement is ensured through the establishment of a so called “Sustainability Board” in which representatives of the construction industry and other stakeholders contribute to keep the scheme “relevant and valuable to a wide range of users” [BRE 2010].

Table 5 Weighting of the topics of the BREEAM Code for Sustainable Homes
[Source: CLG 2009]

Topic	Weighting	Remarks
Energy & Carbon Dioxide Emissions	36,4%	15 points maximum for the indicator “dwelling emission rate”
Health & Welllbeing	14,0%	
Ecology	12,0%	
Management	10,0%	
Water	9,0%	
Materials	7,2%	15 points maximum for the indicator “environmental impact of materials”
Waste	6,4%	
Pollution	2,8%	
Surface Water Run-Off	2,2%	

CASBEE

The CASBEE system operates with an approach which is a bit different from the others, as it opposes the environmental performance of a building to the environmental impact. The points for the individual indicators are calculated according to the respective performance or impact. Basis of the assessment is a five-point-scale in which 3 represents the standard. Worse performance is indicated by a score less than 3 (i.e. between 1,0 and 2,9), while better performing indicators score more than 3 (i.e. between 3,0 and 5,0). The overall rating called building environmental efficiency (BEE) is computed by dividing the environmental performance Q by the environmental load reduction LR.

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Table 6 Weighting of the topics of the CASBEE system
[Source: JSBC 2008]

Topic	Weighting Q or LR	Weighting Total	Remarks
Q1 – Indoor Environment	40,0%	20,0%	15 points maximum for the indicator "dwelling emission rate"
Q2 – Quality of Service	30,0%	15,0%	
Q3 – Outdoor Environment on Site	30,0%	15,0%	15 points maximum for the indicator "environ-mental impact of materi-als"
Q – Environmental Quality (Total)	**100,0%**	**50,0%**	
LR1 – Energy	40,0%	20,0%	
LR2 – Ressources & Materials	30,0%	15,0%	
LR3 – Off-Site Environment	30,0%	15,0%	
LR – Load Reduction (Total)	**100,0%**	**50,0%**	
BEE = Q/LR			

The environmental performance is divided into the three topics "indoor environment", "quality of service", and "outdoor environment on site". The first constitutes a share of 40% for environmental performance while the two other make up 30% each.

The environmental load composes of three topics as well: "energy", "resources & materials", and "off-site environment". Again, the first accounts for 40%, while the other topics both have a share of 30%.

DGNB

The DGNB's scoring system with its six topics (so called qualities) is based on attaining points for each indicator with a maximum of 10 points. Each indicator is weighted with a factor from 0 to 3 due to its assigned relevance. The results of the individual topics (such as ecological quality) are derived from the indicators' percentages multiplied with the individual weighting. The overall result, which can be interpreted as the degree of compliance with a reference building defined as optimal25, is calculated by computing the mean value of all six qualities.

[25] For each indicator measurable target values are defined and the attained points relate to the building's degree of compliance concerning this indicator.

Table 7 Weighting of the topics of the DGNB
[Source: DGNB 2009]

Topic	Weighting	Remarks
Ecological Quality	22,5%	
Economic Quality	22,5%	
Socio-cultural Quality	22,5%	
Technical Quality	22,5%	
Process Quality	10,0%	
Site Quality	-	Not part of the overall rat-ing

The four topics ecological quality, economic quality, socio-cultural & functional quality, and technical quality each account for 22,5% of the overall rating, while the process quality contributes with 10%. The site quality is not considered in computing the final rating of the building as the developers of the DGNB argue that the site can merely be influenced by sustainable building, but is a value by itself.

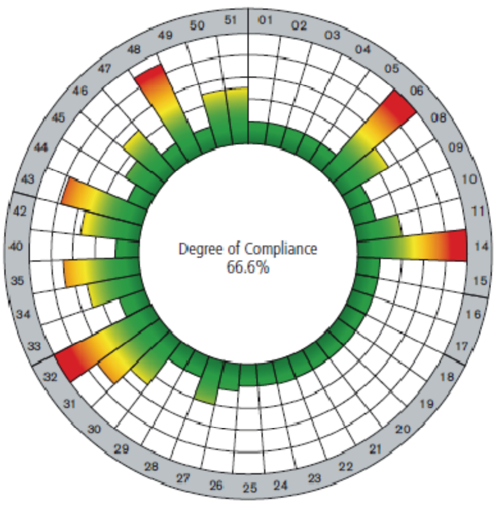

Figure 11 Radar chart depicting the results of an assessment with DGNB
[Source: DGNB 2009, p.10]

Dwelling Value Barometer

The DVB approach is principally score-based. The maximum score for each of the 43 indicators under this scheme is 5 points. For example in order to achieve the maximum score for the indicator “energy demand for heating” in the topic “resource demand” an existing building must reach the energy-efficiency of new built houses. In case the energy demand is even less, additional bonus points can be attained. In contrary, the indicator receives the minimum score of 1 point for extremely unsound solutions which is in the case of the aforementioned indicator a very high annual energy demand. In order to emphasise the problems caused by unfavourable solutions and their impact the assessment scheme offers also the possibility to lower the attained points of a whole topic. The results for each topic are summarised by calculating the average and graphically displayed as a radar chart. The overall result, finally, is computed from the weighted average of the points for the individual topics.

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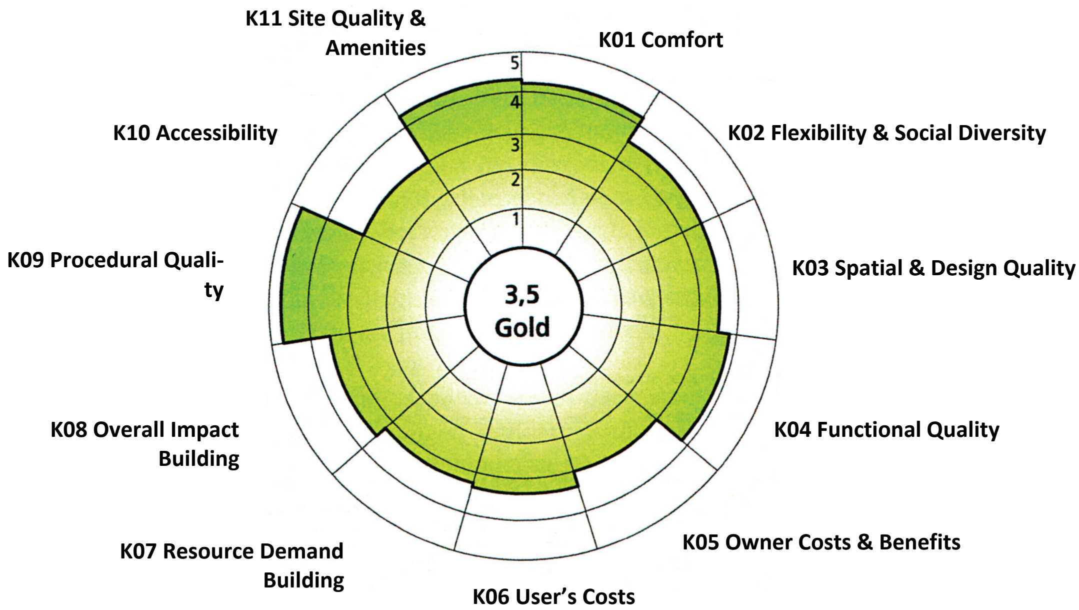

Figure 12 Radar chart depicting the results of an assessment with DVB
[Source: Hegger (ed.) 2010, p.106]

The individual indicators receive specific weights on a scale from 1 to 3 where 1 means limited important, 2 means important, and 3 means very important. The weightings of the topics are derived from an analysis concerning the topics' interaction with each other. The calculation procedure is divided into six steps [cf. Hegger 2010, p.99ff]:

- The external weighting of a topic is computed as the ratio of "passive sum of the topic" to "passive sum total" as percentage.
- The own weighting of the topic is calculated as the ratio of "own weighting of the topic" to "sum of all won weightings of all topics" as percentage.
- The weighting of a topic is derived as the mean value of external and own weightings and a transformation of the results to a scale of 1,000 points.
- Caclulation of the weighting factor of the indicators as follows: average points of the own weightings of the indicator of each topic multiplied by the own weighting of the indicator.
- Issue rating: sum of the weighted indicators divided by the sum of the weighting factors of the indicators.
- Topic rating: mean value of the issues (no weighting on the level of issues).

Where other tools (like BREEAM) to a large extend build on stakeholder consensus to define the relevance of considered topics, the DVB is an example of a mathematical approach.

Table 8 Weighting of the topics of DVB as mean value of own and external Weighting [Source: Hegger 2010]

Topic	Own Weight-ing	External Weight-ing	Weight-ing	Remarks
Resource demand building	8,2%	13,9%	11,1%	Topics' weighting is derived as the mean value of own weighting and external weighting
Flexibility and intermix	10,2%	8,6%	10,2%	
Overall impact of building	8,2%	12,0%	10,1%	
Site quality and supply	11,3%	9,0%	10,1%	
Process quality	7,2%	12,7%	9,9%	
User costs	10,3%	8,2%	9,2%	
Comfort	9,2%	7,9%	8,6%	
Accessibility	9,7%	6,0%	7,9%	
Ownership costs and revenues	5,1%	10,5%	7,8%	
Functional quality	9,7%	5,6%	7,7%	
Spatial and design quality	9,2%	5,6%	7,4%	

Green Build

The topics covered by the Green Build scheme are: "building urban development area & methods for sustainable development & sustainable urban management", "waste", "materials & construction", "energy", "indoor air climate", and "water, rainwater, sewage".

Points are attached to the criteria of the questionnaire depending on the degree of compliance. For the individual indicators the maximum available scores range from 1 to 5. Certain criteria such as the energy consumption appear several times with different levels. In this case each indicator accounts for 2 points (less than 46 kWH/m²·a, less than 40 kWH/m²·a, less than 35 kWH/m²·a) – a building with a consumption less than 35 kWH/m²·consequently scores three times, and receives 6 points in total for this (these) indicator(s).

There is no further weighting apart from the different scaling and the consideration of a varying number of indicators. Based on this the most important topic of Green Build is "energy" constituting roughly 39%, followed by "materials & construction" with a share of 22%. Less emphasis is put on "water", "indoor air climate" (each 8%), and "waste" (4%). Roughly 19% of the indicators belong to the broad topic "building & urban development area, methods for sustainable development & sustainable urban management".

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Table 9 Weighting of the topics of the Green Build scheme
[Source: SolarVent n.d.]

Topic	Weighting	Remarks
Water, Rain Water, Sewage	8,5%	
Indoor Air Climate	8,0%	
Materials & Constructions	22,1%	
Waste	4,0%	
Energy	38,7%	
Building & Urban Development Area, Methods for Sustainable Development & Sustainable Urban Management	18,6%	

LEED

The LEED systems covers the classical canon of environmental assessment such as "energy & atmosphere" or "water efficiency" and adds as a cherry on the top topics of "innovation in design" and "regional priority".

Table 10 Weighting of the topics of the LEED rating system
[Source: USGBC 2009]

Topic	Weighting	Remarks
Energy & Atmosphere	31,8%	Up to 19 points for an "optimised energy performance", and up to 7 points for "on-site renewable energy"
Sustainable Sites	23,6%	
Indoor Environmental Quality	13,8%	
Materials & Resources	12,7%	
Water Efficiency	9,1%	
Innovation in Design	5,5%	
Regional Priority	3,6%	

The conceptual design of the scoring system is relatively simple. There are prerequisites (up to 3) in each category that must be fulfilled as minimum requirements in order to receive a certification. The building can be assigned points for the different indicators once more on a basis of a scale from 1 to 6 generally. Exceptions are to be found in the topic "energy & atmosphere" where up to 19 points are achievable for an "optimised energy performance", and up to 7 points can be awarded for "on-site renewable energy". In total 110 points can be reached. Similar to other systems the importance of energy for the sustainability of a building is implemented by assigning the maximum number of available points to this topic. There is no real weighting of the different topics, but when the maximum achievable points are added, "energy & atmosphere" has a share of nearly 32%, and "sustainable sites" account for roughly 24%. Less attention is paid to "indoor environmental quality" (14%) and "materials & resources" (13%). "Water efficiency" accounts for only 9%.

LEnSE

The LEnSE tool considers all three dimensions of sustainability for the assessment of the buildings. The topics covered are listed in Table 11. For each indicator the building's performance is measured – in case of the indicator "use of renewable energy" the percentage of the utilisation of renewable energy is taken as the indicator's value. Then, this is translated into a score26.

Table 11 Weighting of the topics of LEnSE
[Source: LEnSE Partners 2007]

Topic	Weighting	Remarks
Climate Change	18,8%	
Biodiversity	12,5%	
Resource Use & Waste	12,5%	
Occupant Wellbeing	9,4%	
Social & Cultural Value	8,1%	
Accessibility	7,8%	
Whole Life Values	7,5%	
Environmental Management & Geophysical Risk	6,3%	
Financing & Management	6,3%	
Externalities	6,3%	
Security	3,8%	

Just like the LEED system the LEnSE tool does not include a real weighting , but the figures depicted in the table are based on the summation of the points available for the indicators of one topic. The biggest portion of points can be achieved in the topic "climate change" (19%), followed by "biodiversity" (13%) and "resource use & waste" (13%). In total ecological topics make up 50%, while society-related topics account for 29% and economic topics have a share of 20%.

The weighting, i.e. the maximal achievable points for the 11 topics, can be adjusted to country-specific needs what makes the tool very flexible and interesting in international context.

SB Tool

In the denomination of SB Tool there are three levels of parameters: issues, categories and criteria. In order to avoid misunderstanding these notions are called topics, issues and indicators such as in the other schemes when translated into "Longlife language". Indicators score according to the following scale:

[26] At the time of the elaboration of this report the scoring system was not made public. The project's website does not provide any document explaining the transfer of the measured values into scores.

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-1	Deficient
0	Minimum acceptable perform-ance
+3	Good practice
+5	Best practice

Table 12 Weighting of the topics of SB Tool
[Source: IISBE 2007]

Topic	Weighting	Remarks
Environmental Loadings	25,9%	
Energy & Resource Consumption	21,6%	
Indoor Environmental Quality	21,6%	
Service Quality	15,5%	
Site Selection, Project Planning & Develop-ment	7,8%	
Social & Economic Aspects	5,2%	
Cultural & Perceptual Aspects	2,6%	

The score for the individual indicators are weighted. All indicators of an issue add to 100%, whereas the individual weighting can vary reflecting the relevance of an indicator for the issue. The same procedure is done with the weighting of the issues that are totalled to 100% as well, again with differing percentages for the different issues. Finally, the topics also receive a weighting to illustrate the unequal importance of topics for the whole assessment. The weighting of each single indicator is indicated in the system, e.g. the score of indicator A 1.1 (pre-development ecological value or sensitivity of land) contributes to the overall rating with 0.4%.

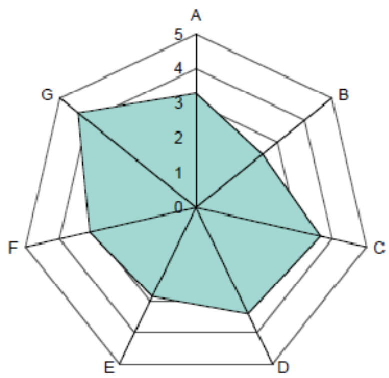

Figure 13 Radar chart of an assessment with SB Tool
[Source: IISBE 2007, p.12]

SB Tool is designed to offer many opportunities for a flexible adaptation of the system to different circumstances. Hence, it is possible for example to omit an indicator when its consideration appears not appropriate. When the architecture of the building is oriented towards natural ventilation for example, it is definitely reasonable not to take into account the indicator(s) dealing with mechanical HVACR systems. When indicators are omitted the weighting of the issue has to be adjusted in order to reach 100% with the remaining indicators.

Discussion

It is obvious, that the procedures of determining the individual weightings for the topics and for the indicators differ, and consistently all schemes use a different weighting as well. The most sophisticated (and at the same time most complicated) approach offers the DVB system calculating the weighting based on the mutual influences and dependencies of the topics among each other.

The calculation of the ratings the building receives is typically score-based, but the scales applied in the schemes differ again. Nevertheless, in most schemes the rating is finally translated into a percentage or aggregated number expressing the degree of compliance of the considered indicator or topic or of the whole construction with sustainable building principles or a reference building respectively.

At the end of the day, the weighting must be regarded too in the light of the particular context. To this end, the option to adjust the weightings of the topics and indicators in response to the specific needs as provided in some of the methods (LEnSE, SB Tool) as well as the involvement of concerned stakeholders to ensure meaningfulness and acceptability in everyday use can be recognised as reasonable and useful features.

In the next chapter the institutional basis of the assessment schemes are examined.

10.1.2.4.3 Institutional Basis

This section deals with the basis of the assessment schemes from institutional perspective, e.g. which institution is offering the scheme, how is the procedure of receiving a certification, are user boards stipulated and how are the assessors trained. The comparison aims to detect those elements, which are valuable being considered for the conceptual development of the framework scheme of the LONGLIFE certification.

The responsibility for the development, provision and up-dating of the various assessment schemes can be in the responsibility of national GBCs, administrative bodies (e.g. building authorities), national associations, research institutions, etc. The picture in this respect is characterized by considerable diversity (Table 13).

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Table 13 Classification of institutions providing assessment schemes

Providing Institution	No.	Assessment and Certification Schemes
Ministries/Building Authorities	4	BNB, Green House No., Green Mark, GSB
National GBC's	4	CASBEE, DGNB, Green Star, LEED
Academic Institutions	4	BREEAM[27], DVB, LEnSE, SB Tool
Engineering Consultancies	3	ASCOT, Green Build, Opti Build
Public-Private Partnerships	2	Miljöklassad[28], MINERGIE®-ECO[29]
Private Associations	2	AKOEH, Green Diploma
Technical Supervisory Associations	1	ImmoPass

Ministries and Building Authorities, GBC's, and Academic Institutions each provide and maintain four assessment schemes. Academic Institutions are typically active in developing methods for the assessment of sustainable buildings in the framework of projects, e.g. international EU-funded projects. This means, that these tools usually are not provided on the market but can be used as a valuable source for further development. Also, Engineering Consultancies (3 schemes) can be dedicated to the development as a partner in such a project. Private or Technical Supervisory Associations (3 schemes) form another group of institutions involved in the design and operation of an assessment scheme. Their rationale for developing such a system must be seen in close conjunction with their goals as an association. Another group are Public-Private Partnerships which are constituted by a public partner (commonly a building authority) and private partners representing stakeholders such as the building industry; two of the assessment schemes are provided by such an institution.

From the viewpoint of the user (house owner, client or planner) the maintenance and continuous adaptation of the system in the future plays an important role for choosing a system for an assessment of the development project, since the credibility and the function as a communication tool highly depend on the future perpetuation of the system. Principally, authorities are known to be more reliable in that sense that the assessment scheme is provided and maintained over a longer period of time. In contrast, schemes developed in the framework of a single project by consultancies or academic institutions tend to be used only for that single project, and afterwards fall into oblivion. Certification schemes provided by associations, finally, can be classified in-between these two opposing poles.

Another important aspect being part of this section is the analysis of the procedural conception of the schemes: how is the certification actually performed? Is it based on a self-assessment, are there external assessors executing the certification and is the validity of the certificate limited in terms of the time? Principally, one can differentiate between three types of assessment: first party, third party, and fourth party establishments (cf. Blum 2001, p.4f):

[27] The responsibility of BREEAM lies with BRE, formerly a research institution founded and supported by the government which was transformed into a private company in 1997.
[28] The assessment scheme Miljöklassad is provided by a platform composing of companies, municipalities, national and local authorities, and the government in Sweden.
[29] MINERGIE as the organisation providing the assessment scheme is carried by the Swiss government, the cantons, and the economy in Switzerland.

Table 14 Types of institutional establishments with reference to the building sector [Source: Blum 2001, p.4f, slightly modified]

Type of Establishment	Designations/Variations	Explanation	Examples
First party	Self-declarations Product-lines	There is a immense variation in terms of content, scope and concept among these tools. Though there is no external verification these private tools can be backed by a serious commitment, but due to the supposed missing objectiveness the quality of the label is generally in question.	Eco house Natural building Passive House
Third party	Assessment schemes Certification systems Labelling systems Rating systems	The tool is offered by a (neutral) third party institution and can be distinguished into private, semi-public, public/publicly authorised certification tools.	Green Build Green Diploma ImmoPass
Fourth party	Assessment schemes Certification systems Labelling systems Rating systems	The characteristics stated above are considered as well, and supplementary a superordinate institution is appointed as an instance to ensure reputability and comparability of the schemes involved.	BREEAM DGNB LEED

With regard to certification systems for buildings, there are two general types of assessment: self-assessment and external assessment through accredited assessors. Another alternative is a combination of the aforementioned types in which the assessment is performed by the user (planner, client, owner, etc.) himself, and the results of this self-assessment are verified concerning their plausibility by external experts. This verification may either be conducted from the desk without actual inspection of the building and/or by on-site inspections (see Figure 14).

Self-assessment is part of the conceptual structure of some assessment tools and the underlying purpose of such schemes is rather to function as a guideline for sustainable building than performing a real certification. The assessment scheme shall predominantly enhance the communication (cf. chapter 10.1.2.3: building communication) among the stakeholders (typicaly between planners and clients / house owners) in order to ensure an optimal implementation of sustainable building practices into the construction works. Such a self-assessment can also be used as the basis of an external certification. In that case the assessors check the results of the selfassessment concering plausibility. Additionally, on-site inspections may be used for verifying the assessment.

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Table 15 Institutional basis of the examined assessment schemes
[Source: author]

Assessment Scheme	Providing Institution	Type of Assessment
ASCOT	Engineering Consultancy	Self-assessment
DVB	Academic Institution	Self-assessment[30]
Green Build	Engineering Consultancy	Self-assessment
Green Diploma	National/Private Association	Self-assessment
Green House No.	Minstry	Self-assessment
GSB	Ministry	Self-assessment
LEnSE	Academic Institution	Self-assessment
Opti Build	Engineering Consultancy	Self-assessment
BNB	Ministry	Third-party assessment Assessors accredited by ministry
BREEAM	Academic Institution	Third-party assessment Assessor licensed by the institution
Building Letter AKOEH	National/Private Association	Third-party assessment Assessor accredited by association
DGNB	National GBC	Third-party assessment Assessor accredited by national GBC
Green Mark	Building Authority	Third-party assessment Assessors from the authority
ImmoPass	Technical Supervisory Associa- tion	Third-party assessment Assessors from the supervisory association
Green Star	National GBC	Self-assessment verified by third-party assessors commissioned by national GBC
LEED	National GBC	Self-assessment supervised by national GBC experts
CASBEE	National GBC	Self-assessment Third-party assessment Assessors: experts
MINERGIE®-ECO	Private-Public Partnership	Self-assessment verified by certification authority
Miljöklassad	Private-Public Partnership	Self-assessment (low level) Third-party assessment (high level) Assessors: experts with relevant expertise
SB Tool	Academic Institution	Self-assessment Third-party assessment in case of certification Assessor from local academic institution

The assessors being responsible for external assessments are typically trained and examined by the institution providing the scheme. In some cases such as in the CASBEE system or the Miljöklassad scheme it is possible that any third-party assessor with relevant expertise can execute the assessment, e.g. a certified energy consultant may assess a building and accomplish the certification according to the requirements of the scheme.

[30] In future versions of the system third-party assessments will be offered additionally.

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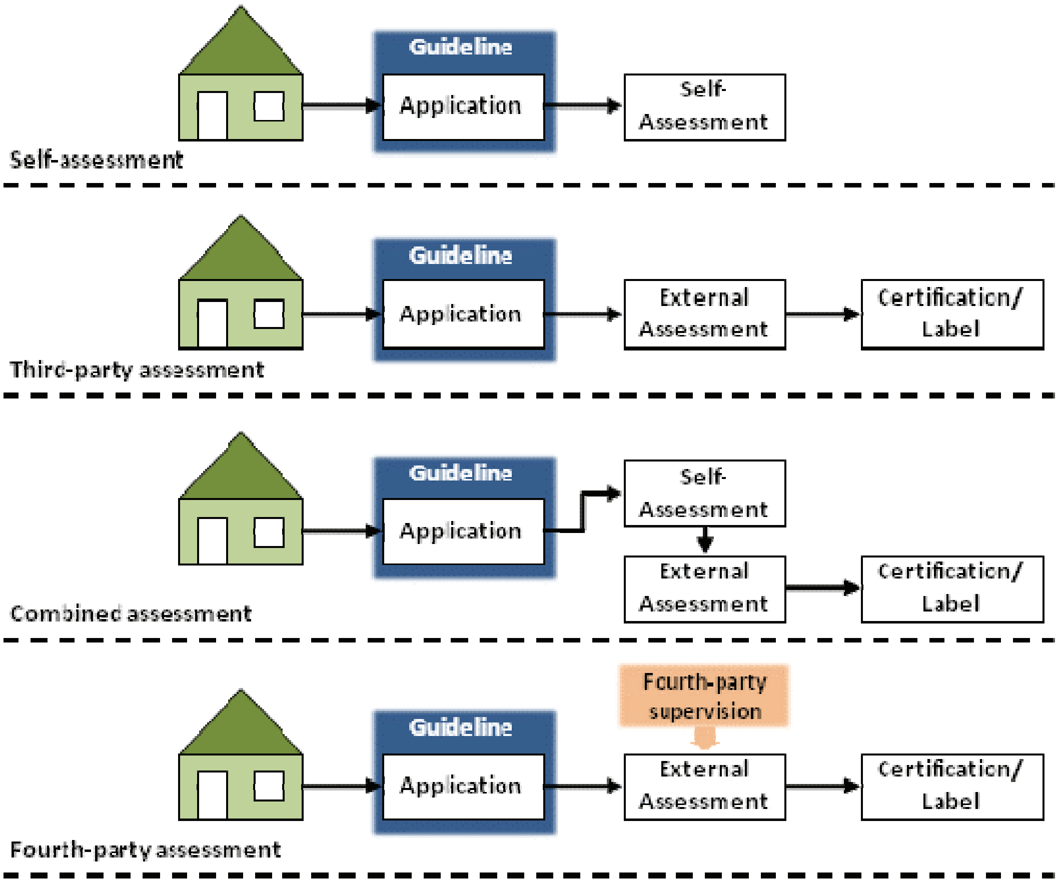

Figure 14 Types of assessment
[Source: author]

As examples the certification procedure of the LEED system and the DGNB scheme are described in more detail since these system are selected to function as a cross check reference for the LONGLIFE pilot building.

The assessment according to the **LEED system** (see Figure 15) requires a registration with the offering institution, the GBCI, first. After registration the user has access to tools and resources that allow to compile an application for a certification. While preparing the application the user selects the credits to be pursued, assigns the responsible persons (of the development team) and starts collecting the required set of information and data. When a LEED certification is aimed for, usually the cooperation with a LEED accredited architect is recommended from the very beginning to support a selection of reasonable sustainability targets and characteristics and ensure successful certification. The application is then submitted online through the LEED project administrator after completion of the documentation. After submission of the application and receipt of the certification fee, GBCI starts the application review depending on the review path the applicant has decided to pursue. A split design and construction review is divided into a maximum of four stages (preliminary design review, final design review [optional], preliminary construction review, final construction review [optional]), while a combined review consists of up to two parts (preliminary review, final review [optional]). The optional reviews are executed in case the applicant does not acccept the results of the anteceding review stage. In case the applicant is not satisfied with the results of the final verification, a review can be appealed for under the condition that an additional fee is paid. Certification is the final step after successful review of the project and certified projects receive the formal certification, and, additionally, information on how to order marketing material such as a plaque, etc. [cf. GBCI 2010a]

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Figure 15 The LEED certification procedure
[Source: GBCI 2010a, authors drawing]

The procedure for receiving the certification for a building develoment under the DGNB scheme is relatively similar. First of all, the user registers the project with DGNB at the website31. The user then submits the specification sheet to DGNB, which contains the required information concerning all indicators and shall be deemed to be a declaration of intent for realising the indicated goals. DGNB checks the compliance with the requirements and the owner receives a pre-certificate for his building project, which may be used for marketing purposes. Now the design and construction process can be conducted in which the responsible auditor, e.g. an DGNB accredited architect, must compile a documentation according to the DGNB specifications. Once the building project is completed the actual implementation of the specifications of the pre-certificate are verified through a DGNB-assessor inspecting the building, checking for plausibility and taking samples for control. In a final review the whole certification process is verified concerning its proper execution, and in case of fulfilment of all requirements the certificate in bronze, silver or gold as well as the corresponding plaque is awarded. An aspect that seems worth to be mentioned in this respect is that in the certification procedure under the DGNB scheme the auditor plays an important role as he functions as a consultant for the design team in respect of sustainable building practices. [cf. DGNB 2009, p.6f]

Figure 16 The DGNB certification procedure
[Source: DGNB 2009, p., authors drawing]

Another crucial aspect of the institutional design of a certification scheme are the costs for under-going the certification. Costs are not made publicly available by most of the organisations providing the systems. National GBC's, however, tend to commonly publish this information. With the excep-tion of CASBEE information was found for the three GBC systems. To enable an exemplary view on the cost situation the fees for a DGNB, a Green Star and a LEED certification are compared.

[31] http://www.dgnb.de/

Table 16 Fee structure of DGNB
[Source: DGNB 2010]

Stage	< 4,000 m²	4,000-20.000 m²	20,000 m²	20,000-80,000 m²	> 80,000 m²
Pre-certificate	4,000 €	4,000 € + 0,35€/m²	9,600 €	9,600 € + 0,06 €/m²	13,000 €
Certificate	6,000 €	6,000 € + 0,75 €/m²	18,000 €	18,000 € + 0,17 €/m²	28,000 €

Table 17 Fee structure of LEED ($ converted into €32)
[Source: GBCI 2010b]

Stage	< 50,000 sf	50,000-500.000 sf	> 500,000 sf
Design review	1,869 €	0,037 €/sf	18,689 €
Construction review	623 €	0,012 €/sf	6,230 €
Combined review	2,284 €	0,046 €/sf	22,842 €

The costs for a Green Star certification are not divided in different stages, but only based on the building size. With a size of up to 9,999 m² the fee amounts to 15,231 €33 ($ 22,000), from 10,000 to 29,999 m² the user has to pay 19,016 € ($ 27,500), and finally with higher building sizes than 30,000 m² the fee remains at ($ 33,000).

In order to allow a reasonable comparison the costs of the considered schemes are converted to Euro and – where necessary – likewise the square feet are transferred to square metre34. As an example we compare the costs for a building with 15,000 m² for non-members of the refering national GBC. Under the DGNB scheme the combined costs for both stages amount to 12,250 €, while the same building size generates a fee for the combined review to the amount of roughly 7,380 € when certified against LEED, and Green Star demands 19,016 € for certification.

Only with these three fees taken as an example it becomes obvious that the costs for certification are very diverse. Nevertheless, it can be assumed that the fee structures for the certification including all stages range between 1 and 2% of the overall budget for the construction work.

Last, but not least, the involvement of the public and the stakeholders forms another relevant criterion to be regarded in the comparison. As seen in section 4.3 many schemes build upon the involvement of stakeholders, which can be institutionalized for example through the establishment of a user board as suggested by BREEAM. This "Sustainability Board" is responsible for considering stakeholders' needs in terms of standards, guides, ways of operation, etc and meets regularly three times per year. The design and suggestion of relevant indicators is commonly justified based on scientific evidence, but the final decision for indicators to be considered in the scheme is usually based on the involvement of stakeholders. Such a consensus-based approach involves a wide selection of stakeholders in the development of the system and the agreement upon the set of indica-

[32] 1 US-$ equals 0,8306 € (state: June 9, 2010).
[33] 1 Australian-$ equals 0,6915 € (state: June 9, 2010).
[34] 1 square feet is equivalent to 0,092903 m².

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tors. In fact, every GBC comprising of members representing certain positions and interests in sustainable building can be regarded a stakeholder board.

Concerning the operation, maintaining and updating of a certification scheme three general institutional types can be distinguished:

Many schemes can be called **public** schemes as they are offered under the umbrella of an authority (Ministry or Building Authority).

Then we have another group, which can be classified as **semi-public** methods, provided by GBC's or academic institutions where a certain involvement of or support from public bodies can be stated.

Finally, **private** tools are developed by private organizations such as Engineering Consultancies or associations for quality assurance.

Discussion

Starting with the last mentioned issue, publicly developed schemes on the one hand can expect to be considered as highly reliable among stakeholders in the building sector. On the other hand, due to their political character, they tend to be very much consensus based and thus also tend to have potentially weaker requirements. Private players can provide tools that are more specifically designed for their target groups and as such eventually aim for stronger targets. However, at the same time private schemes have to be sold as a (consultancy) service on the market with the result, that again their potential strictness might be weakened in order to appeal as much users/clients as possible. An approach that can often be found to balance the ideal of going for best practice in sustainable construction with market requirements is to choose a modular approach. This way assessment schemes can be widely adopted with a mandatory minimum scope, which can be broadened by opting for additional modules according to the specific user requirements or building characteristics.

The latter also points at the idea of a fourth-party establishment: While core characteristics of an assessment scheme, content-wise (topics, issues and indicators) as well as procedural (training of auditors etc.), could be defined and supervised by a super-ordinate association ("fourth party"), the operating institutions "on site" ("third parties") would be free to offer additional modules to satisfy specific user needs.

The close cooperation between the certifying institution – usually represented by a certified auditor or assessor – and the house owner or planning team also plays a crucial role in the process of implementing sustainable building practices into the construction work and contributes immensely to the successful execution of the assessment. Examples give the procedure followed in the DGNB certification where the project team is assisted by an assessor or the LEED approach where often a LEED accredited architect integrates planning and certification from the very beginning of the project.

The option of "self-assessment" within a reliable certification scheme seems restricted to the very initial phase of a project and in any case needs verification on later stages. Another option, as possible under the BREEAM schemes particularly for large developments, could be an assessor, who in fact is a first party actor but at the same time trained and supervised by a third party (BRE in the case of the example). A pure self-assessment, however, definitely does not seem appropriate as basis of a reliable certification towards sustainable construction.

Concerning the costs of certification, it can be assumed that the fee structures for the certification including all stages range between 1 and 2% of the overall budget for the construction work.In the following section the instruments offered by the assessment schemes to communicate the results of the assessment are addressed.

10.1.2.4.4 Communicational Instruments

One of the most important functions of an assessment scheme is to support building quality communication. Firstly, the communication is enhanced in the planning phase when the desired quality features are defined, but also during the construction phase when decisions are required concerning the actual implementation of structural solutions. Secondly, the certification scheme serves as a tool to communicate the building quality and its "greenness" or degree of sustainability respectively. The engagement – and most likely investment – of the house owners or the investor respectively into sustainable building practices must be made visible for the public in order to fulfill the core functions of a certification and labeling scheme to support signaling and screening purposes (see chapter 3).

To this end, assessment schemes aiming for a certification usually provide a plaque or logo after successful certification, which can be placed at the building as a visible signalling of the greenness of the building or degree of consideration of sustainability issues. Additionally, the house owner typically receives a certificate in which the overall result as well as the score in the different topics are depicted. Some schemes offer a more detailed description of the building's sustainability performance as well. Table 18 shows the plaques/labels of the schemes or logos of the providing institutions, a short information on the certification and the available categories/levels as well as a more detailed description relating to the certification procedure.

Table 18 Communicational instruments of the examined assessment schemes [Source. author]

Assessment Scheme	Plaque/Logo	Certification	Detailed Description
ASCOT	ASCOT	The tool pre-dominantly functions as a decision support tool.	The ASCOT tool demonstrates the ecological advances of a building renovation project n relation to its economic costs.
BNB	Federal Ministry of Transport, Building and Urban Development	Certificate levels: bronze, silver and gold	The assessment depicts the sustainability of federal administration buildings considering six qualities such as the DGNB (which is the basis for this system) on the basis of 46 indicators.
BREEAM	THE CODE FOR SUSTAINABLE HOMES™	Level 1 (★) … Level 6 (★★★★★★)	The Code for Sustainable Homes certification signals the sustainability rating in nine categories, and as of April 2008 it is mandatory part of the "Home Information Pack"[35], a structured information on core characteristics of the building without awarding a certification requested in case of purchase.

[35] Houses can be nil-rated, i.e. they receive the nil-rated certificate to be included in the Home Information Pack (HIP), but are actually not assessed against the Code. As of May 19, 2010 the HIP is suspended due to a decision of the new government of the United Kingdom. Only the energy performance certificates will be kept.

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Assessment Scheme	Plaque/Logo	Certification	Detailed Description
Building Letter AKOEH	AKÖH	AKOEH building letter	The building letter ensures standards such as exclusion of chemical wood protection, excellent thermal protection, avoidance of damages through condensate, etc. The label is offered for members companies of the asscociation building houses according to the criteria.
CASBEE	CASBEE	S: BEE ≥3.0 A: BEE ≥1.5 B+: BEE ≥1.0 B-: BEE ≥0.5 C: BEE ≤0.5	The self-assessment tool with external verification can be used as a guideline as well as an environmental labelling tool. The BEE rating signals both, the environmental performance of a building and the environmental load as a quotient.
DGNB	DGNB	Certificate levels: passed, bronze, silver, gold	The DGNB certification demonstrates the sustainability of a building with 49 indicators in 6 qualities.
Dwelling Value Barometer	ee	Certificate levels: bronze, silver and gold	The certificate indicates basic information of the building and signals the building's sustainability.
Green Build	–	A documented proof of the building's sustainability	The "Green Build" assessment provides the user with a documentation proving the sustainability of the examined building.
Green Diploma	–	Awarding of the Green Diploma	The certification shows the efforts of housing associations or private house owners in reducing environmental impacts and increasing energy efficiency.
Green House No.	27 Die Grüne Hausnummer Saarland Ministerium für Umwelt	No certification levels	The Green House Number award demonstrates the implementation of green building features in the house owner's building.
Green Mark	BCA GREEN MARK	Platinum (90 and above) GoldPlus (85-89) Gold (75-84) Certified (50-74)	The Green Mark assessment signals the environmental performance of buildings in four areas.
Green Star		Up to 6 green stars	The Green Star rating tool depicts ecological aspects of the assessed building.
GSB	Federal Ministry of Transport, Building and Urban Development	Building passport	The building passport gives a detailed documentation of a development project including basic information on the building and the surrounding environment as well as details on

Assessment Scheme	Plaque/Logo	Certification	Detailed Description
			various aspects of sustainability such as the utilization of daylight, energy demand, water demand, ventilation. Additionally, maintenance is mentioned as well as the operation costs are indicated.
ImmoPass		ImmoPass	The ImmoPass assessment ensures and demonstrates the quality of a building project in six different topics.
LEED		Certified (40-49 points) silver (50-59) gold (60-79) platinum (80+)	The LEED certification shows the environmental performance of a building, concerning seven topics.
LEnSE		Rating A, B, C or D	The rating methodology provides an assessment of existing, new and renovated buildings concerning their sustainability.
MINERGIE®-ECO		MINERGIE®-ECO certificate	The certification signals environmental topics (health and building ecology), but also integrates economic aspects in the certificate.
Miljöklassad		Classification classes: A – B – C – D	The certification demonstrates the documented environmental quality of a building concerning energy performance, indoor environment and harmful substances, and additionally signals that the environmental performance has been measured on the basis of a systematic and scientific methodology.
Opti Build	–	No certification, but calculation of life cycle costs for energy-saving measures	The decision-support-system demonstrates the calculated life cycle costs of various energy-saving measures.
SB Tool		Performance profile, performance explanation, ecolabel	The certification shows the environmental performance of the building, and additionally gives an explanation of the performance results.

Discussion

At the beginning of the building process an assessment and certification scheme has the potential to function as a means to enhance the communication among the persons involved in the planning procedure for a development project and supports the search for an agreement upon building quality and sustainable building aspects. Several schemes beside offering assessment, certification and labeling can be considered as “tools to talk”. The communicational elements or “output” the

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various schemes provide at the end of the assessment procedure vary from mere decision-support to real certifications which includes the awarding of a plaque/label and a documentation. The

majority of the systems (e.g. BREEAM, CASBEE, DGNB, LEED, SB Tool) award a certification which is commonly, but not necessarily offered in different levels. Mostly there are four classes (e.g. passed – bronze – silver – gold), but some schemes are divided into six levels (BREEAM, Green Star) while others provide an unclassified certification (ImmoPass, MINERGIE®-ECO). The schemes functioning as a decision-support tool (ASCOT, Opti Build) have a particular focus, namely the comparison of various energy-saving measures.

Again, there is no ideal solution or general answer how the assessment and certification scheme is supposed to be designed in this respect, and, once more, it highly depends on the specific context and individual situation of the user and his or her purpose. For the common house owner the Green House No. offering an award is a nice opportunity to show the building's greenness, while a real-estate company rather requests a real certification including a full documentation of the building's sustainability features.

However it becomes clear, that three typical communicative outputs of a certification scheme can be identified: A **label** for quick signaling of advanced quality and attracting attention, a **certificate** or "passport" displaying core characteristics and values (e.g. energy benchmarks) and a comprehensive **documentation** as in depth source of information.

In the final chapter the results gathered from this in-depth analysis are addressed and an outlook is given to the principal conception of the framework of the LONGLIFE certification system.

10.1.2.5 Results & Outlook

As a result of the comparison concerning content and conceptual details those elements of the existing assessment schemes could be identified that constitute sound and appropriate solutions. Main results are summarized in the next section.

Results

After this analysis which generated more detailed insight concerning the design and concept of the assessment schemes it is not possible to identify the optimal method that performs best in all perspectives and contexts. The result is rather that each of the regarded schemes offers advantages in certain areas while other conceptual details are less suitable. Therefore, it is recommended to compile a separate and specific LONGLIFE certification scheme that considers particular requirements and conditions relevant in order to serve the project's goals. This adaptation, however, takes into account knowledge about and experiences gained from the existing schemes.

In the following, elements and details that have been proven reasonable and manageable for such a certification are presented. The development of a LONGLIFE certification scheme will build on these procedures, organizational and structural elements.

With respect to the **indicator catalogues**, many of the certification schemes offer characteristics worthwhile to be considered. The specific layout of the topics and the indicators classified to the topics seems to vary extremely, but at closer inspection it is possible to identify comparable catalogues of indicators in the majority of the schemes.

Concerning the number of involved indicators a concept seems to be useful encompassing rather few indicators. Consisting of aggregated values of high significance these indicators give evidence of a broad range of aspects and are, at the same time, relatively easy to determine. In contrast, the concepts of Green Build or Green Diploma for example requesting an immense number of indicators seem to be not really adequate. The mere function of a guideline which is perfectly fulfilled with such an approach is not enough – though it is clearly important and relevant especially at the beginning of the development project. Also, the very diverse splitting of the topics leads to relatively laborious and time-consuming assessments.

The flexibility and adaptability of the system such as provided by SB Tool for example where indicators can be dropped upon need, and/or desire is another interesting approach.

Additionally, the future tightening of the indicators' requirements as considered in the BREEAM Code for Sustainable Homes36 (or the according Building Regulations) is an important feature of a certification system37: For acceptability purposes a scheme might start with the most consensual topics, issues, indicators and requirements and then have regular, e.g. annual, revisions in order to check to what extend a more engaged scope of assessment is possible. An example to this end is given by the BREEAM Eco-Homes scheme (Rao et al. 2000) , that list possible future additional indicators as an Annex under the headline "Beyond Eco-Homes" to keep the idea on the agenda that a stakeholder consensus at a given point of time should strive to be improved during future revisions.

The full declaration of materials and substances deployed in the building as demanded by Swedish Miljöklassad method for example is an interesting feature, as it increases the security for the house owner immensely. It is also of valuable support in the case of refurbishment, reconstruction or demolition of a building as it potentially decreases analytical effort.

The consideration of "activity radii" as conducted in DVB is a quite sophisticated example on how to consider the users' needs within the issues of an assessment scheme. The user of the building/apartment and his/her needs is focused by distinguishing his/her areas of activity into three zones: the apartment itself, the building and its close environment, and, finally, the neighborhood.

Concerning the **weighting and scoring** sound solutions assign the score for each indicator on the basis of a percentage demonstrating the degree of compliance with this characteristic of the assessed building. An aggregation taking into account the higher relevance of some indicators/issues/topics through weightings is favorable as well as an overall result for the building as the weighted average of the indicators' precentages. Such a rating expressing the "degree of sustainability" in a single number is a memorable and expressive way to communicate a building's sustainable quality. This concept of "one number says it all"38 is criticized by many experts since extreme results in individual indicators and topics are balanced, and shortcomings can be hidden easier. Nevertheless, the advantages of such an approach seem to be major, and the identification of low sustainable performance in detail indicators can be achieved through other means as well.

Moreover, the consideration of interrelations between the topics as applied in DVB is useful when defining the weighting of the indicators and topics in order to retrieve a realistic picture of the relationship between the different topics.

Since an agreement on indicator weightings and appropriate aggregation of detailed information to a certain extend has to be considered as "political", the involvement and participation of stake-

[36] Actually, the increasing requirements are constituted in the amendments of the British Building Regulations incorporating clauses required in conjunction with the EPBD.
[37] The Code requires more demanding values in the course of time – within 10 years starting from 2006 the requirements for newly built homes are supposed to increase from Level 1 to Level 3 in 2010 to Level 4 (2013), and, finally, to Level 6 in 2016 which is equivalent to zero carbon homes.
[38] E.g. the "Environmental Index" developed by the Dutch Government Buildings Agency is a concept expressing the sustainability of a building in a single number for which the developers claim having managed to solve the problem [SUREAC 2010].

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holders and consideration of their perspectives within the management and development of the system is also an important element.

With respect to the **institutional basis**, there are several aspects to be mentioned.

In order to reach a large commitment of the users the consensual elaboration of the layout and procedures of the scheme is sensible. The larger the stakeholder involvement is in which they can express their interests and needs, the higher the acceptance in the practical implementation will be.

The certification procedure as performed under the DGNB scheme with close and continuous consultancy of the development team through an experienced auditor throughout the planning and construction process is a useful solution which potentially ensures the adequate implementation of sustainable building principles on the one hand, and a successful certification on the other hand.

Additionally, the implementation as a third- or fourth-party assessment provides a transparent and externally verified certification, which can increase the users' and stakeholders' confidence in the results.

With respect to certification costs, different rates can be found. Taking usual planning costs as a guideline, a span of 1-2% of the overall project costs seems reasonable.

Finally, the **communicational instruments** vary from a label quickly signaling the advanced quality, over a certificate to communicate the building's core characteristics to a full documentation. All instruments have their entitlement and the implementation into a scheme actually depends on the purposes and targets of the method. Usually a combination of these instruments seems recommendable. To maintain the relevance of communicational instruments over time, the validity of a certification may be limited in time and up-dating/revision cycles may be considered.

For the internal communication between involved actors – for example towards the definition of appropriate sustainability targets – guidelines as well as positive or negative lists to support the choice of construction materials are a useful feature.

The next steps to be taken for the conceptual design of the framework are indicated in the following and final section of this report.

Outlook

For the next steps towards the design of a LONGLIFE framework for certification towards sustainable construction the following elements and features are considered as crucial:

First of all, the **catalogue of indicators** that should be considered for the certification according to LONGLIFE should be determined in close cooperation with the project partners and the relevant stakeholders. It is desirable to reach an understanding as far as possible among the persons concerned with regard to the indicators in order to ensure a large commitment to the scheme. This will potentially increase the chances of the scheme on the "certification market.

Secondly, the method of **weighting and scoring** as well as the aggregation of the points is another important aspect to be performed in this context. Again, the agreement among the involved stakeholders is crucial for the scheme's successful implementation.

Thirdly, the **institutional basis** such as the type of assessment, the assessment stages from registration to certification, etc. has to be defined. This includes for example organisational details concerning the documents that are required from the project team for the submission of the application. Additionally, the institution providing the certification scheme must be identified and determined in terms of its organizational structure. The idea of a "Baltic Sea Housing Development Association" (BASHDA) developed out of the LONGLIFE project and in close cooperation with LONGLIFE partners points in this direction.

Finally, the **communicational instruments** of the certification scheme should be fixed. This includes the design of the label as well as the layout of the actual certificate and supplementary documentation providing detailed information on the building and the assessment results. Also a guideline for consultancy might be considered

Given the derived results and in consideration of the requirements and circumstances in the project region, the characteristics of an appropriate scheme can be compiled as indicated in **Fehler! Verweisquelle konnte nicht gefunden werden.**.

Table 19 Features of an assessment and certification scheme

Feature	Description
▪ Holistic approach	The approach should cover all three dimensions of sustainability.
▪ Scientifically justified foundations	The basis of the assessment scheme shall be scientifically justified. However, the procedural conception such as the selection of topics and indicators as well as the layout of the certification procedure shall preferably be developed as a consensus-based agreement involving concerned stakeholders.
▪ Transparent procedure	The assessment and certification procedure should be developed and maintained with involvement of users and other stakeholders and made public.
▪ Adjustable conception	The scheme should be the designed as such to allow an adjustment for other purposes and/or other housing types or specific demands of applicants. However, a mandatory core is necessary to ensure comparability.
▪ Comparable certification	The concept of the assessment scheme must be designed in a way that ensures the comparability of the certification and the results for different building/construction types.
▪ Reliable institutional background	The providing institution has to have a certain reliability for the concerned stakeholders / target groups.
▪ Easy to understand method	The assessment method and its results should be easily understandable for the user.
▪ Regionally adaptable system	The system design should allow an adaptation to other regions with its specific climatic, topographic and legislative requirements.
▪ Attractive label	The awarded label should be attractive for the user and target groups.
▪ Marketable results	The system design must make sure that the certification results can be used effectively on the real-estate and tenancy market.
▪ Easy to use tools	The tools used for the assessment and certification shall be easy to use.
▪ Reasonable costs	Taking usual planning costs as a guideline, a figure of 1-2 % of the project costs seems reasonable.
▪ Telling the same story in different ways	To meet the needs of different target audiences of a certification scheme the deployed communicational instruments (documentation, passport, profile, label) should provide the means to tell "the story about the building performance" [Cole, Larsson, 1998] in different ways.
▪ Up-dating	To keep the scheme relevant, regular revisions of assessed topics, issues and indicators, benchmarks and procedures is essential. Also the certification itself might imply the option/requirement to regularly update the rating. At least the building documentation should be kept up-dated for the building lifetime.

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10.1.3 Report.3

Outline of a Framework for a Longlife certification scheme

10.1.3.1 Abstract

This final report provides an initial outline of a framework for a *LONGLIFE assessment, certification and communication scheme* and defines the pathway that may be pursued in order to establish those organisational structures and conceptual procedures required in this context. In particular the development of the framework encompasses:

- the presentation of basic elements constituting the institutional basis,
- suggestions for topics to be considered in the course of the assessment,
- a description how to reasonably determine a set of indicators,
- the definition of a framework for the actual certification process,
- and recommendations for instruments being useful to communicate sustainable building quality.

In the final chapter the results of the discussions among the project partners are summarized and a concept is presented to reconcile the concept of a certification as suggested by the authors with the alternative concept of a *Performance Pass* as favoured by several members of the project team.

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10.1.3.2 Introduction

The analysis elaborated in the first two reports identified characteristics, procedures and elements in existing assessment and certification schemes that could reasonably be considered for an adaptation in the Longlife project.

These building blocks now have to be assembled in order to develop a framework for an adapted *Longlife Assessment, Certification and Communication Scheme towards Sustainability* (***LONGLIFE certification***). Principally, the *LONGLIFE certification scheme* addresses several targets.

First, it should provide a **method to communicate the building quality** with special regard to sustainable building practices. As identified in the comparison of the second report [Dirlich 2010b] beside **signalling** the building's sustainable quality on the market in a reliable way, one of the main functions of a certification scheme is the communication about building quality during the planning and construction process. Many existing schemes include elements of **consultancy and guidance** towards an advanced choice of sustainable building characteristics.

Second, due to the conception of the project and in response of the dominating role of **energy- and resource-efficiency**, the system must address these two goals in particular.

Third, the project goals of **integrating new and adapted technologies** into the building process must be reflected as well. This aspect obtains further relevance as it can be regarded as a method to communicate reliable information about innovative technologies beyond the technological state of the art among all involved actors. This helps to prevent information deficits during the different phases of planning, tendering, construction and use of the building as well as on later stages like maintenance, refurbishment or even demolition.

Last but not least, the **consideration of life cycle costs** as an integral part of the scheme should be aimed for as these are relevant to a high extent for the Longlife project.

The steps and components necessary to develop the framework of the certification scheme are described in the following sections.

10.1.3.3 Development of a Framework

The development of a framework for a *LONGLIFE certification scheme* requests the determination of the thematic scope, structural elements such as the institutional basis (providing organisation) as well as procedural characteristics such as the certification process.

10.1.3.3.1 Basic Conception

First of all the basic conception shall be presented. Figure 17 depicts the various foundations the certification scheme is influenced by.

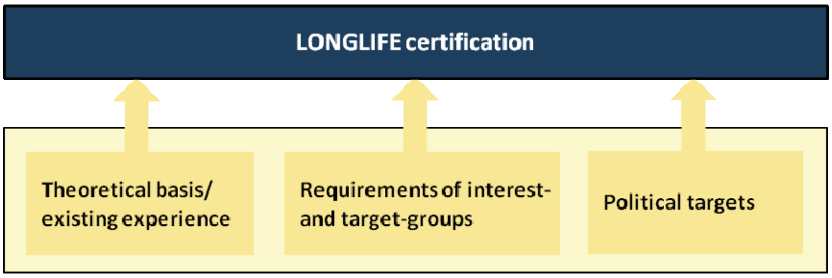

Figure 17 Foundations of the LONGLIFE certification scheme
[source: authors, developed from Blum 2001]

General foundations of the certification scheme are:

- The theoretical basis and existing experience,
- the requirements claimed by stakeholders, and
- the targets defined by political instances.

The *theoretical basis* as well as the experience gained with existing schemes has been comprehensively dealt with in the first two reports [cf. Dirlich 2010a, Dirlich 2010b][39]. The prominent relevance as a means to support and foster the communication process concerning building quality has been emphasised in this context. Additionally, ISO 21931-1 dealing with methodological aspects of the design of building assessment schemes has been used as a general background for the development of this framework.

Concerning the *requirements stakeholders claim for*, the concept of the *LONGLIFE certification* should ensure a broad involvement of concerned stakeholders. As elaborated in the first two reports the commitment of stakeholders during the practical implementation, i.e. the conducting of a certification, and thus the success of the scheme highly depends on their degree of contribution to the initial and eventually further development of the scheme.

Political targets as codified by political instances in regulations and standards (e.g. the European Construction Products Directive [Council Directive 89/106/EEC] or the European Energy Performance of Buildings Directive [EP/EC 2002]) determine values for certain aspects such as the annual primary energy demand of buildings which must also be considered in the design of the assessment and certification. These values should be regarded as minimum requirements which must be kept strictly (“compliance”), but may be exceeded by the examined building.

[39] In the following these two reports are not explicitly indicated as a reference when they are referred to, but still shall be regarded as the source of information by the reader.

Phases of the certification process that should be differentiated are defined in analogy to the common life cycle perspective and comprise the planning phase, the construction phase up to the completion of the building, and finally, the phase of operation. For a dynamic scheme it has to be decided, to which extend future works like refurbishment or even demolition had to be incorporated into eventually updated certification documents. The various tools and support the *LONGLIFE certification scheme* shall offer should be seen in close connection to these phases:

- Consultancy (1)
- Monitoring (2)
- Documentation and Certification (Label) (3/4)
- Updating (5)

A comprehensive **consultancy** from the very beginning is crucial to assist the users in specifying sustainable building features of the building. A sustainability planning checklist (see section 3.7.) would be a reasonable and helpful tool in this respect. Also, an appropriate **monitoring** during the phase of construction is important to ensure the proper implementation of the defined specifications. A detailed and structured **documentation** supports this function as well, and additionally, produces a distinct description of the building quality. After the completion of the construction work the building receives the **certification** and, eventually, a **label** for sustainable building quality is awarded. A comprehensive explanation of these individual components is given in the referring sections below.

Elements of sustainability communication and informative basis of the certification could be a "Building Logbook" (a comprehensive documentation of relevant documents and information), a "Building Passport" (a briefing document summarizing core characteristics and quality issues) and a "Label" (as an element of rapid communication of advanced sustainability). These elements should be seen as supplementary parts of the documentation/communication process of the certification with different functions. A more detailed description is given below in section 3.5.

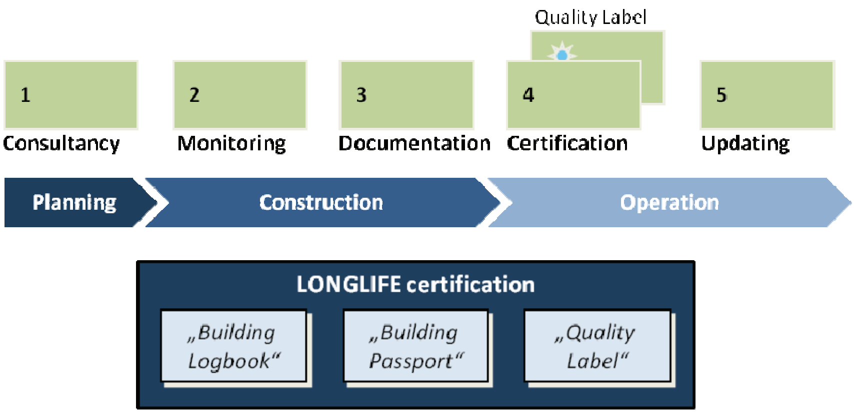

Figure 18 Phases and elements of LONGLIFE certification scheme
[source: authors, developed from Blum 2001]

As the first step in the description of the framework conception the institutional basis of the scheme is presented in the next section.

10.1.3.3.2 Institutional Basis

The suggested organisational structure of the *LONGLIFE certification scheme* is depicted in Figure **19**. For the general institutional setting, a "fourth-party"-structure is suggested. The certification scheme should thus preferably be provided and managed by the "**BAltic Sea Housing Development Association**" (BASHDA), an organisation to be founded to continue the cooperation between the project partners, disseminate results and involve further actors after conclusion of the project Longlife as "parent organisation". One of the main functions will be the spreading of optimized constructive solutions for buildings in terms of cost-effective energy performance and resource demand. This involves e.g. the provision of information on energy and resource efficiency, reduction of life-cycle costs, and sustainable building principles in general through the development and communication of guidelines. For the purpose of managing the operational implementation of the scheme and day-to-day work it should be helpful to establish national branches of BASHDA in all partner countries. The responsibility for the development, realization and actual implementation of the certification scheme shall lie in the hands of BASHDA and its national branches. The supranational BASHDA organisation would be responsible for the development and general management as well as for tasks like supervision, accrediting, research initiating, development of shared training requirements etc. for the national branches while these are rather responsible for managing the operational tasks.

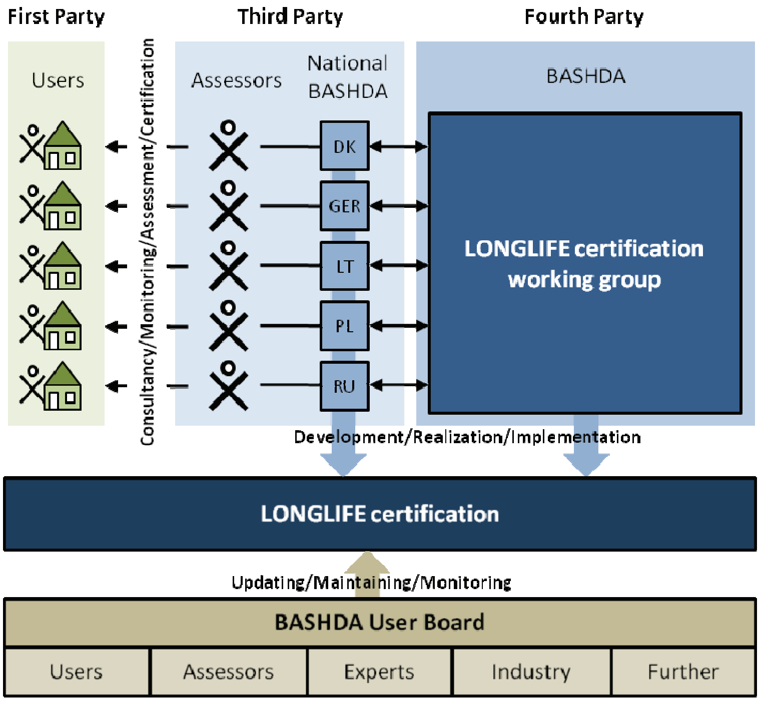

Figure 19 Organisational structure of the LONGLIFE certification scheme
[source: authors]

With respect to the practical implementation it is suggested to confer the assessment upon **BASHDA accredited assessors** who beforehand received a comprehensive education on the certification scheme and sustainable building practices in general. These assessors must be trained on a regular basis by the national BASHDA branches in order to impart up-to-date knowledge and skills on the certification of sustainable building quality.

The involvement of stakeholders has been detected as a relevant and prominent characteristic of major certification schemes. As such the establishment of a so called "user board" seems to be essential. The user board should meet regularly in order to support the BASHDA organisation in the process of maintaining, updating and further development of conceptual, organisational and practical aspects of the *LONGLIFE certification scheme*. The board should be formed by representatives of all relevant stakeholder-groups like users (planers, house owners), assessors, sustainable building experts, representatives from industry etc. Main target of the board is to adjust the scheme and its procedures to new developments, requirements and conditions. For example periodical negotiations concerning the indicator catalogue is a striking task of the user board. Single indicators may be identified as not relevant anymore, others may newly come into the stakeholders' scope or the method of assessing the indicator may be adapted. Furthermore, the board shall be responsible for the monitoring of the actual certifications, and discuss in this context for example the quality of the assessors' assessments or the integration of innovative technologies.

Finally, due to the described structure it becomes obvious, why the suggested *LONGLIFE scheme* is a fourth-party certification. The supply-side (investor, owner, eventually the planner) is regarded as "first party", the client, buyer or tenant (demand side) has the role of the second party, while the assessors as members of the responsible national BASHDAs are called "third-party". BASHDA as the organisation holding the final responsibility and acting as the supervising and monitoring instance can be deemed to be "fourth-party".

Since BASHDA as an organisation will have other tasks besides managing the *LONGLIFE certification scheme*, the transnational scheme does not necessarily have to be equalled with BASHDA as an organisation. Also the national *LONGLIFE certification organisations* do not necessarily have to be national BASHDAS: It might be reasonable to decide upon a "*LONGLIFE certification*" trademark, like "*LONGLIFE-cert*" or similar that could also be hold by any (BASHDA-)accredited national body, like for example consulting engineers, without subscribing to the overall BASHDA organisation. However, for this initial outline we keep the structure simple, and this means to have a supranational parent organisation BASHDA with national BASHDA-branches implementing the *LONGLIFE certification* through accredited assessors.

The third part of the framework outline addresses the topics that should be considered in the assessment.

10.1.3.3.3 Topics

The decision for certain topics should be based on the experiences with sustainability indicators and the conclusions drawn during the analysis of existing schemes. Figure **20** delivers a suggestion for topics which encompasses all three dimensions of sustainability. Additionally, a declaration of life cycle costs (besides integrating life cycle costs as one or more indicators) and a full declaration of substances and materials may be submitted as part of the complete documentation in separate documents. Depending on the final scheme of assessment they might be part of the qualitative elements of assessment (e.g. provided/not provided). Life cycle cost, however, should also be part of the assessment in the topic "economy".

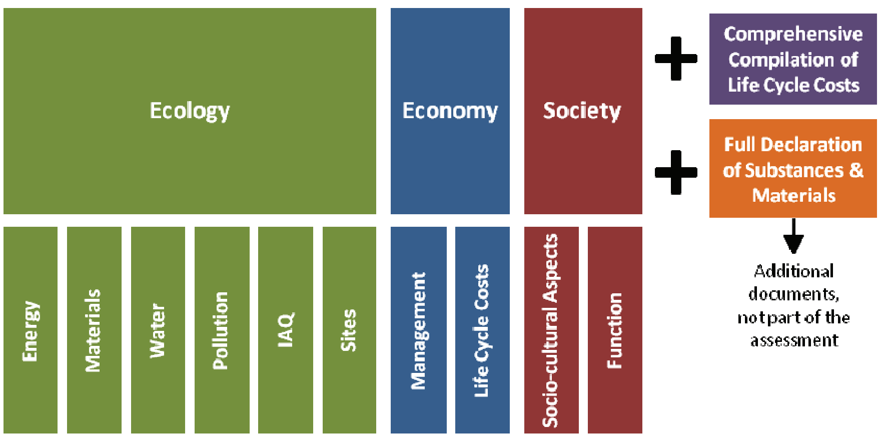

Figure 20 Suggestion for topics considered in the LONGLIFE certification
[source: authors]

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In order to keep the scheme as simple, transparent and comprehensible as possible the number of topics touched for the certification should be relatively limited.

The ecological topics suggested for consideration are “energy”, “material”, “water”, “pollution”, “indoor air quality (IAQ)”, and “sites”.

The relevance of the first three is obvious and can be justified by three reasons: Firstly, these are the topics identified as the most important ones in terms of quantity and quality in the analysis of the existing schemes. Secondly, the stakeholders in the partner countries deem them utmost relevant for sustainable building as detected in an inquiry in April 2010 [see Dirlich 2010a]. Finally, the targets of energy- and resource-efficiency defined in the outline of the Longlife project correspond particularly to these topics and emphasise their tremendous significance.

“Ecology” should additionally incorporate “pollution”, “IAQ” and “sites” as all three aspects have an immense impact on the environment, and on the personal health and wellbeing of the owners and users of buildings.

With respect to the dimension “economy”, the current state of discussion among the Longlife partners points towards an assessment, that should span “management” and “life cycle costs”. “Management” could involve aspects such as the commissioning of domestic technology or the integration of maintenance and repair plans, while the indicator “life cycle costs” assesses the overall costs for the building over its assumed lifetime.

The social dimension of sustainability shall be represented by socio-cultural aspects such as barrier-free accessibility of the building, and the functional quality. Both are relevant for a sustainable building as they refer to aspects with a pretty large influence on the users’ comfort and perception.

Moreover, the denomination of the topics as well as the selection allows for an easy adaptation in case it is necessary. Aspects from very diverse areas can be allocated to one of the suggested topics when the maintaining instance of the certification scheme detects the need for it.

In the following section the different opportunities of defining an indicator catalogue are described indicating the alternatives with higher preference.

10.1.3.3.4 Indicator Catalogue

The selection of indicators for the different topics can only be performed in a process ensuring the active participation of the relevant stakeholders. As mentioned above, in the second report the importance of stakeholder-involvement for the successful implementation and execution of the certification scheme has been identified. The design of the organisational structure as specified in section 3.1. ensures the participation through a user board.

The selection of topics/issues/indicators should meet several requirements according to Oldenburg [1998], Henseling et al. [1999], FUE [1997]:

- Political relevance
- Usefulness for the user/target audience
- Measurability
- Scientific supportability
- Comprehensibility
- Awareness-generating relevance
- Selectivity
- Adequate cost-benefit-ratio

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Therefore, the indicators making up the considered topics are subject to negotiations amongst the developers of the certification scheme and the stakeholders. Preferably, the discussion should use a neutral basis as a starting point, e.g. a (European) standard such as ISO/TS 21929-1[40]. This ISO standard provides rather a framework for the development of indicators than an actual set of indicators, but as also several examples are presented it is yet reasonable to consider it. Furthermore, the standard is currently under development and a core set of sustainability indicators is under discussion for an amended version that could be a valuable reference for future substantiation. Also, ISO 21931-1 provides a list of issues for the environmental dimension of sustainability that can be referred to as a reasonable starting point for the selection of indicators.

Another alternative to define indicators would be to utilize results and experiences gathered in other projects preferably on European level (e.g. LEnSE [LEnSE Partners 2007]). The set of indicators used therein could be adapted for the *LONGLIFE certification scheme*.

Finally, in case an agreement can not be found amongst the stakeholders, the definition, – or better said – suggestion of considered indicators must be delivered and decided upon by the project team itself. The final definition of characteristics of a Longlife prototype building as a reference would be an essential precondition and corner stone to this end.

Regardless of the above stated, due to the specific targets of the Longlife project it is definite that "life cycle costs" are to be integrated as an indicator. The question remains which types of costs should be included into it? Basis of the decision should be the relevant standards such as DIN 276 ("Costs in the building industry – Part 1: Structural engineering"), DIN 18960 ("User costs in structural engineering") and DIN 277 ("Building area and volume of buildings in structural engineering"). In combination these standards provide means to approximately determine the required life cycle costs.

In order to determine life-cycle costs either the project team can develop its own tool, or integrate an existing method into the certification scheme. A possible tool for performing such an identification and detailed declaration of the life cycle costs could be LEGEP [König 2009]. This software consists of several modules like "warmth/energy" which calculates the heat balance and the energy demand or "eco-balance" which considers aspects such as radioactivity, acidification potential, ozone depletion potential or global warming potential. The period under consideration for these aspects is the full life-cycle of the building. Additionally, LEGEP offers the calculation of life cycle costs which covers costs for cleaning, maintenance, repair, operation, dismantling and further cost-effective activities. The cost groups differentiated refer to DIN 276 and include ancillary construction costs, costs for outside facilities, costs for construction works – technical installations, costs for construction works – building construction, costs for preparing and developing, costs for the site.

For the scope of topics and indicators used for assessment and certification a general question to be dealt with is the distinction into mandatory and voluntary elements. Several existing schemes (e.g. Green Diploma and LEnSE) start with a mandatory core set of issues or "modules" to be considered. In addition the mandatory scope can then be extended according to project specific features. A modular approach seems to be reasonable also for the *LONGLIFE certification scheme*, to ensure both, *comparability* with a mandatory shared core and at the same time *flexibility* in order to fit for different national or regional contexts. In any case a modular approach would make it necessary to document the actual scope of assessment and certification when the results are communicated, i.e. to clearly display, which issues were tackled and which were not.

[40] This ISO standard entitled "Sustainability in building construction- Sustainability indicators – Part 1: Framework for development of indicators for buildings" provides methods to determine indicator sets for the assessment of buildings concerning sustainability.

With special accordance to the indicator catalogue it should be made clear, that it is of great importance that the Longlife prototype standards should function as a reference framework. Therefore, the definition of the prototype specification in the future is important for the practical implementation of the certification framework into a working certification scheme.

The following section deals with the definition of a conceptual framework of the certification procedure.

10.1.3.3.5 Certification Procedure

A suggestion for the certification procedure is shown in Figure **21** as an overview. The applicant (investor, planner, owner, ...) registers his project at the website of BASHDA and in cooperation with BASHDA and its assessors the specifications for the development project are defined in an initial consultation. Especially in case of a modular approach (as suggested for the *LONGLIFE scheme*) the targeted topics, issues and indicators for assessment and certification are identified. This procedure might be supported by a "*LONGLIFE sustainability checklist*" (see Annex 1). On the basis of this documented list of desired sustainable building features the application is gathered and finally submitted by the user. BASHDA reviews the application and included documentation. In cooperation with the applicant appropriate stages of the construction process are identified for the on-site monitoring (construction site audit(s); see below) to ensure the intended quality being correctly implemented. Additionally, a final inspection is recommended, at least for example to check air tightness when the building shell and envelop is completed. (An)other audit(s) can take place in case of justified doubts concerning the indicated sustainable building quality.

An important characteristic of the suggested scheme is that throughout all stages of the procedure BASHDA accredited assessors are actively assisting and consulting the users. So the procedure generally follows the idea of teamwork and cooperation towards sustainable construction ("qualification") rather than a concept of rigid requirements and control ("pass/fail"). The assessors are trained comprehensively concerning sustainable building principles and the *LONGLIFE certification procedure*. At the beginning of the certification procedure the assessor functions as a consultant for the applicant and supports him in all questions of building quality and the integration of sustainable building features as well as the proper performing of the assessment. His tasks also comprise the monitoring during the construction phase which should be done through on site inspections. Additionally, he is responsible for the assessment and the verification of the assessment results. The assessors may be members of BASHDA as well as external experts such as architects, planners or experts of buildings' energy performance, but need to be accredited by BASHDA.

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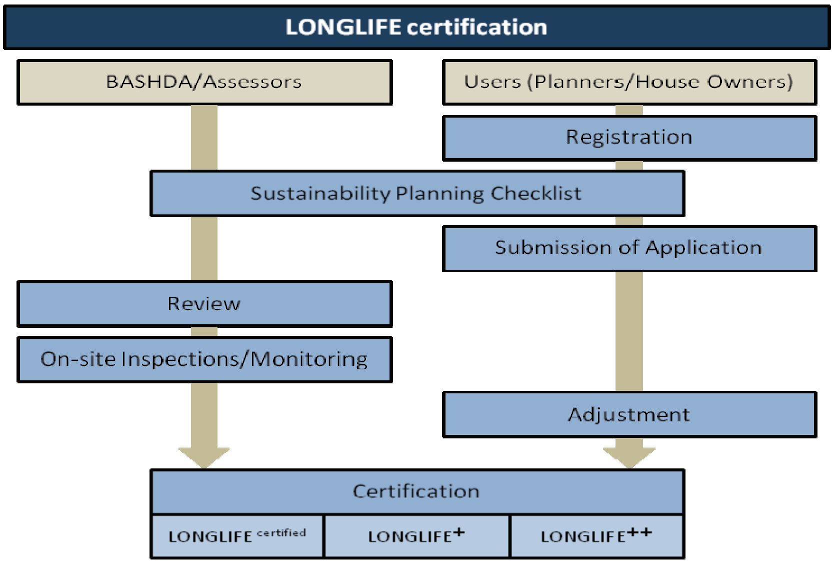

Figure 21 Certification procedure as suggested for LONGLIFE certification
[source: authors]

The application including the documentation has to be prepared by the planning team in cooperation with the BASHDA-assessor and submitted to BASHDA. Probably the most important document at this stage is the *LONGLIFE sustainability planning checklist* which should be filled in by the planning team in cooperation of planner, investor/owner/client and BASHDA-assessor. It serves as a reference for the further planning and construction process. The complete documentation may include for example:

- Drawings and floor plans
- Calculation of energy performance according to EPBD
- Targets for the various indicators to be considered by the assessment and certification (*LONGLIFE sustainability planning checklist*)
- Agreement about on-site inspections
- Full declaration of materials
- Comprehensive compilation of life-cycle costs
- Statement on compliance with the positive-negative list

The certification in general is successful in case the Longlife core or minimum requirements are met. However, for an attractive scheme and in order to set an incentive for better practice it seems advisable to offer the certification and an eventually resulting labelling in different levels. A suggestion for three levels is shown in the following (example; for alternatives see table below):

- LONGLIFE$^{\text{certified}}$ ▶ Certified compliance with national building standards/regulations
- LONGLIFE^{+} ▶ Fulfilment of Longlife prototype requirements
- LONGLIFE^{++} ▶ Implementation of additional features of sustainable building

Buildings having undergone the assessment and certification and complying with applicable building regulations and standards are eligible for receiving the basic *LONGLIFE rating* called "LONGLIFE$^{\text{certified}}$". The idea behind this first stage certification is to assure good quality construction[41] as a first step towards sustainability and provide a low level entry point for the subject of sustainable construction. Those buildings meeting the minimal requirements defined under the *LONGLIFE certification* and therefore, exceeding the building standards are able to be awarded the advanced certification named LONGLIFE^{+}. Finally, at the top level the LONGLIFE^{++} award is assigned when the building additionally integrates certain sustainable building features.

Table 19 Evaluation alternatives
[source: authors]

LEVEL	"Qualitative"	"Quantitative"	"Combined"
LONGLIFE$^{\text{certified}}$	Compliance with applicable building regulations and standards	50% to 60% of prototype standard (e.g. Longlife minimum requirements)	Compliance + Longlife minimum requirements (50% to 60% Longlife requirements)
LONGLIFE^{+}	Prototype standard	Up to 80% of prototype standard	>60-100% prototype credits
LONGLIFE^{++}	Additional advancements	Up to 100% of prototype standard	Additional credits

For this distinction there are three alternatives of evaluation conceivable: qualitative, quantitative, or a combination of both approaches. The requirements for the three levels in each of these alternatives are depicted in Table **19**.

For a **qualitative rating** the differentiation of certification levels is derived from a rather qualitative rating as describe above the table.

A **quantitative rating** is simply based on the credits received in the assessment compared to the Longlife prototype building as a reference. The rating would be expressed as an overall score. LONGLIFE$^{\text{certified}}$ for example might be assigned when the building meets 50 to 60% of the prototype standard (which might represent the Longlife minimum requirements). LONGLIFE^{+} requires a compliance of between 60 and 80% while LONGLIFE^{++} is awarded for more than 80% accordance with the prototype standard (percentages indicative suggestions).

A **combined approach** mixes both types of rating. The basic certification level is reached when the building complies with applicable building regulations and standards plus meeting Longlife minimum requirements (in this example 50% to 60% of prototype standard). LONGLIFE^{+} is awarded for a score of >60% to 100% of the prototype standard. Finally, the top level LONGLIFE^{++} is assigned for a score of more than 100%, i.e. the building fully complies with the Longlife prototype standard and provides extra features of sustainability that qualify it for additional credits.

The qualitative approach opens a broad range of options for participation rather than fixed specifications. It awards certified compliance with applicable building regulations and standards as a first important step towards sustainable construction on a market, where under tight economic conditions good quality construction can not necessarily be taken for granted. A qualitative approach

[41] As a minimum framework for the certification of good quality construction the six general headings of the European Construction Products Directive (CPD) reflecting essential requirements for buildings should be referred to: Mechanical resistance and stability, Safety in case of fire, Hygiene, health and the environment, Safety in use, Protection against noise, Energy economy and heat retention.

also keeps the threshold low to get engaged – with the result, that eventually more committed sustainability targets are set than initially intended.

The quantitative approach fully focuses on a given reference system or standard, in this case the Longlife prototype building. The rating is easy to use and handle, in particular for comparisons.

From an academic viewpoint the combined rating method is favourable. On the one hand it offers an easy usable system for the basic and advanced certification level. On the other hand this procedure allows a more unstructured and open determination of sustainable building practices in the discretion of the user. The house owner does not depend on an exact stipulation of sustainable building features specified in the scheme, but can decide freely for a feature that complies with his needs and intentions. In addition, for comparison purposes the LONGLIFE$^+$ rating might be graded by displaying also the achieved percentage of the prototype standard.

The certification procedure is accompanied by several instruments and tools such as a checklist on sustainable construction options which can be used for consultancy in the planning phase as well as in the construction phase. The checklist on the one hand should provide information on Longlife core or minimum requirements, and at the same time suggest further possible and measures to widen the scope of consideration on planning stage. Additionally, for monitoring reasons on-site inspections and auditing are reasonable elements to be applied in the scheme. A supportive tool to this end could be a selection and description of typical critical stages of the construction process that need increased attention. Crucially for the scheme also seems to be a comprehensive documentation which should include not only the documents directly related to the certification, but all documents relevant for the building process such as drawings, information on the technical equipment, plans for maintenance and inspections, insurance contracts, etc. (see section 3.6 and 3.7.)

In the following section the instruments that shall be used to communicate concerning the certification are introduced.

10.1.3.3.6 Communicational Instruments

The aforementioned elements of the communication (see 3.1) are described here more detailed.

The **Label** is a plaque installed after successful certification at the building either interior or exterior to visualise the sustainable quality of the building to visitors, tenants, potential investors or other stakeholders. This label indicates the certification level the building has achieved.

The **Building Passport** is another element of the documented sustainability of the building and can be compared to the energy passport where the energetic performance of a building is demonstrated. On the front-page details of the building such as a photo, the address, the building area, year of construction etc. should be indicated. The building passport extends the range of targeted topics and includes all major topics examined during the assessment and the assigned scores. The Passport would also reflect information determining the levels of rating as specified in the previous chapter. The overall result is depicted graphically as well as the scores reached for topics and indicator for example by a radar chart which shows strengths and weaknesses of a building in a demonstrative and easily understandable way.

One of the major arguments for performing a certification beside the improvement of the communication concerning building quality and enhancing competitiveness of sustainable construction is the comprehensive documentation a certification mandatorily requires. As practical experience indicates, a **"Building-Logbook"** or "building-folder", filing up-dated(!) building related documents and information should be of considerable value for different actors at different stages of the building life-cycle. A possible structure of this documentation could be derived from the German "Hausakte" ("Building-Folder"; [BMVBS n.d.]):

- Planning/construction phase
  - Planning documents/drawings
  - Energetic performance
  - Technical equipment/domestic technology
  - Building materials and installed equipment
  - Involved persons (planning/construction)
  - Acceptance report
- Operation phase
  - Inspection/maintenance
  - Operation costs
  - Performed maintenance and modernisation
  - Photographic documentation
- Contract documentation
  - Planning and construction
  - Financing
  - Insurances

The following section provides information on tools that could assist the applicant during the certification process.

10.1.3.3.7 Suggested *LONGLIFE tools* to support the certification process

In order to assist the applicant during the certification procedure it is reasonable to provide several tools

LONGLIFE Sustainability Planning Checklist: The *LONGLIFE Sustainability Planning Checklist* is not intended as a mandatory programme to comply with, but as a guideline for structured decision making process towards sustainable construction measures. The checklist includes (might include) mandatory core features as well as suggested additional measures towards a LONGLIFE^{++} certification.

LONGLIFE Building folder: The *LONGLIFE Building Folder* is a pre-prepared structure for the filing of building documents, such as drawing, contracts, checklists, files concerning the installed equipment, lists of materials used, etc. It gathers the relevant documents

LONGLIFE Audit Form: The *Audit Form* serves as a tool for recording on-site inspections during the assessment. It provides a structured questionnaire/checklist which shall be completed step by step.

LONGLIFE Full Declaration of Materials: The full declaration should indicate the complete list of minerals, metals, glasses, organic materials, plastics, chemicals, eventually hazardous substances, etc. used for the construction of the building.

LONGLIFE Positive-Negative List: A list indicating the substances that must by all means be excluded from being built into the building (negative list), as well as a list of those materials that should preferably be used for the construction (positive list) might be provided among the *LONGLIFE tools* also.

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LONGLIFE Life-Cycle Costs**:** Apart from being an indicator the estimated (or calculated) life-cycle costs of the building development is another integral tool to be thought about. In analogy to existing methods the list should comprise cleaning, maintenance, repair, operation, dismantling and further costs.

LONGLIFE Building Passport**:** The *Building Passport* summarizes the results of the assessment in a 4-pages document that includes indentifying details on the building (location, dimensions, photography, etc.). It also contains results for the topics and the individual indicators as the energy rating, a table and a radar chart in which the strengths and weaknesses of the building are clearly visible. Additionally, details on the certification procedure such as the name of the assessor, the date of issuance, eventually updates etc. are given.

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10.1.3.4 Summary

This report provides an initial outline of a generic framework for a *LONGLIFE assessment, certification and communication scheme* for sustainable construction.

Concerning the **overall conception** it should be stated that the certification scheme for Longlife should be designed to cover the whole life-cycle of a building. Concerning the organisational structure it seems advisable to authorize BASHDA, its (external) assessors and the national subordinate organisations to hold responsibility for the scheme. A stakeholder involvement should be realized through the establishment of a user-board. In order to ensure the objectiveness of the certification the procedure should be implemented as a fourth-party assessment.

The **topics** covered by the scheme shall incorporate all three dimensions of sustainability.

With respect to the **set of indicators** three alternatives of defining them are imaginable of which using an international standard (e.g. ISO 21929-1) as a basis seems to be preferably due to the broad recognition of ISO and its standards. Other possible options include the adaptation of indicator catalogues being elaborated in the framework of international (European) projects, or the own definition of indicators by the institution providing the certification scheme, in the Longlife context for example based on Longlife "benchmarks" (WP3 Output; see Annex "Draft *LONGLIFE sustainability planning checklist*") or prototype requirements.

The **certification procedure** should be similar to existing processes. Additionally, it should be characterized by an emphasis on continuous consultancy and close cooperation between the applicant and the assessor (and BASHDA) throughout the whole procedure. As such it should be ensured that to include as much sustainability into the development project as possible. In analogy to other schemes the certification shall be awarded in three levels called "certified", "plus" and "plus-plus". The rating methodology applied to gather the results may be quantitative, qualitative or a combination of both approaches.

Concerning the **communicational instruments** the *LONGLIFE certification scheme* should offer three different elements. The Label, the Building Passport and the Building Logbook shall be seen as products representing the approach of continuous consultancy and communication concerning sustainable building quality throughout the planning and construction process. All three serve these purposes to different extents, but definitely contribute to communicate sustainable building quality and consult the applicant. They can be considered as modules.

The **tools** listed and described above (Sustainability Planning Checklist, Building Folder, Building Passport, Audit Form, Full Declaration of Materials, Positive-Negative List and Life-Cycle Costs) shall assist the applicant in the course of the certification process. These should be regarded as suggestions, and it is self-evident that further instruments are imaginable in case of need.

All components described herein should be regarded as suggestions which may be integrated into the *LONGLIFE certification scheme*. The suggestions are based on knowledge and experience derived from existing assessment and certification schemes but nevertheless, there is no unavoidability in it; the final design of the system has to reflect the overall final Longlife project outcomes and decisions.

However, irrespective of the final exact embodiment of the different elements there are three important aspects that should be taken into account by the developing instance. As one of the core characteristics being crucial for the certification scheme the analysis of existing assessment systems detected the emphasis on the **communication process**. Therefore, the *LONGLIFE certification*

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scheme should not be restricted to an “end-of-pipe”-assessment, but assist informed decision making by providing means to foster the communication concerning sustainable building quality. Also, the **stakeholder involvement** can be regarded as a very relevant component of the certification scheme which enhances acceptability and ensures that the developed methodology is used in practice in the end. Finally, the **adaptability and flexibility** of the system should be considered in the design of the scheme as well. It allows to adjust the assessment for example to different economic conditions and different users’ requirements as well as to enforce the requirements in the future in response of eventually advanced political or societal strategic targets to build more sustainable.

The following section documents the discussions and results from the Longlife St. Petersburg workshop and conference and the Longlife Berlin certification workshop and draws the necessary conclusions for the further development of the outlined framework.

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10.1.3.5 Discussion and Conclusions

This section primarily summarizes the discussion of an assessment and certification scheme for sustainable building in the framework of the Longlife project, based on the developed outline of a framework for a *LONGLIFE certification scheme*. In second place, characteristics and implications of a “*Performance Pass*” as presented during Longlife conference in June 2010 are scrutinized. Finally, a suggestion is made to reconcile both approaches, and develop a concept incorporating elements of an extended energy pass and of a “light” version of a certification scheme. A possible way to develop such a method is described as well.

The discussions during the Longlife St. Petersburg workshops and conference made clear, that the conceptions of the project partners concerning general features, conceptual layout and principal structure of the certification scheme as part of the Longlife project’s work steps differ considerably. While some partners support the idea of a fully developed sustainability certification and especially partners from the housing companies tend to generally reject the idea of certification, the lead partner suggests a conception denoted “Performance Pass”. Therefore, the suggested conceptual framework obviously needs a principal adjustment to respond to the project partners’ concerns and ideas. The concept of a *Longlife Performance Pass,* understood as an improved and extended energy pass, can in this context be regarded as an intermediate starting point for the revised certification scheme. The new concept should address the advantages of the *Performance Pass* such as the (supposed) cost-neutrality and simplicity as well as it should remain certain pillars as core essential features of a real certification process such as the monitoring of a third-party to ensure credibility.

The according discussion and criticism is summarized in the next chapter.

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10.1.3.5.1 Criticism on the conceptual framework of a certification scheme

The proposal for a conceptual framework of an assessment and certification scheme for Longlife as introduced in the paragraphs above was presented and discussed during the workshop and conference in St. Petersburg in June 2010. As it could be understood the anticipated complexity of a fully developed scheme – with respect to both, content and conceptual structure – as well as the costs to be expected are questioned by a several project partners (including the lead partner). Furthermore, the process of selecting a comprehensive set of indicators was questioned as it supposedly requires a lot of subjective decisions and value judgements – this was presumed especially for those indicators that can only be assessed qualitatively.

Further and more fundamental criticism concerning the appropriateness of certifying residential buildings was expressed by representatives of the housing associations. Their main concern is that with the introduction of a certification scheme on the level of urban quarters or districts buildings in the same quarter which are not certified are left behind the development. Uncertified buildings might implicitly appear labelled as “scrap”, and as such both, investors and tenants, could refrain from demanding such buildings. At the end of the day, such buildings may develop into problematic objects which face marketing disadvantages as investors and tenants might prefer (apartments in) buildings of certified quality. This would even be in contradiction to the sustainability target to prefer the use of the existing building stock over new construction. Alike other project partners, the housing association representatives also question the procedure of defining the indicators. Also, they point at the well known dilemma that the stakeholder investing in sustainability (i.e. the housing association in this case) is not able (at least fully) to benefit from the saved operation costs as this will predominantly favour the tenant. Finally, they are worried about the possibility that through the implementation of certification schemes the strong legislation concerning regional and urban development and the building sector may be weakened in the longer term. This criticism is based on a supposed negative correlation between existing legislation and certification. In countries with a strong legislation in the building sector the need for a certification is lower, as the legislation itself ensures a certain quality of a building, while in countries with a weaker regulatory framework certification becomes an informal tool for quality assurance.

Discussion

Developing a certification system which is easy to use, comprises easily measurable criteria and indicators for exceptionally low costs cannot easily be brought in line with other objectives of a certification scheme as can be derived from the experience with existing schemes [Dirlich 2010a and Dirlich 2010b]. For example, existing schemes usually are based on a third party assessment and a more or less comprehensive set of criteria, often developed in close cooperation with the target actors. Nevertheless, the reduction of complexity is a goal that should be addressed in a revised concept. Furthermore, the objections concerning a certification of residential buildings – especially as far as they are part of a larger portfolio – are taken serious, and have to be acknowledged in the further development as well. However, the conception of the certification scheme, outlined in this expertise, as a methodological framework with a set of different tools allows a modular approach as well. The assessment of the building performance could first start with only the “*Building Logbook*” as a documentation of relevant information. As desired the user could also decide for the “*Building Passport*” as a brief summary of the building’s core characteristics and quality issues (which is in fact not too different from the *Performance Pass*). Finally, the user could also opt for the “*Quality Label*”, and the building would only then be assessed and certified by an external instance. The costs involved with the first two modular elements would most probably be not too large, while only in case of a certification higher costs can be expected due to the external supervision. In the next paragraph the *Performance Pass* is presented and analyzed as far as its elements and characteristics are known yet.

10.1.3.5.2 Basic conception of a *Performance Pass*

As a consequence of the discussion so far the lead partner proposed a so called *Longlife Performance Pass* as an easy-to-use method to give an overview of the building performance regarding a set of several criteria such as the energy consumption or the resource demand of the building. In short, the suggested *Performance Pass* can be regarded as a tool in between the legally compulsory energy pass and a voluntary certification scheme with the ambition to present a full picture of the sustainability of a building.

The *Performance Pass* concept is intended as an extended energy pass through the integration of additional criteria such as materials or water consumption. The focus is on the building performance and on measurable criteria while indicators requiring a qualitative judgement for the assessment should be excluded. Nevertheless, it should be made clear that a crucial pre-requisite for the development of the performance pass will be to **select, define and specify the performance criteria** to be reasonably considered as well as the respective measurements.

Due to cost constraints the *Performance Pass* will not be a real certification monitored and supervised by a third party as so far suggested by the expertise of the authors, but rather appears to be intended as a self declaration. The values for the various criteria shall obviously be calculated on the basis of the architectural planning details and documents. An audit to control the degree of compliance of the building with the indications in the plans and drawings is not stipulated. The Performance Pass could thus be considered a brief summary of the planning documents, a factsheet, listing core sustainability characteristics of the building based on calculated figures.

Discussion

The consideration of a limited number of criteria – for the moment: energy and resource efficiency – is an approach to minimize the necessary efforts (considering time and costs as well as other resources), and from that viewpoint it is definitely appropriate to follow this alternative. On the other hand, at the same time it should be clear that a reduction of complexity (through the integration of fewer criteria) leads to a rather coarse grained picture of the building and its overall performance. This might especially interfere with the goal to convince the target audience of the sustainability of the building. The concept of developing the “certification” scheme as a self declared factsheet stands in sharp contrast to the abilities of the target groups to assess the building quality and performance[42]. An independent and trust-worthy assessment would be desirable for the users in order to be relatively sure about the pretended qualities of the building in terms of energy and resource efficiency.

The next chapter sheds some light on a possible solution reconciling both contrasting approaches.

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[42] In this context the reader should be referred to the second report of the expertise in which the problem of “adverse selection” was explained thoroughly [Dirlich 2010b].

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10.1.3.5.3 Development of a general suggestion for a solution

The solution could be seen in a combined concept which can be regarded as the essence of both approaches. Those elements of the Performance Pass which are favourable, as the cost-effectiveness and the easy handling of the tool, should be kept and transferred into the new concept. Likewise, the advantages of the suggested certification scheme should be remained and translated into the combined concept which could be labelled as an **Extended Performance Pass** due to the slight expansion of the scope and procedure.

Development of an *Extended Performance Pass*

In order to develop the described concept for the *Extended Performance Pass* further steps are required. One key issue to be addressed is to achieve a better understanding of the idea, purpose and meaningfulness of a sustainability certification scheme among the Longlife partners. This approach needs further clearance and agreement. The suggested further steps should serve the following goals:

- Opinion forming concerning the topic "certification of residential buildings in general" and the *Extended Performance Pass* as a communication and decision support tool in particular through identifying project partners' positions, opinions and attitudes (all teams and partners);
- comparative analysis of both approaches and documentation of advantages and disadvantages of both approaches (passport / descriptive self declaration vs. certification / third party evaluation);
- compilation of conclusions;
- specification and agreement on core sustainability issues and criteria (Longlife Prototype)
- development of a shared basic concept for a *Longlife Extended Performance Pass*.

This development should address conceptual details such as the values which should reasonably be measured (also answering by whom this should be done), or which institution should issue the pass.

The development process should be even more accompanied by the project partners, and the communication among the partners should be improved. Main objective of this process would be to agree on core performance criteria and targets, which is not only an indispensable prerequisite for a meaningful *Performance Pass* but also for a certification scheme. Being based on the concept as well as on the input from the project partners the concept of the *Longlife Extended Performance Pass* is developed. Finally, a further report would be elaborated in which the concept is described in detail. This report would be a first working document for the implementation of the Longlife Prototype as well as for further activities towards a BASHDA (see 3.2) sustainable housing construction quality association.

The core idea is to enter a structured process of finding a tailored solution for the certification of buildings in the Longlife project in order to accomplish one of the Longlife targets as indicated on the project website: "The prototype building will be certificated as a sustainable building" [Rückert 2010]. Therefore, the communication among the partners is crucial to achieve a solution every partner can agree to, and thus, the full participation of the members of the project team should be ensured through a targeted moderation during all stages of this process.

10.1.3.5.4 Final Conclusions

This report demonstrates different approaches and tools to serve one of the targets of the Longlife project. The certification is essential part of the outcomes of the project, and a solution should be found to develop a tool that on the one hand ensures the simplicity (and the involved cost-effectiveness) of the procedure, but on the other hand provides valid, transparent and reliable statements/indicators concerning sustainable building quality as well.

The project partners deem the certification as suggested – although in line with existing experience an expertise – to be too complex to fulfil the specific conditions with respect to region, market structure, intended building type, etc. But also, a *Longlife Performance Pass* as discussed does not fulfil all desirable features. It will therefore be necessary to merge both approaches in the further course of the project.

Nevertheless, the discussion during the German partner meeting and certification workshop on September 15, 2010 in Berlin proved that an agreement among the project team concerning certification is generally possible, as the main elements of a certification system were not questioned. The representative of the Federal Institute for Research on Building, Urban Affairs and Spatial Development (Bundesinstitut für Bau-, Stadt- und Raumforschung) presented core requirements for a certification during the presentation of their own system (Bewertungssystem Nachhaltiges Bauen des Bundes – BNB) being to a large extent in line with the suggested *Longlife certification scheme* (Rietz 2010). Also, the representative of the Federal Association of German Housing and Real Estate Companies (Bundesverband deutscher Wohnungs- und Immobilienunternehmen – GdW) supported the main features and characteristics of an assessment and certification system in general (Vogler 2010). In particular the three basic pillars of any comprehensive scheme – documentation, assessment and labelling – were acknowledged. Also the idea of a qualitative rating, starting with a compliance audit (see 3.5), was supported. However, difficulties and specific conditions of the residential building sector were also acknowledged once more, and must be reflected in a scheme designed to assess residential buildings. In particular from the perspective of housing companies, dealing with large(r) building stocks, any assessment of a (single) building has to consider also external effects in terms of a portfolio analysis.

Finally, any assessment and communication scheme providing information on building performance to a target audience must fulfil a number of essential characteristics which are basically independent from the actual conception of the system. Therefore, both a comprehensive certification scheme and a *Performance Pass* should address the following issues:

1. **Transparent definition of criteria and indicators** in agreement between all involved and concerned stakeholders.
2. **Reliable and verifiable measurements and determination of scores**.
3. **Accompanying guidance** and **quality-assurance** during all phases to ensure the best possible implementation of sustainable building principles (instead of an end of pipe evaluation).
4. **Supervision** (preferably through an external instance) of the whole process in order to ensure the credibility and reliability of the system for the target groups as a means of decision support to distinguish sustainable construction from “green washing”.

The elements of a possible solution suggested in these concluding paragraphs can be regarded as starting point and stepping stones for the works on a tailored final conception, as soon as the core sustainability performance characteristics of the Longlife prototype are determined.

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10.2 Method of planning, permit and tendering procedures - Legal sustainability requirements and building permit procedures

Summary: Legal sustainability requirements and building permit procedures

A comparison of the legal framework in Germany, Denmark, Poland and Lithuania

10.2.1 Introduction

Environmental considerations in terms of sustainability requirements are gaining increasing awareness in relation to residential construction projects. Although this issue would appear to be more of a technical and economic topic, one should not underestimate the importance of the legal framework set out, for instance, by the European Union (EU). Harmonising the different legal systems, and thus preparing the Member States to undertake new steps in this field, can create a great impact, as can be seen by the fact that the Commission now estimates a energy efficiency savings potential of 20 % by the year 2020, which would result in savings of 60 billion euro.

This summary of our extensive legal expertise deals selectively with some of the most important legal aspects of the sustainability deliberations and actions undertaken by the EU and its Member States in the Baltic Sea Region. It begins with an overview of the European legal framework related to sustainability requirements. Then, proceeding from the basis of German law, the respective building laws in Germany, Denmark, Poland and Lithuania are briefly introduced. We then describe the building permit procedures before dealing with some selective examples in the field of material sustainability requirements in German, Danish, Polish and Lithuanian law. The discussions during the mid-term conference in Saint Petersburg indicated that it might be an interesting and promising task to analyse the structure and requirements of Russian building law as well and to compare it to the other jurisdictions in a future stage of the Longlife project.

10.2.2 European legal framework

10.2.2.1 Primary Legislation: The Treaty on the Functioning of the EU

The Treaties of the European Union comprise the legal basis of the relationship between the EU and its Member States. They authorise the EU to adopt laws: regulations, directives, decisions, recommendations and opinions, of which only the first three are binding instruments provided by secondary EU legislation. Directives must be implemented by the Member States into national legislation in order to become binding, whereas regulations apply directly in all of the Member States.

The following articles of the Treaty on the Functioning of the European Union (TFEU) form the basis for authorisation with respect to energy efficiency, sustainability, resource-conserving buildings and low lifecycle costs:

- Art. 11 TFEU (ex Article 6 EC) stipulates that in defining and implementing its policies the European Union must take into account ”environmental protection requirements […], in particular with a view to promoting sustainable development”.
- Art. 114 TFEU (ex Article 95 TEC) empowers the EU to adopt measures for the harmonisation of the provisions in Member States which have as their object the establishment and functioning of the common market. A key provision is the establishment of harmonised standards for products to remove technical barriers to trade. These standards must take into account requirements such as environment and sustainability.
- Art. 192 TFEU (ex Article 175 TEC) authorises legal measures with regard to the objectives of preserving, protecting and improving the quality of the environment, protecting human health, prudent and rational utilisation of natural resources and regional or worldwide environmental problems, and in particular combating climate change (Art. 191 TFEU). A key provision is the implementation of the EU Ecolabel for certain products.
- Art. 194 TFEU, introduced by the Treaty of Lisbon, enables measures to be taken in order to ensure the functioning of the energy market and the security of energy supply in the EU, as well as to promote energy efficiency and energy saving and the development of new and renewable forms of energy. It is thus intended to enable secondary legal acts in the energy sector, which up to that point had been based on Art. 95 EC (now: Art. 114 TFEU). It is too early to tell if this will lead to a significant expansion of the EU’s competence .

10.2.2.2 Conceptual ideas and strategies of the Commission

The Commission has issued several non-binding strategy papers and action plans with the intention of implementing the provisions of primary legislation, in particular Art. 194 TFEU. Those with the greatest impact on sustainable construction include:

Green Paper on Energy Efficiency – COM(2005) 265 final

This Green Paper opens up a wide-ranging discussion of how to achieve cost-effective savings. It initiates Action Plans with the goal of harnessing the potential energy efficiency savings that have been identified. The Commission estimates a savings potential of 20 % by the year 2020, which would result in savings of 60 billion euro. At the EU level, this requires the integration of energy issues into other EU policies, as well as specific energy policy measures. The heating and lighting of buildings alone comprise 40 % of EU energy consumption. Therefore, the Green Paper considers extending the area of applicability of the Directive on the Energy Performance of Buildings 2002/91/EC to include the renovation of buildings and to support the use of energy-saving lighting.

Action Plan for Energy Efficiency – COM(2006)545 final

The Action Plan aims at mobilising the general public, policy makers and market actors. The Plan, which runs from 2007 to 2012, is an attempt to transform the internal energy market in order to provide EU citizens with the most energy-efficient infrastructure (including buildings), products and energy systems in the world. The objective of the Action Plan is to reduce energy demand and to take targeted action on consumption and supply in order to save 20 % of annual consumption of primary

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energy by 2020. Therefore, the Commission intends to implement the following measures in European legislation:

- Dynamic energy performance requirements for products, buildings and services;
- Improvements in energy transformation;
- Financing of energy efficiency, economic incentives and energy pricing;
- Changes in energy behaviour.

In this context, the Labelling and Eco-design Regulations, the Directive on end-use energy efficiency and energy services, the Energy Performance of Buildings Directive (including the development of a strategy for very low energy or passive houses) are mentioned specifically. The Action Plan thus attempts to combine the Community goals of climate protection, supply security, low energy costs and energy efficiency. However it does not set priorities or establish a hierarchy between the different goals or the points in time at which goals can be deemed to have been achieved.

A new Energy Action Plan has been announced for the year 2010, which will run from 2011 to 2020, in which emphasis is to be placed on energy efficiency in buildings undergoing energy-saving renovations and on fully implementing the existing framework, translating it into concrete results.

Lead Market Initiative for Europe

In 2007 the EU Commission announced a Lead Market Initiative for Europe (LMI). This initiative was intended to strengthen markets which have the potential to more than double their economic volume by 2020 and create a combined total of one million jobs. The EU Commission designated sustainable construction as one of the first six lead markets. In its opinion, the significance of this market lies primarily in the fact that the highest share of end-use energy consumption in the EU (42 %) derives from buildings. Moreover, 35 % of all greenhouse gas emissions come from buildings. Sustainable construction is an extremely extensive market sector in which aspects of environmental protection (e.g. efficient heating systems), health issues (e.g. air quality in buildings) and user comfort (e.g. mobility for older people) all play a role. The various regulations for the building industry on the European and national levels are inadequately coordinated with each other, resulting in considerable administrative burdens and a serious fragmentation of the market for sustainable construction. It is therefore necessary to take a far-sighted approach in the area of regulation and contract award decisions.

a. **Action Plan for sustainable construction – SEC(2007) 1729**

The Action Plan for sustainable construction is part of the Lead Market Initiative for Europe – COM(2007) 860 final. The main points of the Action Plan are:

Legislation: Encourage the adoption of a performance-based approach in national building regulations, expand the scope of the Energy Building Performance Directive in accordance with the Energy Efficiency Action Plan, and analyse and assess the innovation potential and cumulative effects of EU and national legislations.

Public Procurement: Develop guidance for the choice between the EMAT (Economically Most Advantageous Tender) and the lowest price and for the use of life cycle costs in construction works.

Standardisation, labelling and certification: Develop voluntary performance targets to enable the implementation of policy measures to promote sustainable buildings and construction practices, develop European standards which take sustainability aspects into account, and define the framework for technical assessment and rapid certification of innovative products which meet sustainability criteria.

The instruments proposed are thus not directed exclusively at the Commission, but also include Member States and industry.

b. **Mid-term progress report – SEC(2009) 1198 final**

The Commission Staff Working Document "Lead Market Initiative for Europe – Mid-term progress report – SEC(2009) 1198 final" contains an executive summary and provides an assessment of the progress made in the implementation of the Action Plan, as well as in each of the cross-cutting measures during the first 15 months of the LMI, in comparison with the action plans. According to the report, most of the envisioned activities have been initiated according to plan. The most visible progress has been made on two proposals that were approved in 2010: the proposal for a Construction Product Regulation (CPR) and the proposal for recasting the Energy Performance of Buildings Directive (EPBD). Other actions relate to the preparation of life cycle costing guidance for procurers, to procurer networks, research on performance targets and benchmarking, guidance on partnering in the construction value chain and the development of a strategy on skills and competencies in the construction sector. The final ex-post evaluation report is planned for 2011.

10.2.2.3 Secondary Legislation: European Regulations and Directives

The goals established in EU primary legislation provide the Commission and other EU institutions with a broad scope of implementation. Through strategy papers and concept proposals, with the involvement of the public and affected groups, measures for implementation are being worked out. Several acts of secondary legislation affect sustainability in construction directly or indirectly.

1. Construction Products Directive 89/106/EEC and the Proposal for a Construction Products Regulation, 2008/0098 (COD)

Council Directive 89/106/EEC of 21 December 1988 on the approximation of laws, regulations and administrative provisions of the Member States relating to construction products intends to create harmonised standards at the European level for construction products. Member States may not impede the free movement, placing on the market, or use in their territory of products which satisfy the provisions of this Directive. The products must be suitable for construction works which are fit for their intended use, account being taken of economy, and in this connection satisfy the following essential requirements:

- mechanical resistance and stability,
- safety in case of fire,
- hygiene, health and the environment,
- safety in use,
- protection against noise, energy economy and
- heat retention.

The requirements set forth in the Construction Products Directive are elaborated further in harmonised technical specifications. The purpose of a technical specification for a product is to cover all the performance characteristics required by Regulations in any Member State. In this way, manufacturers can be sure that the methods of test and methods of declaration of results will be the same for any Member State, (although the regulatory values may differ from one Member State to another).

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The CE marking indicates the marked item's compliance with the relevant national standards transposing the harmonised standards, with a European technical approval, or with national technical specifications in as much as harmonized specifications do not exist.

2. Proposal for a Regulation of the European Parliament and the Council laying down harmonised conditions for the marketing of the construction products, 2008/0098 (COD)

The Proposal mainly intends to clarify and reduce the administrative burden, in particular for SMEs (small and medium-sized enterprises), through more flexibility in the formulation and use of technical specifications, lighter certification rules, and elimination of the implementation obstacles that so far have hampered the creation of a full internal market for construction products. The proposed Regulation calls for the repeal of Council Directive 89/106/EEC, which led to differences in content and timing of the transpositions by Member States, and its replacement with a directly applicable regulation. The objective of the proposal is to clarify the basic concepts and the use of CE marking, granting it an exclusive role in the future, and to increase the credibility of the system. Harmonised technical specifications should provide reliable test or calculation methods which should be the most appropriate ones for assessing and verifying constancy of the performances of the respective products.

With regard to basic works requirements, the proposal adds the requirement of sustainable use of natural resources. This means that the construction works must be designed, built and demolished in such a way that the use of natural resources is sustainable and ensure the recyclability and durability of the construction works, and that environmentally compatible raw and secondary materials must be used.

The regulation is not expected to enter into force before mid-2011.

3. Hot-Water Boilers Directive 92/42/EEC

Council Directive 92/42/EEC of 21 May 1992 on efficiency requirements for new hot-water boilers fired with liquid or gaseous fuels establishes harmonised standards at the European level on their efficiency requirements. Boilers must comply with certain useful efficiency requirements, bear a CE marking and be accompanied by an EC declaration of conformity.

Appliances Burning Gaseous Fuels Directive 2009/142/EC

Directive 2009/142/EC of the European Parliament and the Council of 30 November 2009 relating to appliances burning gaseous fuels intends to set harmonised standards at the Community level, in particular with regard to the construction, operation and installation of these appliances, so that products complying with them may be assumed to conform to the essential requirements regarding safety, health and energy conservation. It covers appliances burning gaseous fuels that are used for cooking, heating, hot water production, refrigeration, lighting or washing and have, where applicable, a normal water temperature not exceeding 105°C. The CE marking must be affixed to appliances which conform to these essential requirements. The European Committee for Standardisation (CEN), the European Committee for Electrotechnical Standardisation (Cenelec) and the European Telecommunications Standards Institute (ETSI) have drawn up "harmonised standards" concerning safety of use; technical instructions; appropriate materials and rational use of energy.

However, according to Recitals 5 and 7 of the Directive, rational energy use does not stand in the foreground of this Directive; rather, the products need only conform to the current state of technology (3.5, Annex I). The Directive does not provide for testing the products to ascertain whether they meet the criteria. Thus as far as energy saving is concerned, this Directive makes little or no contribution to the improvement of product safety for appliances burning gaseous fuels.

EU Ecolabel Regulation (EC) No 66/2010

Regulation No 66/2010 of 25 November 2009 on the EU Ecolabel forms a part of Community policies on sustainability in production and consumption for conserving resources and protecting the environment. The voluntary Ecolabel was introduced in 1992 and further improved by Regulation No 66/2010 to support these goals. It is awarded on the basis of criteria worked out by scientists for environmentally friendly consumer goods, including building products (floor coverings, paints and varnishes, heat pumps). However, at present it cannot be awarded to buildings. Thus, Regulation No 66/2010 as a whole makes only a slight contribution to sustainability in construction.

Energy Performance of Buildings Directive 2010/31/EU – A recast of Directive 2002/91/EC

Because buildings represent around 40% of all energy use and are Europe's largest source of emissions, the EU has addressed the problem by introducing minimum requirements for the energy performance of buildings. In 2002, the EU adopted Directive 2002/91/EC of the European Parliament and of the Council of 16 December 2002 on the energy performance of buildings, which committed the Member States to apply minimum requirements as regards the energy performance of new and existing buildings, ensure the certification of their energy performance and require the regular inspection of boilers and air conditioning systems in buildings.

The Commission proposed a recast of the Directive as part of its Second Strategic Energy Review in November 2008. On 18 May 2010, the European Parliament finally approved the EU's new energy efficiency legislation for buildings, namely Directive 2010/31/EU of the European Parliament and of the Council of 19 May 2010 on the energy performance of buildings (recast). The objective of this recast of Directive 2002/91/EC is to clarify and simplify certain provisions, and to extend the scope of and strengthen other provisions to increase their effectiveness.

The main provisions of the Directive 2002/91/EC and the new Directive 2010/31/EU aim for

- a common methodology for calculating the integrated energy performance of buildings,
- minimum standards on the energy performance of buildings,
- systems for the energy certification of buildings,
- prominent display of this certification and other relevant information in public buildings and
- regular inspection of heating and central air-conditioning systems in buildings.

The new Directive 2010/31/EU adds in particular

- independent control systems for energy performance certificates,
- inspection reports and
- national plans for increasing the number of nearly zero-energy buildings.

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Although the Directive allows the Member States a broad scope of implementation, its greatest influence might be on sustainability in construction. The main aim of the Directive – improving the energy performance of buildings – corresponds to the demand for sustainability in the building industry. The Member States are to ensure that by 2021 all new buildings are nearly zero-energy buildings, and that by 2019 all new buildings occupied and owned by public authorities are nearly zero-energy buildings. In order to meet this requirement, it will be necessary to integrate sustainability requirements into national legislation more actively than has been the case up to now.

Energy End-Use Efficiency and Energy Services Directive 2006/32/EC

As an indicative target for Member States, Directive 2006/32/EC of 5 April 2006 on energy end-use efficiency and energy services states that by 2016 they should achieve and provide evidence of energy end-use savings of nine per cent in comparison with average energy end-use consumption between 2001 and 2005 (see also Art. 194 TFEU). The Directive allows Member States the choice of various instruments for increasing energy efficiency and supporting the market for energy services. No special guidelines for the construction sector are to be found in the Directive, but since energy end-use savings via efficiency improvement measures are possible in the housing sector (Annex III), Directive 2006/32/EC also supports sustainability in construction.

Energy Label Directive 2010/30/EU – A recast of Directive 92/75/EEC

Council Directive 92/75/EEC introduced the energy label to help consumers assess running costs when buying new household appliances. Manufacturers of refrigerators, freezers, washing machines, driers, dishwashers, ovens, etc. are obliged to indicate the energy consumption, irrespective of whether the product performs well (dark green "A" class), or poorly (red "G" class).

The Commission submitted a recast proposal of the Directive as part of its Second Strategic Energy Review in November 2008. On 18 May 2010, the European Parliament approved the new legislation in its new Directive 2010/30/EU. In the future, the energy labelling obligation will also apply to energy-related products, including construction products, which do not consume energy but have a significant impact on energy savings, such as window glazing and frames or outer doors.

Services in the Internal Market Directive 2006/123/EC

Directive 2006/123/EC of 12 December 2006 on services strengthens the freedom of establishment of service providers by granting the right to take up and pursue a service activity in every Member State as a general principle. With regard to the building permission procedure, this means that national building laws may only make the provision of services dependent on authorisation requirements if they are non-discriminatory and proportionate. Hence, building applications must be accepted from persons who are authorised to supply building application documents in another Member State of the EU or in a state on equal legal terms according to the law of the European Communities (cf., e.g., sec. 66 (4) Berlin Building Act – *Landesbauordnung Berlin*). Accordingly, any architect is allowed to supply building application documents in the entire EU. Although sustainability in construction is neither directly nor indirectly promoted though the Directive, it does result in changes to national building laws in favour of the freedom of services, which may affect the quality of construction work.

Energy from Renewable Sources Directive 2009/28/EC

The Directive 2009/28/EC of 23 April 2009 on the promotion of the use of energy from renewable sources establishes a common framework for the production and promotion of energy from renewable sources. Potentially, this could have a great impact on sustainability in construction, since the ecological aspect of sustainability in construction also involves evaluating the extent to which the primary energy requirements of a building are covered by renewable or non-renewable sources. The Directive opens up to Member States the possibility of increasing their binding quotas for the use of renewable energies through changes in their building regulations. However, it is only from 2014 onwards that a "minimum" percentage of renewable energy in new buildings or existing buildings under renovation will have to be used.

Conclusion

European Union law consists of primary and secondary legislation. On the level of primary legislation, sustainability in construction is not directly mandated, but rather is promoted indirectly, above all by the pursuit of the Community goals of the common market, energy savings and environmental protection (Art. 114, 192, 194 TFEU). As "guardian of the treaties", the Commission is preparing for the implementation of primary legislation provisions in its strategy papers. Of particular relevance for the sustainability of construction is the Union's goal of a 20% reduction in total energy use by 2020. Acts of secondary legislation prepared by the Commission on the basis of the strategy papers realise Community goals and establish binding provisions for the Member States. In this respect, the issue of energy savings in buildings is increasingly gaining in importance, as can be seen in several recent Directives (in particular Directives 2010/31/EU and 2009/28/EC).

As most of the acts of secondary legislation are issued in the form of Directives, Member States have some discretion with regard to regarding the implementation of the Union's provisions into their national legislation. Thus, the efforts of the Member States will also determine the extent to which the European Union will push forward the ecological and economic aspects of sustainability in construction. This should become clear from the Energy Action Plan announced for 2010, which is supposed to focus on the energy-conserving renovation of buildings.

10.2.3 Comparison of national legal systems

The following comparison of the national legal systems takes German law as a starting point since the authors are German lawyers. The statements on Danish, Polish and Lithuanian law are primarily based on contributions provided by the project partners in the respective countries.

10.2.3.1 System and structure of the national building law

In the following, the different systems and structures of the national building laws of Germany, Denmark, Poland and Lithuania will be introduced briefly.

1. Germany

German law falls into two major parts: administrative building law on the one hand, and planning law on the other.

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As a consequence of the German federal system, the competence for administrative building law is divided between the Federation (*Bund*) and the 16 German Federal States (*Länder*). Traditionally, administrative building law falls under police law (*Polizeirecht*), which lies within the competence of the Federal States. Thus, every Federal State has its own building act that imposes requirements on buildings in order to ensure that public safety and order are not endangered by physical structures or construction projects. The building acts mainly contain material requirements for buildings and rules

for procedural questions, in particular the permitting procedure. The provisions of the 16 building acts are identical in some respects, but differ in others. This means that different material requirements and procedural rules may apply in different Federal States, e.g. Mecklenburg-Western Pomerania and Brandenburg.

In addition to the administrative building law set forth in the building codes of the Federal States, the Federation has adopted some laws and regulations relating to energy requirements for buildings on the federal level. These federal regulations under administrative building law include, but are not limited to, the Act on the Conservation of Energy in Buildings in the version of 1 September 2005, last amended in 2009 (*Gesetz zur Einsparung von Energie in Gebäuden – Energieeinsparungsgesetz, EnEG*) and the Energy Saving Ordinance in the version of 24 July 2007, last amended in 2009 (*Verordnung über energiesparenden Wärmeschutz und energiesparende Anlagentechnik bei Gebäuden – Energieeinsparungsverordnung, EnEV*) and the Renewable Energies Heat Act in the version of 7 August 2008, last amended in 2009 (*Gesetz zur Förderung erneuerbarer Energien im Wärmebereich – Erneuerbare-Energien-Wärme-Gesetz, EEWärmeG*).

The main sources of German planning law are the Federal Building Code in the version of 23 September 2004, last amended in 2009 (*Baugesetzbuch*) and the Ordinance on the Use of Land for construction in the version of 23 January 1990, last amended in 1993 (*Verordnung über die bauliche Nutzung der Grundstücke – Baunutzungsverordnung, BauNVO*). The Regional Planning Act in the version of 22 December 2008, last amended in 2009 (*Raumordnungsgesetz*) sets up the legal framework for planning on a national level and, together with the regional planning codes of the Federal States, planning on the state and regional level. The central instruments for land use and urban development planning are the land use plans (*Bebauungspläne*), which municipalities can draw up for parts of their territory. The Federal Building Code stipulates requirements which apply to land use plans – and, thus, indirectly to buildings. In particular, it contains an exhaustive list of stipulations which municipalities may enact in their land use plans (sec. 9), as well as requirements and restrictions for construction projects in unplanned areas. Generally speaking, buildings are not allowed in undeveloped outskirt areas (sec. 35 – *Aussenbereich*) and must fit into the surroundings in built-up areas (sec. 34 – *Innenbereich*). However, there are exceptions to these general rules.

2. Denmark

The system of Danish building law also is divided into administrative building law and planning law.

The basis of Danish administrative building law is the Danish Building Act in the version of 9 October 1995, last amended in 2010 (*Byggeloven*), which sets up general safety requirements for buildings and contains some procedural provisions. The Danish Building Act provides the basis for several ordinances which set up a more detailed legal framework. The Building Regulations in the version of 17 December 2008, last amended in 2010 (*Bygningsreglementet 2008 – BR08*), contain detailed stipulations on technical and energy requirements for buildings and establish a detailed legal framework for the permitting procedure. Several other ordinances exist on the basis of the Danish Building Act, including ordinances on the certification and control of building products, which impose specific requirements on building products and, thus, indirectly on buildings.

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Danish planning law is based on the Planning Act in Denmark in the version of 20 October 2008, last amended in 2009 (*Planloven – Lov om planlægning*), which sets the legal framework of planning in Denmark. There is a hierarchy of four levels: country level, regional level, municipality level and local level. The most important instruments are the community plans and local plans, which are drawn up by the municipalities. The Planning Act contains several requirements and options which the municipalities can adopt in their local plans, thus imposing local requirements on buildings.

3. Poland

Like Danish and German building law, Polish building law can also be divided into administrative building law and planning law.

The key instrument of Polish administrative building law is the Building Act of 7 July 1994, last amended in 2009 (*Ustawa z dnia 7 lipca 1994 r. Prawo budowlane*). It contains general technical requirements and procedural regulations, in particular on the permitting procedure. Based on the Building Act, the Ministry of Infrastructure has enacted the Ordinance on Technical Requirements for Buildings and their Locations on 12 April 2002, last amended in 2009 (*Rozporządzenie Ministra Infrastruktury w sprawie warunków technicznych, jakim po-winny odpowiadać budynki i ich usytuowanie z dnia 12 kwietnia 2002 r.*), which contains detailed requirements pertaining to technical, energy and sustainability issues. Additionally, the Polish Construction Products Act establishes requirements for building products.

Polish planning law is based on the Act on Spatial Planning and Development of 27 March 2003 (*Ustawa z dnia 27 marca 2003 r. planowaniu i zagospodarowaniu przestrzennym*). Based on this act, the state, the voivodeships and municipalities can adopt plans of the land use and urban development. Plans adopted on a lower level must comply with the plans adopted on the superior levels. The most detailed requirements applying directly to buildings result from municipal plans which municipalities can adopt for parts of their territory based on a municipal study. The Act on Spatial Planning and Development establishes the legal framework for these municipal plans. It stipulates some regulations which municipal plans must include and others which are optional.

4. Lithuania

Lithuanian building law also consists of administrative building law and planning law. The main source of the administrative building law is the Law on Construction (*Statybos įstatymas*) of 19 March 1996, last amended on 7 February 2010. Similar to the Polish Building Act it mainly deals with general technical requirements, procedural regulations and in particular with the permitting procedure. Along with the Law on Construction, there are many technical regulations (at least 91) which establish the essential requirements for all construction works. For instance, the Technical Regulation for Construction STR 1.01.04:2002 “Construction Products, Conformity Attestation and CE Marking” establishes six requirements named in Annex I of the Technical Regulations, namely mechanical resistance and stability, safety in case of fire, hygiene, health and environment, safety in use, protection against noise and, finally, energy economy and heat retention.

Lithuanian planning law is determined by the Comprehensive Plan of the Territory of the Republic of Lithuania (*Zin., 2002, No. 110-4852*) and the Republic of Lithuania Law on Territorial Planning (*Zin., 1995, No. 107-2391; 2005, No. 152-5532*). The former sets important goals and main directions of the regional policy and thus contains guidelines and planning preconditions for the national and county level. The Law on Territorial Planning regulates the inter-relationship between national and legal entities and public authorities involved in the process of territorial planning.

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5. Conclusion

Although the legal systems of Germany, Denmark, Poland and Lithuania have their specific differences, they generally share a common basis. The building law in these countries breaks down into administrative building law and planning law. Both are able to promote sustainability, albeit in different ways, e.g. planning law through local plans and administrative law through building permit requirements.

10.2.3.2 Building permit procedure

1. Germany

In Germany, the building permit procedure is governed by the laws of the Federal States. In this summary, the procedure will be exemplified by the building permit procedure in the State of Berlin.

Construction of residential buildings in all of the Federal States generally requires a building permit. In Berlin, a building permit must be issued if the construction project is not in conflict with any regulations, which is to be ascertained by the building authority *(Bauaufsichtsbehörde)* (sec. 71 Berlin Building Act – *Bauordnung für Berlin, BauO Bln*).The district offices (*Bezirksämter*) as building authorities generally grant building permits. The special empowerment to issue building permits is regulated not only in the general clause (sec. 58 (1) BauO Bln), but also in sec. 69 BauO Bln.

All of the state Building Codes differentiate between the developer (*Bauherr*) on the one hand and his auxiliary personnel (*Hilfspersonen*) on the other. The developer is the “master of the entire construction project” (*Herr des gesamten Baugeschehens*), who in particular appears vis-à-vis the building control authorities in his own name on an external basis. Because everyone is entitled to the “freedom to build” (*Baufreiheit*) as part of the general freedom to act under Art. 2 (1) of the German Constitution (*Grundgesetz*), the developer need not necessarily be the owner of the construction property. In all of the Federal States, the developer must generally appoint (1) an architect, (2) an entrepreneur and (3) a site manager for the preparation, supervision and execution of a project requiring a permit (sec. 54 (1) BauO Bln). In the course of implementing Directive 2006/123/EC on services in the internal market, under which the Member States must respect the right of a service provider to render services in a Member State other than that in which it is established, sec. 66 BauO Bln was amended with respect to the authorisation to draw up building documentation. Pursuant to sec. 66 (2) no. 2 BauO Bln, registrations of other states now also apply to the Federal State of Berlin. Moreover, pursuant to sec. 66 (4) BauO Bln, persons who are registered as authorised to draw up building documentation in another Member State of the European Union or an equivalent country under the laws of the European Union are deemed to be authorised even without being registered in a list kept in Berlin if they have a comparable authorisation in the state in which they are established and meet the requirements set forth in sec. 66 (3) BauO Bln.

In order to receive a building permit, a building application (sec. 69 (1) BauO Bln) with the necessary building documentation (sec. 69 (2) BauO Bln) must be submitted to the building control authority. The building application must be signed by the developer and the architect. If the developer is not the property owner, the building control authority can additionally require the property owner’s consent to the construction project. Moreover, the following documents have to be submitted: the site plan, the architectural drawing, the building and operation specifications, information on the secured infrastructure with respect to water and energy supply, disposal of wastewater and traffic infrastructure, the data entry form for the construction activity statistics and the decision on exceptions and dispensations pursuant to sec. 31 BauGB.

In a first step, the authority screens the application documents (sec 70 (1) BauO Bln) and checks whether they are complete and properly compiled. This takes approximately two to three weeks. The authority then requests statements from other authorities that could be involved. If they do not reply within a month or if they do not have any objections, the authority will decide within another month whether or not to issue a building permit (sec. 70 (3) BauO Bln). If the authority issues the building permit it is generally valid for three years (sec. 72 (1) BauO Bln); an extension is possible.

2. Denmark

According to 1.3(2) BR08, applications must be made in writing to the municipal council. Unless there is exemption from the building permit provided, work may not commence without the permission of the municipal council.

The application must be signed and dated by the owner. Under 1.4(3) BR08, an application for a new building must normally include: 1) any information necessary for the identification of the property, building or unit, 2) information on any provisions of the Building Act, the Building Regulations, easements and other building guidelines with which the project might be in conflict (the application must contain a substantiated application for any necessary exemptions or permissions if applicable), 3) information on the proposed use of the building, 4) information clarifying how measures essential for responsible construction and necessitated by climatic conditions have been implemented 5) information relating to new buildings, such as energy parameters, the calculated energy needs of the building, documentation demonstrating compliance with the energy parameters; and information on low energy class, where appropriate. 5) Information required for inclusion of the project in the Building and Housing Register (BBR). The municipal council may also require further documents according to 1.4(4), such as fire safety documentation, etc. (cf. 1.4(4) BR08) if it deems this to be necessary.

There is no particular legal provision stipulating a time schedule for completing the building permit procedure. Accordingly, the length of the entire process varies from case to case. It may approximately take one to three months.

Before commencing the construction work, the building permit holder has to submit a building notification. However, pursuant to 1.7(2) BR08, construction work may commence if the municipal council does not respond to this notice within two weeks. Once the construction work is completed, an occupancy permit is also generally required. However, under 1.6(2) BR08, some small buildings (e.g. single-family houses and ancillary buildings) are exempted from an occupancy permit.

3. Poland

The competent authority for reviewing the documents on the lowest level is the governor (*Starosta*). The Wojewode and the Wojewodzki inspector nadzoru budowlanego are the competent bodies on the higher level.

The owner, co-owner, investor, leaseholder, perpetual user (with owner’s consent) are entitled to apply for a building permit. The building application has to contain the construction project/building design, the project with any related agreements, the declaration of ownership, documents on energy performance and documents on technical construction.

The building permit procedure should not take longer than 65 days (sec. 35 (6) Building Act). The building permit expires if the construction work is not commenced within three years or is suspended for a period exceeding three years. Once the building permit is granted and the construction works are completed. the following authorities must be notified: 1) the Inspectorate for Environmental Protection; 2) the State Sanitary Inspectorate; 3) the State Labour Inspectorate; and 4) the State Fire Brigades. The authorities must evaluate the correspondence of the construction of the building with the building design. Should the authorities not respond to the notification within 14

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days of the date of delivery of the notification, it will be presumed that acceptance has been granted and no objections have been raised (sec. 56 (2) Building Act).

4. Lithuania

According to sec. 23 (5) Law on Construction, two authorities are in charge of issuing building permits. If the construction work lies within a territory that is administrated by several municipalities or the construction work serves national defence needs, the county governor is the competent authority. Otherwise, the director of the municipality (or a civil servant authorised by him) is competent to issue a building permit.

The applicant within the meaning of the Law on Construction is the builder (client) (cf. sec. 3 (1) Law on Construction). According to sec. 23 Law on Construction, the builder of a new house must submit the following documents: 1) an application in the proper form, 2) all documents relating to the design of the construction work, 3) documentation of the appointment of a head of technical supervision of construction, 4) a certificate of cadastral measurements

Lithuania’s building permit procedure has the particularity of being divided into two steps. First of all, the developer must apply for “building project planning conditions” from the permitting authority, which must be either rejected within 15 days or granted within no more than 20 days. On the basis of these building project planning conditions, the developer, together with the persons entitled to draw up building documents, can prepare the building application documents necessary for the project. Only on the basis of this building documentation will the building control authority decide on the building permit,

After the director of the competent authority receives the application, the Permanent Construction Commission will ascertain whether the documentation fulfils the requirements for the improvement of a construction plot laid down in physical planning documents as well as the requirements of a set of design conditions and those set forth in the legal acts specified in the regulations of the Permanent Construction Commission (sec. 23 (9) Law on Construction). The Commission then makes a recommendation to the director whether or not to issue a building permit. A construction permit must be issued within no more than ten days (or, in exceptional cases, 15 days) of the submission of the documents. It is valid for a period of ten years. It becomes invalid if the builder has not begun construction within three years or the construction work has not been accepted as fit for use within ten years (sec. 23 (17) Law on Construction. After finishing the construction works, the building needs to be accepted as fit for use (sec. 24 Law on Constructions).

5. Conclusion

The building permit procedures in the various countries are similar in some respects. In each country, the construction of residential buildings generally requires a building permit. In order to obtain a permit, building application documents must be submitted to the building control authority. However, the permitting procedures also differ in many respects: The content of the building application documents, the persons who are entitled to draw up the documents and the duration of the building permit vary from country to country.

10.2.3.3 Sustainability requirements in the national legal systems with regard to energy, heating fuels and construction products

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This section describes some of the material sustainability requirements. Naturally, this selection is not conclusive and additional requirements are analysed in the long version of the legal expertise. The long version also deals in more detail with optional and additional requirements which municipalities can impose in the different Member States by means of land use plans or other local laws. However, one can gain some insight by analysing the different approaches taken by Germany, Denmark, Poland and Lithuania.

1. Energy efficiency

a. Germany

The Energy Saving Ordinance (*Energieeinsparverordnung – EnEV*) relates to energy efficiency. Its primary objective is to ensure that when buildings are constructed or substantially modified, a certain standard for measures to limit the energy consumption of the building in question is met. Among other things, it implements the EU Directive on Energy Performance of Buildings. The central provision of this Ordinance is a cap on annual primary energy demand (sec. 3 and 4). Pursuant to sec. 3 (1), new buildings must be designed such that the annual primary energy demand for heat, hot water, ventilation and cooling does not exceed the value of a reference building of the same geometry, effective area and orientation. The primary energy demand is the parameter for the energy assessment of buildings, taking into account the amount of fossil fuels that must be produced to cover the total energy demand of the building. The technical reference building execution is described in Annex 1 Table 1 of the Ordinance. The building must therefore be calculated twice, once with the values of the reference building according to Table 1 Annex 1, in order to obtain the permissible annual primary energy demand, and then with the actual data. If the building shell and the system technology of the building that is to be certified are executed in the same manner as the reference building, then no further calculation needs to be performed.

The Ordinance further establishes a minimum technical level for construction and facilities. The quality of the shell of the building must ensure that the transmission heat loss designated in Annex 1 Table 2 of the Ordinance is not exceeded (sec. 3 (2)). The table contains the different building types, for instance “Freestanding residential building with less than 350m² effective area A_N” or “Residential building enclosed on one side”, etc. and their relating maximum specific transmission heat loss.

Part 5 of the Energy Saving Ordinance merely takes up the “issuance of energy performance certificates and recommendations for the improvement of energy efficiency”. If a building is constructed, the developer must ensure pursuant to sec. 16 (1) that an energy performance certificate is issued on the basis of the energy features of the completed building.

Voluntary incentive systems exist as well. With the program “energy-efficient construction – financing of high-quality, energy-efficient construction of new residential buildings within the scope of the Integrated Energy and Climate Programme (IEKP) of the Federal Government” *(Energieeffizient Bauen – Finanzierung des energetisch hochwertigen Neubaus von Wohngebäuden im Rahmen des IEKP des Bundes)*, the KfW Bankengruppe enables the financial promotion of construction projects. Developers or acquirers of new residential buildings can apply for financial assistance in the construction, production or first acquisition of residential buildings if these buildings meet a certain energy standard, which derives from the threshold values set forth in the EnEV 09 (see II, 1.1.a). Buildings that fall below the maximum permissible thresholds calculated according to the EnEV will be classified as a “KfW Efficient House” *(KfW-Effizienzhaus)*. The term is a quality mark that was developed by the Germany Energy Agency GmbH *(Deutschen Energie-Agentur GmbH)* (dena) together with the Federal Ministry for Transport, Construction and Urban Development (BMVBS) and the KfW.

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b. Denmark

In Denmark, Building Regulations 2008 (*Bygningsreglementet 2008 – BR08*) mainly deal with the general requirements on energy efficiency in buildings. The EU Directive 2002/91/EC on energy performance of buildings introduced a new chapter into Danish legislation. namely Section 7on "energy consumption". Responsibility for the implementation lies with the Danish National Energy Agency and the Danish National Agency of Enterprise and Construction.

Sec. 7.2 defines an "energy performance framework", which covers the building's total demand for supplied energy for heating, ventilation, cooling, domestic hot water and – where appropriate – lighting. This "framework" is comparable to the German annual primary energy demand (see above). Pursuant to Sec. 7.2.2 (1), the total demand of *every* new building for energy supply for the heated floor area may not exceed 70 kWh/m²/year plus 2200 kWh/year divided by the heated floor area [(70+2200/A)kWh/m² per year].

The BR08 used to designate two categories of "low energy" houses (Class 1 and Class 2) which have a higher energy performance than the general standard. These categories enabled municipalities to impose these higher requirements in their local plans if they wished to do so. However, there will be a change from 1 January 2011 onward. The standard energy requirement will then correspond to the former low energy class 2. The two low energy classes 1 and 2 will be replaced by a single class, namely low energy class 2015 (30+(1000/A) kWh/m²/year for dwelling and similar use and 41+(1000/A) kWh/m2 kWh/m²/year for schools, offices and institutions). For low energy class 2015, the heating demand may be multiplied by a factor of 0.8 if the building uses district heating, due to the lower CO_2-emissions from district heating supply.

Like the German Energy Saving Ordinance, the BR08 sets caps on transmission heat loss for the thermal envelope of buildings (sec. 7.2.1 (7)). Even if the energy performance framework has been complied with, the design transmission loss from single storey buildings, excluding the loss from windows and doors, may not exceed 6 W/m² of the building envelope, excluding windows and doors. For two-storey buildings, the corresponding transmission loss may not exceed 7 W/m², and for buildings of three or more storeys 8 W/m². Additionally, the BR08 defines a minimum standard of heat insulation in section 7.5 (1). The insulation of the individual building elements must at least correspond to the heat loss levels set out in the table in section 7.5 (1).

The calculation of the energy performance must be carried out using the Be06 software which was developed by the Danish Building Research Institute. It covers such factors as thermal bridges, solar gains, natural ventilation, heat recovery, air conditioning, lighting (for large buildings), boiler and heat pump efficiency.

Rules on energy performance certificates are laid down in the Act on Promotion of Energy Savings in the version of 14 June 2005, last amended in 2010 (*Lov om fremme af energibesparelser i bygninger*). An energy performance certificate is required for new buildings as well as for buildings or apartments that will be sold or rented out.

c. Poland

EU Directive 2002/91/EC was implemented in the Building Act of 7 July 1997 and the Ordinance on Technical Requirements of 12 April 2002. Since January 2009, an energy performance certificate has been required for buildings. Chapter X of the Ordinance sets out requirements on energy efficiency and thermal insulation. This part also contains thresholds for building elements such as the maximum permissible U-values, 0.3 W/m^{2}K for external walls, 0.25 W/m^{2}K for roofs, 0.45 W/ m^{2}K for floor on ground, 1.7-1.9 W/m^{2}K for new residential buildings.

However, the Polish regulations provide for two alternative ways to meet energy requirements: 1) by compliance with prescriptive values for components (see above) or 2) by compliance with primary energy values. The first method is prescriptive and consists of a list of detailed requirements for different building components (see above). The second method is based on performance and defines permissible values of specific non-renewable primary energy use, expressed in kWh/(m^2year).

d. Lithuania

The Lithuanian Government approved the “Lithuanian Housing Strategy” on 21 January 2004. One of the goals is to ensure the efficient use, maintenance, renovation and modernization of existing housing and efficient energy use. Although the particular focus is on the renovation of buildings, it also

contains measures that aim to promote energy efficiency in new buildings.

New buildings also fall under the EU Directive 2002/91/EC which was implemented in Lithuanian legislation. Some provisions on the energy performance of buildings and the certification of the energy performance of buildings are described in the Law Amending the Law on Construction (no. x-404 adopted on 17 November 2005) and the Law on Energy. Additionally, the Lithuanian calculation procedure is defined in the Building Technical Regulation STR2.01.09:2005 “Energy Performance of Buildings; Certification of Energy Performance of Buildings“(adopted on 20 December 2005 by Order no. D-1-624; entered into force on 4 January 2006). The responsibility for the implementation is divided between the Ministry of Environment and the Ministry of Economy.

Consequently, all buildings must be designed according to STR 2.05.01:2005 “Thermal Technique of Envelopes of the Building”, which imposes, for instance, the following normative requirements for thermal protection of residential building envelope: roofs (0.16 W/m^2K), ceiling in contact with outdoor air (0.16 W/m^2K), building elements in contact with ground (0.25 W/m^2K), ceilings over unheated basements and crawls (0.25 W/m^2K), external walls (0.20 W/m^2K), windows and transparent building elements (1.6 W/m^2K), doors and gates (1.6 W/m^2K) and linear thermal bridges 0.18 W/m^2K). The energy performance class of new buildings has to be in class “C” or better (classes range from A to G).

2. Heating Fuels and Renewable Energy Sources

a. Germany

The Renewable Energies Heat Act *(Erneuerbare-Energien-Wärme-Gesetz, EEWärmeG*) imposes a duty to use renewable energies for the generation of heat in buildings. This duty, which used to be regulated in the Energy Saving Ordinance of 2007, was removed from the Energy Saving Ordinance 2009 and is now regulated separately in the Renewable Energies Heat Act. The purpose of this provision is to protect fossil resources, reduce dependency on energy imports and promote the further development of technologies to generate heat from renewable energies. Every new building with an effective area of more than 50m^2 must cover a specific portion of its energy needs with regenerative energy sources. The aim of this Act is to increase the share of renewable energies to 14% by 2020 (sec. 1 (2)). Sec. 3 (1) requires owners of newly constructed buildings to cover a share of their thermal energy demand with renewable energy sources. Thus, at least 50% of the thermal energy demand has to be covered with geothermal energy, at least 15% of a building’s thermal energy demand has to be covered with solar radiation and – depending on type – 30% to 50% has to be covered with biomass.

According to sec. 7 no. 3 of the Renewable Energies Heat Act, the building owner’s obligation to use renewable energy sources is also met if the thermal energy demand is covered directly from a local or district heating grid. Pursuant to Annex VII of the Act, a prerequisite for this substitute measure is that a substantial share of the heat from the grid come from renewable energies (no. 1 a) or at least

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50 % of the heat come from installations for the use of waste heat (no. 1 b), from CHP installations (no. 1 c) or from a combination of the aforementioned measures (no. 1 d).

In addition to these nationwide requirements, municipalities are entitled to set additional requirements in their local plans regarding construction measures for the use of renewable energy sources (sec. 9 (1) no. 23 b) BauGB). At the moment it is under debate in Germany whether municipalities are also entitled to enact local laws requiring specific technical measures, such as the actual installation (and operation) of solar panels. It is also disputed whether local plans may prohibit the use of specific heating fuels, such as coal or heating oil, in specific areas with the intention of achieving global climate protection goals if this is not called for due to a specific urban planning situation such as bad air quality in the specific area.

b. Denmark

In Denmark, there are no strict requirements for the use of renewable energy sources in new buildings. However, renewable energy production is taken up in the new regulations in connection with solar panels and photovoltaic cells. and there are subsidy schemes to promote the use of renewable energy.

The municipalities are generally responsible for ensuring a general collective heating supply through ”heat supply planning” according to the consolidated Act on Heat Supply in the version of 17 May 2005, last amended in 2010 (*Bekendtgørelse af lov om varmeforsyning*). The municipalities may thus establish or request the establishment of collective facilities, etc. that are based on different energy sources, including renewable energy. The Act on Heat Supply also empowers the municipalities to request that new buildings be connected to a collective facility (cf. sec. 11-12).

According to the Planning Act, requirements to establish and connect new buildings to collective facilities may be laid down in a local plan. Otherwise, the municipalities are generally not empowered by law to impose obligations on the establishment or actual use of renewable energy sources in new or existing buildings. However, as landowners, the municipalities may register restrictions on land, e.g. restricting use of conventional energy sources. In addition, they may enter into private law agreements with developers or others, e.g. when selling land.

c. Poland

In Poland, there are no regulations referring to renewable energy in buildings. However, similarly to Germany and its “KfW Efficient Houses” there are voluntary incentive systems, including the system of financial support for environmentally clean technologies. Several funds exist, such as the National Fund for Environmental Protection and Water Management, funds of particular provinces, and the ECOFund or co-financed funds by the Bank for Environmental Protection. Pursuant to the Energy Law Act of 27 April 2001, these funds are specifically intended to assist in the introduction of more environment friendly energy carriers, as well as to support activities promoting the use of local renewable energy sources.

d. Lithuania

There are no specific regulations related to the use of renewable energy in buildings. However, pertinent regulations can be found in the Law on Heat Sector From 20 May 2003 as last amended on 12 May 2009 No XI-250. Article 4, which is entitled “Promotion of Cogeneration as well as Heat Production from Bio fuel and Renewable Sources of Energy” stipulates that the cogeneration of heat and electricity is a public service obligation. Moreover, the municipalities must promote the purchase of heat produced from biofuels to heat supply systems, renewable sources of energy, waste incineration and geothermal energy. This is also be considered a public service obligation.

3. Construction Products

a. Germany

In Germany, building products are regulated on both the federal and the state level. The Building Products Directive 89/106/EEC of 21 December 1988 was implemented on a federal level through the Act on the Marketing and Free Movement of Construction Products, in the version of 28 April 1998, last amended in 2006 (*Bauproduktengesetz – BauPG*). Moreover, the provisions of the Construction Products Directive that are of regulatory relevance have been implemented in the different

Building Codes of the Federal States (see, e.g., sec. 17-25 BauO Bln).

b. Denmark

In Denmark, Directive 89/106/EEC of 21 December 1988 was generally implemented through the Danish Building Law (*Byggeloven*). Section 31 (1) empowers the Ministry of Housing to enact ordinances on the implementation of EU Directives concerning construction products. The substantial part of the Directive is currently implemented in two ordinances:

- Ordinance on marketing, sales and market supervision of construction products of 10 November 2008 (*Bekendtgørelse om markedsføring, salg og markedskontrol af byggevarer),*
- Notice of the designation and notification of notified bodies to carry out certification, inspection and verification duties under the EC Directive (89/106/EEC) of 24 June 1998, last amended in 2001 (*Bekendtgørelse om udpegning og notifikation af bemyndigede organer til at udføre certificerings-, kontrol- og prøvningsopgaver i henhold til EF-direktiv om byggevarer (89/106/EØF)*).

c. Poland

In Poland, the Building Products Directive was implemented by the Building Products Act of 16 April 2004 (*Ustawa z dnia 16 kwietnia 2004 r. o wyrobach budowlanych*). The Act itself regulates the CE marking, while at the same time amending the Building Act of 7 July 1994 with regard to the verification and procedural provisions in the Building Products Directive. A new version of the Building Products Act was adopted by the “Sejm” (lower house) on 30 April 2010 and has been in force since 21 May 2010. Among other things, the new version provides for a more stringent monitoring of compliance with the requirements imposed on building products.

d. Lithuania

The Directive 89/106/EEC has been implemented through the Technical Regulation for Construction STR 1.01.04:2002 “Construction Products, Conformity Attestation and CE Marking”. This Regulation contains abovementioned six essential requirements as designated in Annex I of the Technical Regulations: mechanical resistance and stability, safety in case of fire, hygiene, health and environment, safety in use, protection against noise and, finally, energy economy and heat retention.

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4. Conclusion

The subject of “legal sustainability requirements and building permit procedures”, as described in detail in the long version of our legal expertise and summarised in this contribution, is very complex. However, it can be established that the motivation for shaping a legal framework for sustainability in the housing sector is growing. For instance, the implementation of the European Performance of Buildings Directive is a great milestone in terms of promoting energy efficiency. But the Member States are also endeavouring to enhance their performance, one example being Denmark’s introduction of a new stricter low energy class for housing by 2011 while making the former low energy class the standard for new buildings. Our examination has shown that municipalities may take in important role in going beyond national and European standards by setting stricter requirements on a local level. Facilitating and encouraging these local initiatives may contribute to the promotion of sustainability in the housing sector and trigger creative and innovative solutions. All of the countries examined are on a promising track, although the goals set by the EU are fairly demanding, so there is no reason to slow down in their efforts. It will be of particular interest to see how future challenges, such as climate change, will affect Member States‘ policies and how the future European legislative framework will be transposed in the different jurisdictions.

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10.3 Economical and financial basis, industry and quality

10.3.1 Energy Efficiency in the Residential Buildings Sector: Market Barriers and Policy Responses

10.3.1.1 Overview

The problem of anthropogenic climate change, triggered by ever rising energy consumption, and its environmental and economic consequences has attracted increased public attention during recent years. The Stern Review states that the costs of climate change would be much higher than those of mitigating CO_2 in order to stabilize the global surface temperature. At the European level, emission reduction targets for the Post-Kyoto Period have been adopted; the EU committed to greenhouse gas (GHG) reductions of at least 20 percent by the year 2020, compared to the year 1990. Until the year 2050, more radical reductions are called for. Meeting these goals will require transforming the way energy is produced, delivered, and consumed across all sectors of the economy. Buildings, which account for roughly 40 percent of today's energy demand – for heating, cooling, and powering the buildings – will play a critical role in this process; if the energy consumed in manufacturing the steel, cement, aluminium, and glass used in building construction is included, the share of the buildings sector in overall energy consumption grows to approximately 50 percent. Thus, addressing the buildings sector's consumption of fossil energy is indispensable in order to reach the EU's self-imposed GHG reduction targets.

Energy efficiency is identified as the essential lever to bring down buildings' energy consumption and GHG emission.[43] In order to design appropriate energy policy strategies, one has to distinguish between energy efficiency and economic efficiency. Maximizing economic efficiency in a narrow sense means to minimize the overall costs per unit of energy service delivered; in a broader sense it means to maximize the social welfare of the society. As improving energy efficiency comes at a cost, maximizing economic efficiency regularly does not imply to maximize the physical energy efficiency. Enhancing energy efficiency usually involves a trade-off: Better energy efficiency properties require higher upfront costs but facilitate lesser operational and energy costs during the service life of the investment. Rational energy and climate policy will strive for economic efficiency in order to minimize the aggregate costs to the society for achieving given energy conservation and GHG mitigation targets.

Improving the energy efficiency of residential buildings is heralded by several studies as one of the cheapest ways to cut CO_2-emissions. It is asserted that various energy conservation options are available at negative cost, i.e., the investment yields net gains. Hence, improvements of the energy efficiency of residential buildings seem reasonable with regard to the criterion of economic efficiency. The question arises why supposedly cost-effective measures, providing net benefits to the investor, are not already taken by the (private) actors in the buildings sector. The difference between the actually realized level of energy efficiency and the level deemed optimal creates the

[43] Energy efficiency is typically defined as the energy services provided per unit of energy input (e.g., heating, cooling, lighting).

so-called energy efficiency gap. Research efforts have been made to reveal market barriers that may inhibit the realization of the economically efficient energy efficiency level; market conditions as well as the behavior of individual decision-makers were analyzed with regard to their significance for explaining the supposed underinvestment in energy efficiency.

The purpose of this report is to identify potential causes for the existence of the energy efficiency gap in the residential buildings sector, and to assess possible policy responses to address and narrow the gap. We begin with pointing out the magnitude of the buildings sector's energy consumption and GHG emissions as well as its potentials to abate these emissions in a cost-effective manner. Subsequently, section 10.3.1.3 highlights the value chain and the contractual relation of the different actors in the residential buildings market. Section 10.3.1.4 gives a very brief overview of the most relevant legal provision for the buildings sector in the EU and Germany; yet, a detailed depiction of the legal context is provided in the (external) expert report compiled by Gleiss Lutz. In section 10.3.1.5 we analyze several potential market barriers to energy efficiency; these range from energy efficiency disincentivizing price signals to imperfect information and behavioral anomalies. This is followed by a description and evaluation of potential policy instruments to overcome the market barriers to energy efficiency in the residential buildings sector; benefits and problems of the various policy instruments at hands are assessed in order to derive policy recommendations for their implementation. Section 10.3.1.7 contrasts for five Baltic Sea region countries the susceptibility to the market barriers depicted earlier, the policy instruments to foster energy efficiency currently implemented, and the policy actions seeming most urgent. Finally, section 10.3.1.8 summarizes the findings and draws conclusion in terms of a recommended policy mix to stimulate greater energy efficiency in residential buildings.

10.3.1.1.1 Key finding

Improving the energy efficiency of residential buildings is identified by several studies as one of the cheapest ways to save (fossil) energy and cut CO_2-emissions The external expertise imposed the crucial question why supposedly cost-effective measures, providing net benefits to the investor, are not taken by the relevant actors in the building sector; it ended up to the following recommendations:

- Energy efficiency enhancing investments usually involve a trade-off: Better energy efficiency properties require higher upfront costs but facilitate lesser operational and energy costs during the service life of the investment.
- Prevailing market conditions and behavioural patterns of individual decision-makers may inhibit the realization of higher energy efficiency levels that would yield net gains for the investor in the long-run.
- The difference between the actually realized level of energy efficiency and the level deemed optimal creates the so-called energy efficiency gap. A gap that should be seen from different aspects:
    i. The narrow or private efficiency gap refers to energy efficiency improvements that are not implemented,
    ii. Although they would be beneficial to the investor
    iii. The social efficiency gap refers to the difference between the actual energy efficiency and the efficiency level that would be optimal from a social perspective – also considering external effects.

- In order to overcome the various market barriers a policy package comprising diverse instruments is required. No single policy instrument can capture the entire potential of cost-effective energy efficiency improvements in the residential buildings sector.
- It has to be noted, however, that policy interventions to close the efficiency gap come at a cost. Costs are incurred for the design, implementation, and enforcement of the policy measures.
- Rational environmental and climate policy has to balance the benefits and costs of policy action. The optimal level of efficiency is that which is consistent with efficient overall resource use, including efficient use of government resources required for the implementation of environmental policy.
- Reaching an economically optimal level of energy efficiency regularly does not imply to maximize the technically feasible level of energy efficiency.
- The optimal energy efficiency level and the appropriate energy policy strategy to achieve it differ across countries or even regions according to the diverging underlying circumstances (e.g., climate, availability of resources and technologies, institutional structures, etc.).

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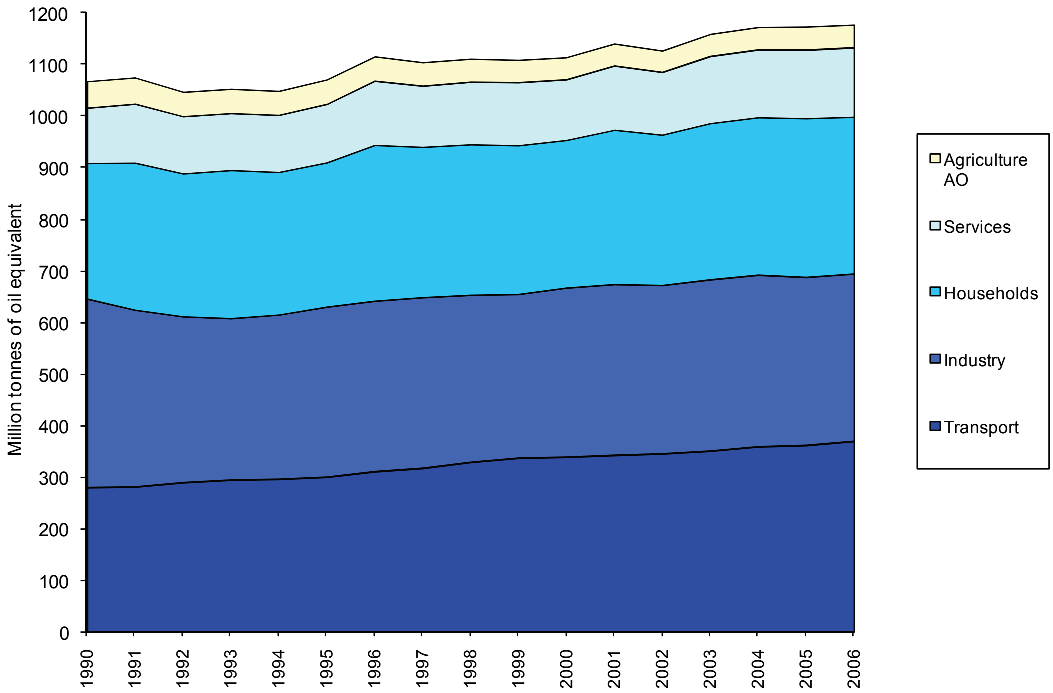
10.3.1.2 Importance of the Buildings Sector for Climate Policy

10.3.1.2.1 Energy Consumption of the Buildings Sector

The consumption of energy in buildings has a major impact on the total energy demand. In total, buildings account for approximately 40% of all primary energy used in most countries.[44] This proportion of energy consumption occurs only during the usage phase of buildings; additional 10% of the overall primary energy consumption is attributed to the construction of the buildings. Energy in buildings is used by households, services as well as industries. Energy is consumed for heating, cooling, lighting, ventilation, and the usage of electrical appliances. As illustrated in Figure 22, the final energy consumption of households in the EU increased from 1990 to 2006 by approximately 16% and amounted in 2006 to a total share of about 26%. The share of the service sector in 2006 amounted to approximately 11%.[45]

Figure 22: Final Energy Consumption by Sector in the EU-27, 1990-2006



Source: EEA (2007).

The rising household consumption of energy in Europe is based on increasing living space, higher expected levels of comfort, and more household appliances. Multi-family dwellings in developed countries use less energy than single-family homes which is based on lower exterior wall area and roof space that reduce energy losses.[46] Furthermore, a rising impact of electronic devices such as

[44] WBCSD (2007).
[45] ICCR (2009).
[46] WBCSD (2010).

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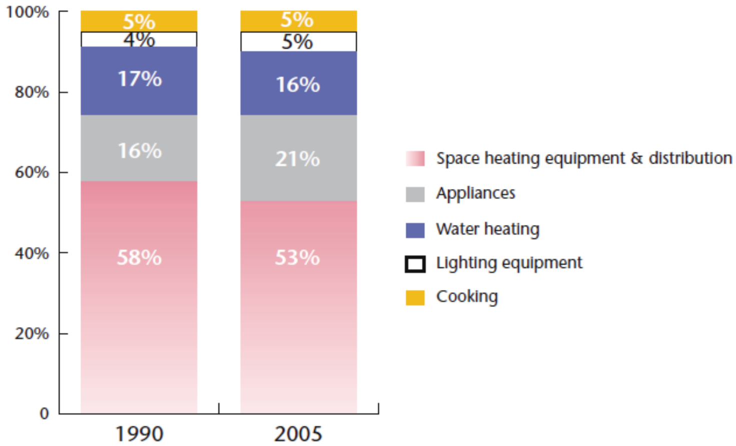
computers and other appliances has taken place within the last years which caused an increasing demand for electricity in households. In Western and Central Europe, the electricity demand of appliances increased from 16% in 1990 to 21% in 2005 in spite of rising energy efficiency of appliances (Figure 23).

Figure 23: Average Distribution of Household Energy Consumption in Western and Central Europe



Source: IEA (2008).

The energy consumption in the buildings sector is closely related to the time period of construction. In the majority of the EU member states 50% to 75% of the buildings stock were constructed before the year 1970. Prior to the oil crisis of the 1970s in most buildings around 200 kWh per square meter and year were consumed for heating and cooling. In the last 30 years the consumption was gradually reduced to around 70 kWh.[47]

The major part of energy demand in households in Western and Central Europe accounts for space heating. The consumption varies significantly based on climatic differences. Moreover, important energy services are domestic hot water, ventilation, lighting and cooling.

In Germany 33% of the primary energy consumption – by end end-use – in 2006 accrue in households and 23.1% in the service sector.[48]

In Russia the total consumption of primary energy in the year 2005 accounted up to 949 Mtce (million tons of coal equivalent). The consumption in the buildings sector is estimated as the second largest with around 36% of the primary energy consumption by end-use. Industry accounts for around 46%, road transport for 10% and 8% are ascribed to power and heat losses (figure 3). Nearly half of the energy consumption of residential buildings is delivered by district heating, the remainder by electricity consumption and on-site heating and cooking. Based on the availability of low-cost and subsidized energy, low investment costs, and quick constructions, most buildings in Russia consume significantly more energy for heating than other countries with a comparable climate.[49]

[47] ICCR (2010).
[48] Statistisches Bundesamt (2008).
[49] McKinsey & Company (2009b).

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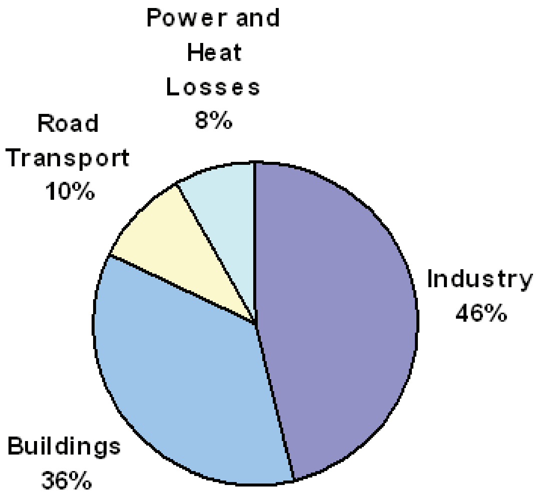
Figure 24: Share of Primary Energy by End-User in Russia, 2005



Source: McKinsey & Company (2009b).

10.3.1.2.2 CO_2-Emissions of the Buildings Sector

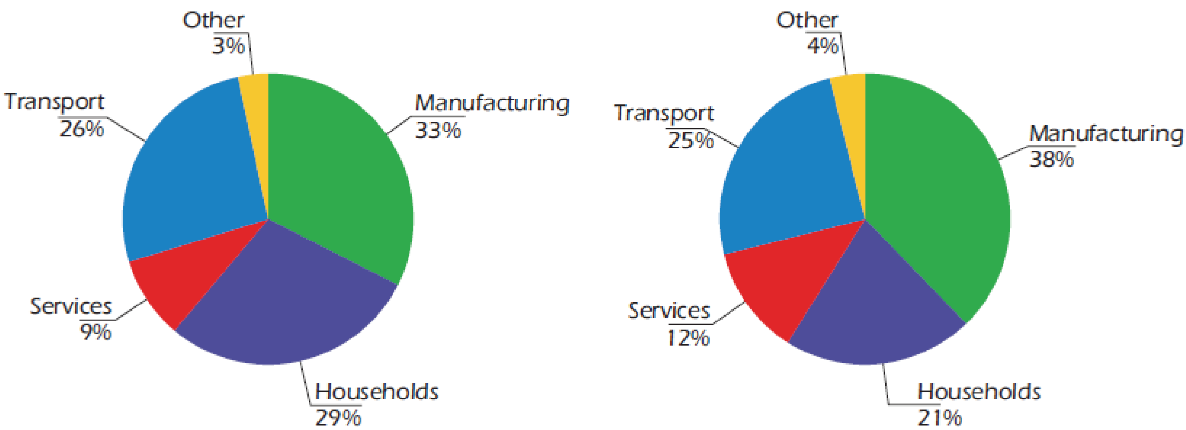
Building emissions result from direct combustion processes within the building and indirect emissions from the use of electricity and district heating; they account for approximately 8% of GHG emissions, and 20% if upstream emissions associated with electricity and district heating are included.[50] Direct combustion of fossil fuels in residential and commercial buildings amounts to 3.3 $GtCO_2$. Almost half of these emissions originate from the combustion of oil, around 40% from gas, and the remainder from coal.[51]

Upstream and indirect CO_2 emissions from the power sector originate through the demand for electricity and district heating. About half of the electricity and heat produced by the power sector is consumed in buildings. In 2003, buildings were indirectly responsible for about 5.4 $GtCO_2$.[52] The share of CO_2 emissions associated with the production of electricity ranks differently depending on

[50] Stern, N. (2006).
[51] IEA (2006).
[52] IEA (2006).

the energy commodities mix used. Households and services account up to 38% of the global final energy consumption, as shown in Figure 25: Share of Global Final Energy Consumption and CO2 Emissions by Sector, 2005

. Figure 25: Share of Global Final Energy Consumption and CO_2 Emissions by Sector, 2005

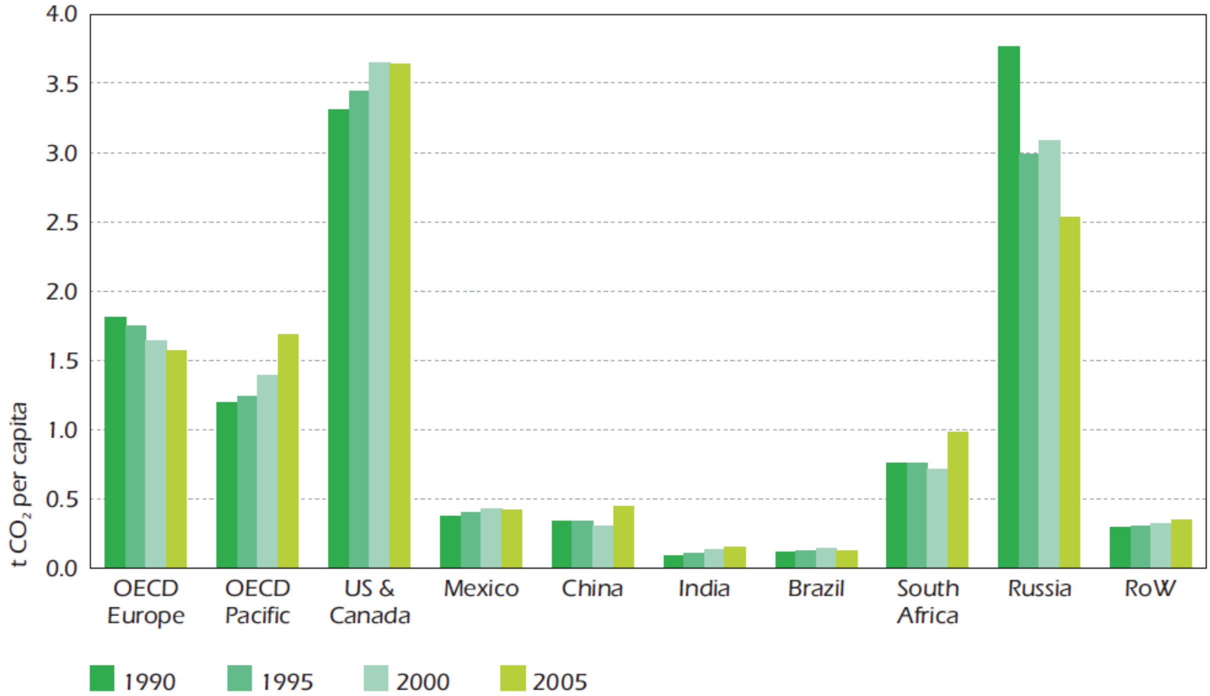


Source: IEA (2008).

CO_2 emissions including the use of electricity in buildings grew from 1971 to 2004 at an annual rate of 2% which is almost equal to the overall growth rate of CO_2 emissions from all uses of energy. During this period, CO_2 emissions of commercial buildings grew at 2.5% and those of residential buildings at 1.7% per year.[53] The global average emissions from households including upstream emissions in 2005 sum up to 0.7 tons of CO_2 per person which is almost the same as 1990. However, great differences between countries exist. The per capita CO_2 emissions in OECD countries are on average more than five times higher than in non-OECD countries. One explanation is the lower per capita energy use in non-OECD countries and the lower carbon intensity of the energy mix due to a high share of renewable energy.[54]

[53] Levine, M. D.et al. (2007).
[54] IEA (2008).

Figure 26: Household CO_2 Emissions per Capita



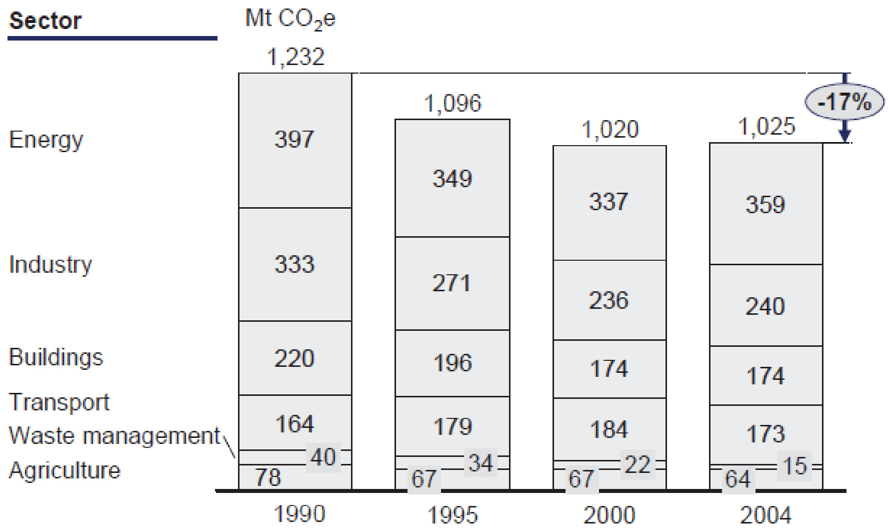
Source: IEA (2008).

As forecasted by business-as-usual trends, direct and upstream CO_2 emissions from buildings are expected to rise by 70% and 140% to 2030 and 2050 respectively. As more buildings are expected to be electrified and the demand for electrical appliances is expected to further increase, upstream emissions are expected to increase more rapidly.[55]

In Germany direct emissions caused by the buildings sector have decreased from 1990 to 2004 by around 20%. This development is mainly based on extensive building renovations including insulation, and modernizations of heating systems which especially have taken place in eastern Germany. Apart from a slight rise in consumption, emissions from central heat supply systems dropped by nearly 40% based on efficiency gains. Within the same time period, electricity consumption in buildings increased by nearly 20%.

[55] Stern, N. (2006).

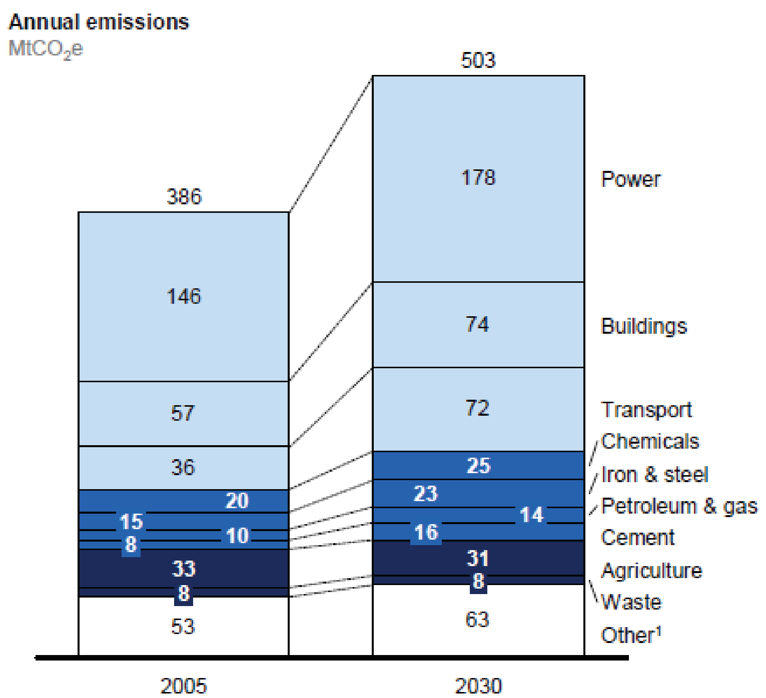
Figure 27: Historical Development of GHG Emissions in Germany, from 1990 to 2004



Source: McKinsey & Company (2007).

In Poland the total annual emissions of the year 2005 amount to 386 $MtCO_2e$. Direct consumption in buildings accounted for about 15%, the power sector for 38%. According to a business-as-usual emissions trajectory in Poland, GHG emissions are expected to grow by 30% above the 2005 levels by 2030.[56]

Figure 28: Business-As-Usual Case Emission Growth in Poland



Source: McKinsey & Company (2009a).

56 McKinsey & Company (2009a).

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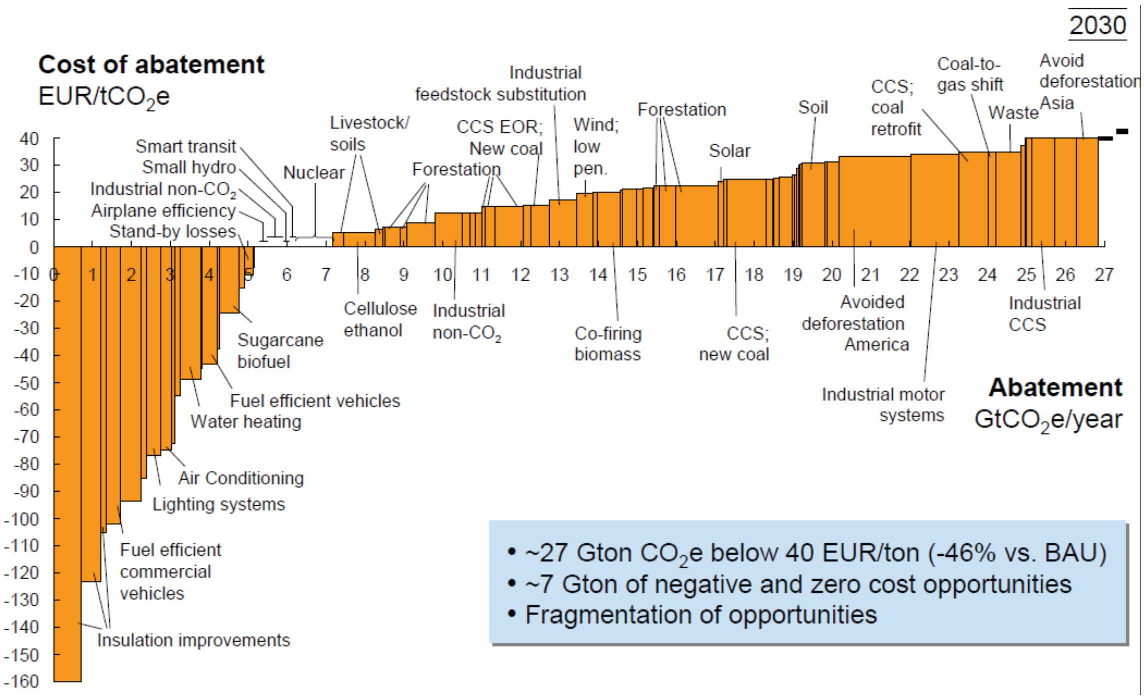
10.3.1.2.3 Abatement Potentials

Several studies suggest significant energy saving and CO_2 emission reduction potentials in the buildings sector. A great share of these potentials seem to be realizable at negative net cost, i.e., discounted future savings in operational costs (including energy costs) exceed the additional initial investment costs.

In a study by Vattenfall of 2007, cross-sectoral abatement potentials were evaluated and compared to future energy cost savings. Figure 29 illustrates the abatement potentials and their costs in relation to the business-as-usual case for the year 2030. In summary, a reduction of about 27 $GtCO_2e$ (CO_2 equivalent) is assumed with costs below 40 EUR/t. This equals a reduction of CO_2e of approximately 46% to the business-as-usual case. The study points out abatement potentials of 7 $GtCO_2e$ with negative or zero cost whereof significant shares are found in the buildings sector. Amendments in insulations, lighting systems, air conditioning, and water heating provide energy saving potential with negative costs.[57]

Figure 29: Global Cost Curve of GHG Abatement Opportunities beyond Business-As-Usual



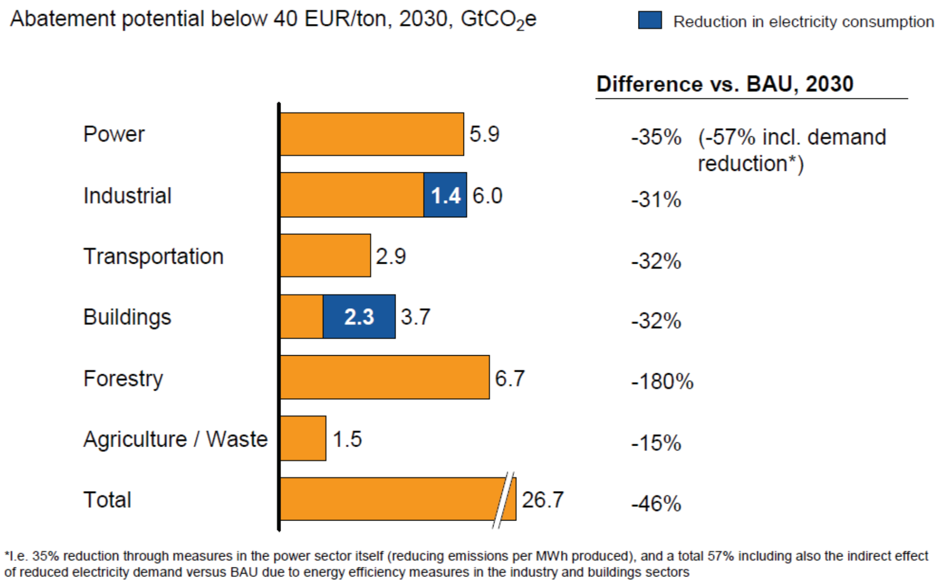
Source: Nelson, B. (2007).

Negative cost abatement opportunities exist for improved insulation and compact fluorescent lamps. Optimized insulation can lower the energy demand for heating by 25% in comparison to the business- as-usual case. The average abatement costs are approximately -130 EUR/t CO_2e, the total abatement potential is 1.6 $GtCO_2e$. The installation of compact fluorescent lamps can lead to an 80% reduction in energy consumption. The average abatement costs of lighting systems are estimated at -90 EUR/t CO_2e for a total abatement potential of 0.2 $GtCO_2e$.

[57] Nelson, B. (2007).

An overall abatement potential in the buildings sector with costs below 40 EUR/t is estimated at 3.7 $GtCO_2e$ which is a reduction of 32% to the business-as-usual case. 1.4 $GtCO_2e$ are ascribed to direct combustion in the buildings, 2.3 $GtCO_2e$ are related to reduced electricity consumption.[58]

Figure 30: Abatement Potential per Sector



Source: Nelson, B. (2007).

Various other studies assess abatement potentials for the residential and commercial sector in the EU and Russia (Table 20). In most studies, measures with high abatement potentials are identified in the buildings sector, mainly through improved insulation, heating systems, and appliances.

[58] Nelson, B. (2007).

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Table 20: CO_2 Emissions Reduction Potential for Residential and Commercial Sectors

Country / Region	Reference	Type of potential	Description of mitigation scenarios	Potential		Measures with lowest costs	Measures with highest potential	Notes
				Million tCO_2	Baseline (%)			
Case studies providing information for demand-side measures.								
EU-15	Joosen and Blok, 2001	Technical Economic	25 options: retrofit (insulation); heating systems; new zero & low energy buildings, lights, office equipment & appliances; solar and geo-thermal heat production; BEMS for electricity, space heating and cooling.	310 175	21% 12%	1. Efficient TV and peripheries; 2. Efficient refrigerators & freezers; 3. Lighting Best Practice	1. Retrofit: Insulated windows; 2. Retrofit: wall insulation; 3. BEMS for space heating and cooling.	(1) 4%; (4) Fr-ef.; (5) TY 2010.
New EU Member States [a)]	Petersdorff et al., 2005	Technical	Building envelope esp. insulation of walls, roofs, cellar/ground floor, windows with lower U-values; and renewal of energy supply.	62	-	1. Roof insulation; 2. Wall insulation; 3. Floor insulation	1. Window replacement; 2. Wall insulation; 3. Roof insulation	(1) 6%; (4) Fr-ef; (5) BY 2006; TY 2015.
Poland	Gaj and Sadowski, 1997	Technical Economic	13 options; lights in streets, commerce & households, gas boiler controls, appliances, heat meters, thermal insulaiton for walls and roofs, window tightening & replacement, fuel switch from coal to gas, solar or biomas, DH boilers.	43 30	26% 18%	1. Efficient street lighting; 2. improved controls of small gas boilers; 3. Efficient lighting in commerce.	1. Insulation of walls, 2. Improvement of home appliances, 3. Fuel switching from coal to gas, solar and biomass.	(1) n.a.; (4) BL; UNFCCC NC3 of Poland, 2001.
Russia	Izrael et al., 1999	Technical Economic	Downsized thermal generators (boilers and heaters), thermal insulation (improved panels, doors, balconies, windows), heat and hot water meters and controls, hot water distribution devices, electric appliances.	182 52	47% 13%	n.a. (not listed in the study)	n.a. (not listed in the study)	(1) n.a.; (4) BL; UNFCCC NC3 of Russia, 2002; PNNL & CENEf, 2004; (5) TY 2010.
Studies providing information about both supply and demand-side options not separating them								
New EU Member States [a)]	Lechtenbohmer et al., 2005	Economic	Improvement in space and water heating, appliances and lighting, cooling/freezing, air-conditioning, cooking, motors, process heat, renewable energies, reduced emissions from electricity generation.	81	37%	n.a. (not listed in the study)	R: 1. Insulation; 2. Heating systems, fuel switch, DH&CHP; C: 1. Energy efficiency, 2. Renewables.	(1) 3-5%; (5) BY 2005; (7) C includes agriculture.
Germany	Martinsen et al., 2002	Technical	Two options: Fuel switch from coal and oil to natural gas and biomass and heat insulation.	31	26%	n.a. (not listed in the study)	1. Heat insulation; 2. Fuel switch from coal & oil to gas & biomass.	(1) n.a.; (5) BY 2002; (7) R only.
Notes specify those parameters which are different from those identified below (the number of a note is the number of the model parameter): a.) Hungary, Slovakia, Slovenia, Estonia, Latvia, Lithuania, Poland and the Czech Republic 1. Discount Rate (DR) belongs to the interval (3%; 10%). 4. Baseline (BL) is Business-as-Usual Scenario (BAU) or similar (Frozen efficiency scenario is abbreviated as (f-ef). 5. Base year (BY) is 2000; Target year (TY) is 2020. 7. Estimations are made for residential (R) and commercial (C) sectors in sum.								

Source: Extract from Levine, M. D. et al. (2007).

Also in Germany, certain levers to increase energy efficiency can contribute most to GHG abatements. Improvements in insulations, replacement of heating systems, facility management systems, efficient electrical devices and lighting are major levers to energy efficiency in the buildings sector. Additional investments for these levers often lead to high energy savings; almost 90% of the abatement potentials in the buildings sector are assigned to pay off for the decision-makers within the respective amortization period. However, due to various barriers these potentials are not always seized. The total upfront payment needed for the investment, amortization periods of more than ten years, and the distribution of costs and benefits between the actors of energy-efficient

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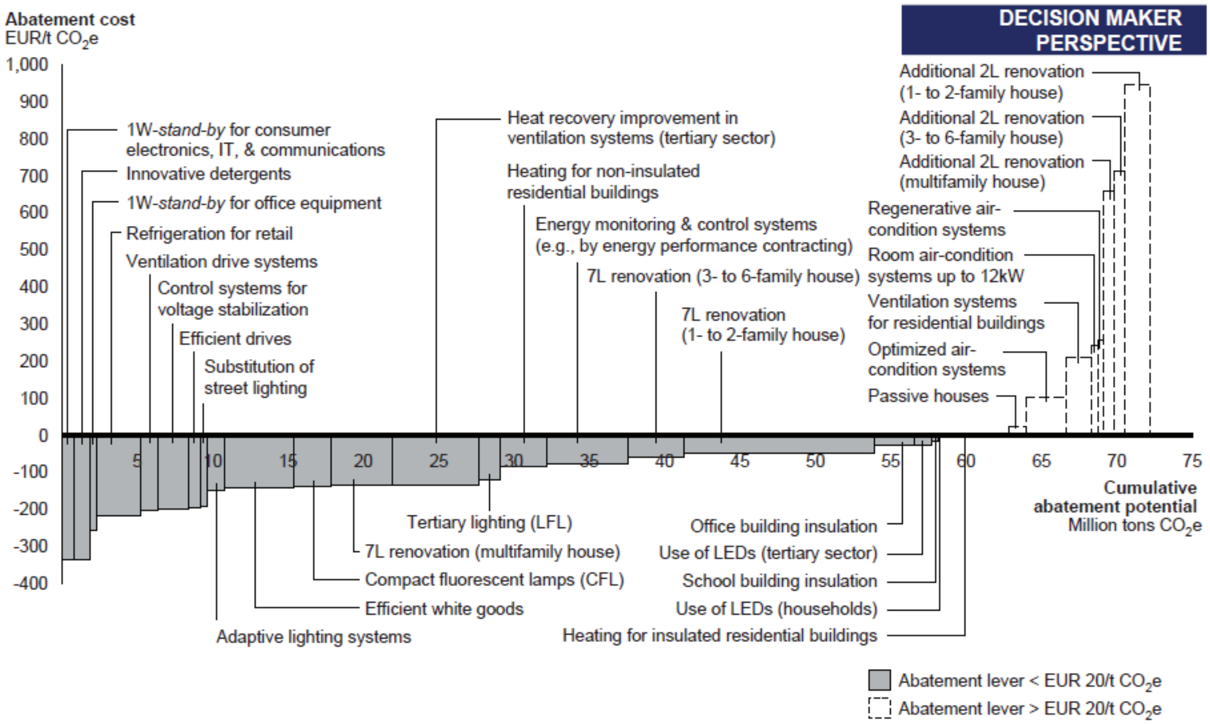
buildings are some of the obstacles. In case of full implementation of economic measures in the buildings sector, emissions can be reduced by approximately 20% to today's level. Assuming a total potential of 72 $MtCO_2e$ in the buildings sector, 63 $MtCO_2e$ can be realized with a positive payoff from the decision-maker perspective, 4 $MtCO_2e$ at costs from 20 to 100 EUR/t, and about one tenth of the abatement potential at costs over 100 EUR/t for the decision-maker.[59]

The greatest abatement potential in the buildings sector in Germany is given by an upgrading of insulation and heating systems for residential buildings which were built before 1979. These measures almost always pay off for the decision-makers over the amortization period. However, these periods are often longer than ten years.[60] For newly constructed buildings, significantly lower potentials are identified.

Figure 31: Buildings Sector: Abatement Cost Curve in Germany, 2020

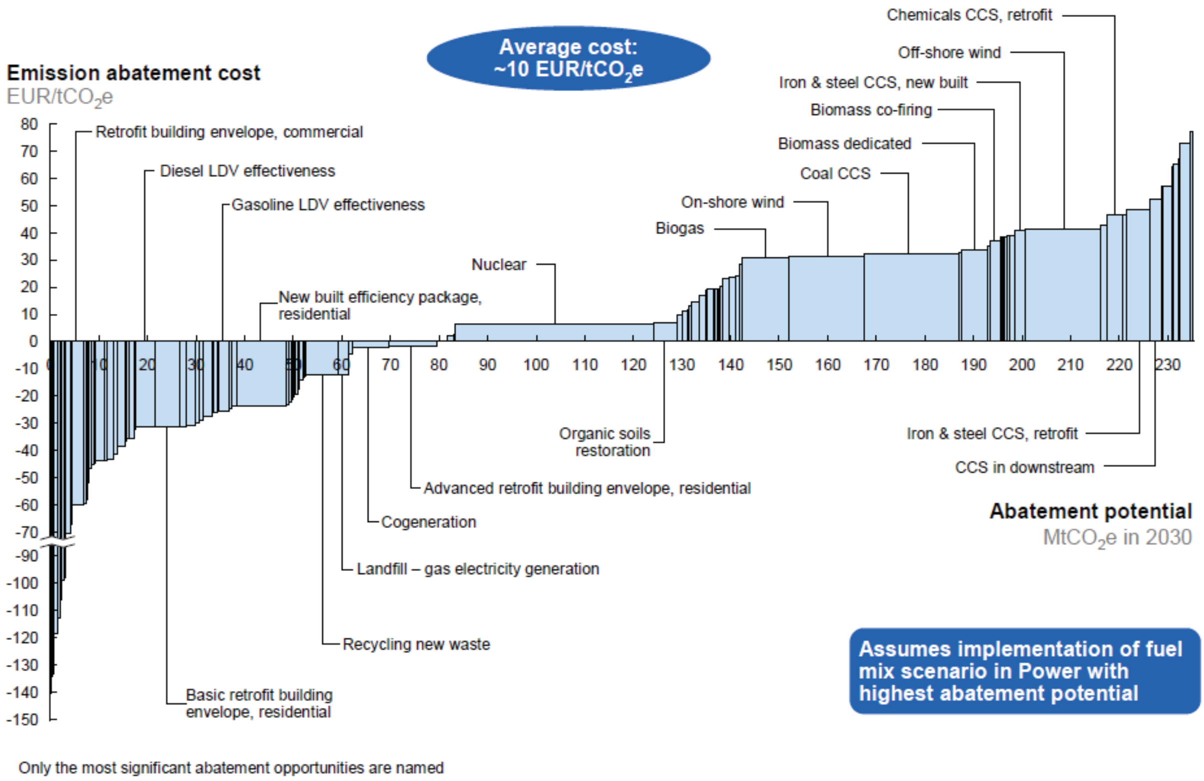


Source: McKinsey & Company (2007).

Also in Poland, various measures to reduce GHG emissions by 2030 were identified. 34% of the total abatement potential of 236 $MtCO_2e$ contributes a net economic benefit in 2030. If these measures were realized, the investments would pay off over time and lead to a reduction of costs and emissions. About 50% of the total abatement potential can be seized with cost between zero and 40 EUR/t CO_2e.

Figure 32: GHG Abatement Cost Curve for Poland in 2030

59 McKinsey & Company (2007).
60 McKinsey & Company (2007).



Source: McKinsey & Company (2009a).

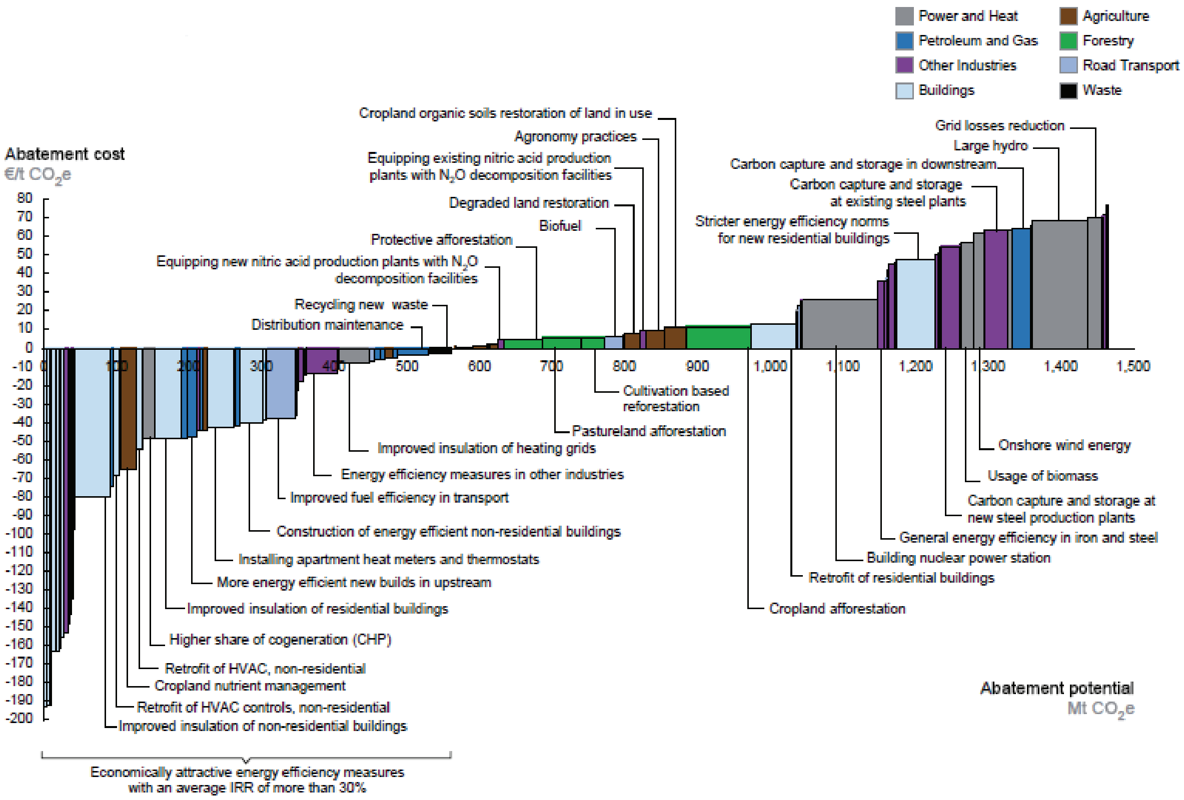
About 65% of the polish potential to energy efficiency is dedicated to the buildings sector. Relevant measures are improved insulation, energy-efficient appliances, water heating, and lighting. Potentials to improve the energy efficiency of residential buildings are recommended to be tapped by a combination of measures, such as improved air tightness, insulation of walls, passive heating and cooling standards. Implementing standards for retrofitting of buildings, passive heating and cooling of buildings could bring down the consumption by 15 $MtCO_2e$ in 2030. The replacement of incandescent and CFL lighting with LED, implementation of lighting controls in commercial buildings, and substitution of appliances and electronic equipment by more efficient alternatives could abate 9 $MtCO_2e$ in 2030. Furthermore, significant energy efficiency potentials for new residential buildings with negative cost exist.

For Russia, 680 Mt CO_2e are identified as abatement potential until 2030. About half of the potential is related to improvements in residential and commercial buildings. Economically attractive measures are improvements of insulation in existing buildings, installing heat meters and thermostats, buildings retrofits and construction of energy-efficient new non-residential buildings. Improvements in insulation of residential and commercial buildings and the installation of heat meters and thermostats would have largest impact with savings of approximately 178 Mtce. The insulation of heating mains and thermostats is accounted with a saving of 37 Mtce.[61] As

Figure 33 illustrates, stricter standards for new residential buildings are not cost-effective in Russia. The availability of relatively low-cost and subsidized energy does not encourage the construction of new residential buildings with higher energy efficiency standards.

[61] McKinsey & Company (2009b).

Figure 33: GHG Abatement Cost Curve for Russia in 2030



Source: McKinsey & Company (2009b).

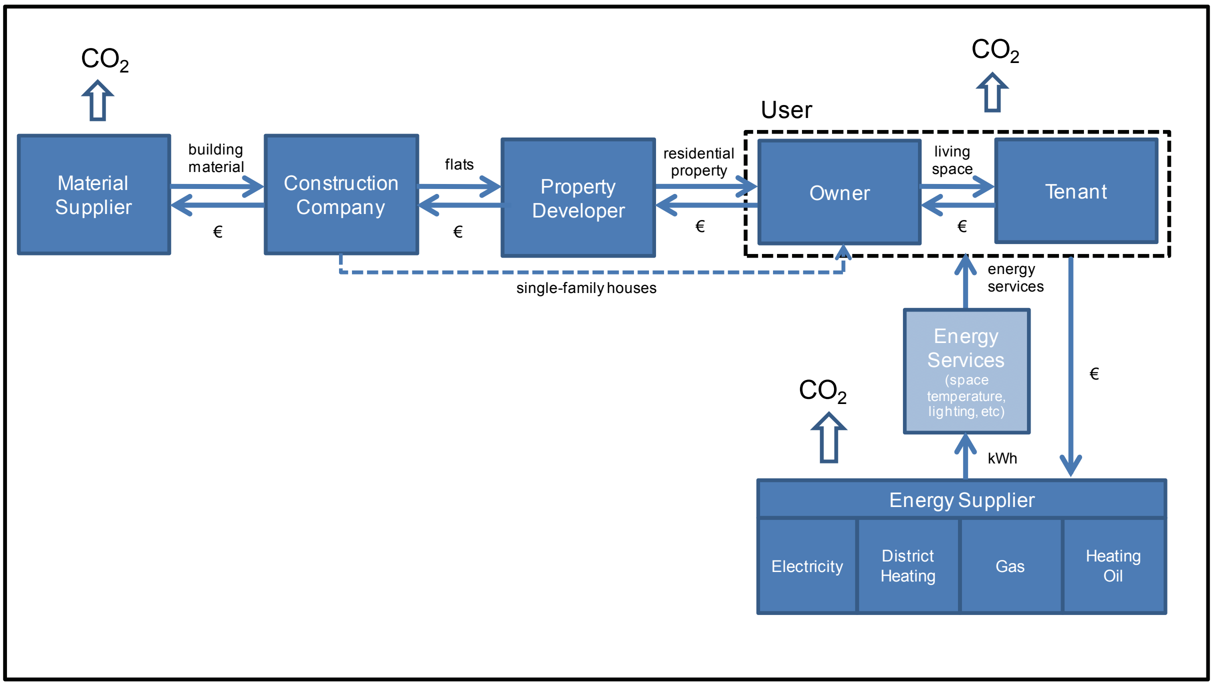
For the design of policy instruments to promote energy-efficient buildings it is crucial to identify technologies with lowest unit abatement costs and largest abatement potentials for the society. Efficient lighting technologies are among the most promising measures in buildings related to cost-effectiveness and size of potential savings in almost all countries. Regarding the extent of savings, improved insulation and district heating in colder climates, and efficiency measures related to air conditioning in warmer climates are the most effective levers. Also solar water heating, efficient lighting, appliances, and building management systems are identified as positive abatement levers.[62]

[62] Levine M. D.et al. (2007).

10.3.1.3 Markets, Transactions, and Actors in the Buildings Market

Energy efficiency in the residential buildings market is influenced by various aspects and conditions. Main actors along the value chain are suppliers of building material, property developers, construction companies, owners of the buildings, tenants, and energy suppliers, as illustrated in Figure 34.

Figure 34: Value Chain of the Residential Housing Market maybe it should be cleared how each group affect increase of CO_2 emissions



Source: Own Illustration.

Energy efficiency should to be addressed at every phase of the building's lifetime: the production of building materials, the construction of the building, and its performance throughout its lifetime. The majority of GHG emissions related to the buildings sector accrue during the production of building materials and – to an even significantly greater extent – during the usage phase of the building. The production of building materials consumes energy, depending on the material type and on the production process of the material. Especially the production of cement and steel causes high CO_2 emissions with abatement potentials related to improvements of the production process. During the usage phase GHG are emitted directly, i.e., through combustion processes at the building site (mainly for space and water heating), and indirectly, i.e., in central plants for generating electricity and providing district heating. GHG emission related to the production of building materials as well as indirect emission caused during the usage phase are already subject to the European Emission Trading System (EU ETS), whereas GHG emitted during combustion processes at the building site (mainly gas and oil fueled heating systems) are not addressed by explicit climate policy measures as yet.

The property developer commissions the construction of the residential building frequently in order to sell the dwellings to prospective owners. Energy efficiency related decisions including the efficiency of the heating system, the type of windows, and the building's resistance to air infiltrations are made by the property developer. Therefore, the property developer decides on the energy efficiency and CO_2 intensity of the building. Speculative developers are mainly concerned with the at tractiveness of the property to potential buyers. Incentives exist to avoid cost intensive investments in highly energy-efficient building components, especially when invisible to prospective buyers. From an economic perspective, energy efficiency choices fundamentally involve investment decisions that trade off higher initial capital costs and uncertain lower future energy operating costs. Decisions about energy-efficient investments require a weighing of the initial capital cost against the expected future savings.[63] The property developer's perspective is to sell the residential building; his objective is to attract buyers related to the buildings price, space, and other aspects visual and relevant to the prospective buyer. In case that the dwelling is constructed without involvement of a property developer, the owner decides on the energy efficiency of the building and the construction company carries out the construction of the building.

The building owner invests in residential housing with equity and – in most cases – debt capital. Capital lenders are predominantly concerned with the risk and return of the investment. Their decision-making is mostly based on financial aspects; energy is normally not sufficiently significant to affect the credit decision. Owners of residential buildings might rent out the living space. Investments in appliances by the landlords are influenced by the price signal of the predicted rent. Yet, the construction commissioner, building owner, and tenant might be the same entity.

End-users request energy services such as heating, cooling, lighting, and motion. Energy services conceptualize energy as an input into the production of desired energy services rather than an end in itself.[64] The quantity of energy services demanded depends on the behavior and customs of the end-user. Energy services are supplied by equipment such as the heating system which is predominantly chosen by the building commissioner and installed by the building constructor. Additional energy services are delivered by appliances and lighting devices, which are partially selected by the user. Efficiency of the installed equipment is, as illustrated in

Figure **35**, determined by the energy services provided divided by the energy input. The majority of end-users pay their energy costs in direct relation to their energy consumption to the suppliers of gas, heating oil, electricity, and district heating. Thus, the tenant as end-user benefits most from energy savings, but is not solely able to invest in devices concerned with energy efficiency.[65] The total sum of energy demanded by the end-user is determined by the consumption of energy services related to space temperature, hot water consumption, lighting, use of other appliances etc, and the energy efficiency of the building and equipment. The calculation of the payment depends on the contractual arrangements, e.g., tariffs related to the square meter of the living space or kilowatt hours of consumption.

[63] Gillingham, K. et al. (2009).
[64] Gillingham, K. at al. (2009).
[65] WBCSD (2010).

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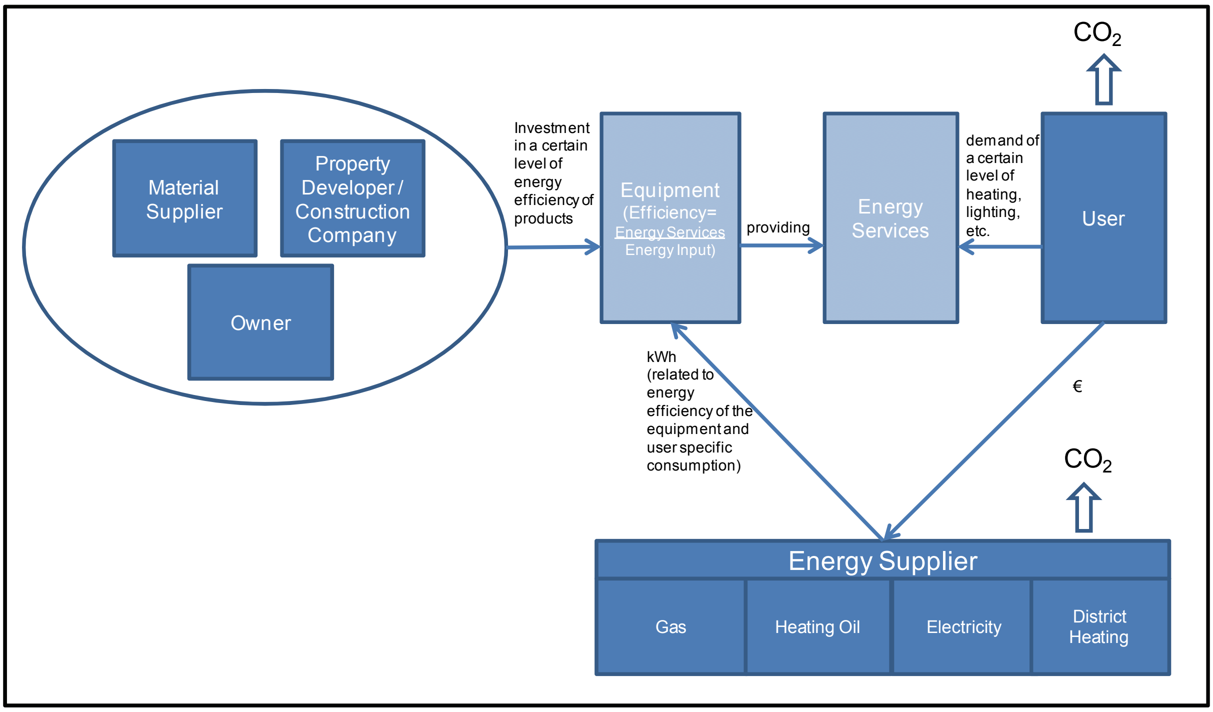
Figure 35: Impacts on Energy Efficiency and Energy Demand



Source: Own Illustration.

10.3.1.4 Legal Context

In the following section existing legislation on EU level as well as national law – using the example of Germany – will be outlined. A further discussion of the regulatory framework is not part of this section since it is depicted in detail in the (external) expert report compiled by Gleiss Lutz.

10.3.1.4.1 EU Directive on the Energy Performance of Buildings (EPBD)

With the Directive on the Energy Performance of Buildings (EPBD) the EU addresses the problem of GHG emissions and energy consumption caused by the buildings sector by introducing minimum requirements for the energy performance of buildings.

In 2002 the EPBD (2002/91/EC) was adopted and obliged its member states to transpose it into national legislation until 2006.[66] The directive obliges its member states to determine a common methodology for calculating the integrated energy performance of buildings, set minimum standards on the energy performance of buildings, implement systems for the energy certification of buildings, and to guarantee the regular inspection of heating and central air-conditioning systems in buildings. The EPBD of 2002 only demanded existing buildings with a more than 1000 square meter to comply with the energy performance standards, so that the majority of the existing building stock was not affected by the directive.[67]

[66] Directive 2002/91/EC.

[67] According to EurActiv (2009) 72% of the existing buildings stock did not have to comply with the requirements and only about 3% of a country's building stock is newly built or renovated.

Due to a lack of qualified experts to issue certificates and carry out inspections as well as a lack of ambition of member states the directive was not fully implemented in all member states until 2006. Therefore, the aim of a new directive was to clarify and simplify provisions and to improve its effectiveness.

In the recast of the EU Directive on the Energy Performance of Buildings (2010/31/EU) the 1000 square meter threshold was abolished, so that all existing buildings undergoing major renovations will have to meet energy efficiency requirements.[68] Furthermore, the new Directive introduces the "nearly zero energy" concept and obliges its member states to enforce that until 2021 all new buildings and until 2019 all new buildings occupied and owned by public authorities meet this standard. However, the "nearly zero energy" concept is not defined by the Directive, leaving member states the opportunity to implement various standards. The 2010/31/EU promotes financial incentives to energy-efficient buildings. It obliges the member states to enlist incentives of technical assistance and subsidies for the transition to nearly zero energy buildings. Moreover, the new directive requires the member states to implement independent control systems for energy performance certificates and inspection reports.

10.3.1.4.2 Legislation to Promote Energy Efficiency in Germany

Energy policy in Germany is primarily in the responsibility of the federal government, predominantly the Federal Ministry of Economics and Technology. The Energy Saving Ordinance (Energieeinsparverordnung – EnEV) can be considered as the most important legal provision promoting energy efficiency in buildings in Germany.[69] With the adoption of the regulation main elements of the EPBD such as energy performance requirements on the basis of a defined methodology for energy performance calculation, and energy certificates were implemented in German law.

In Germany a national standard for the calculation of energy demand was set up with DIN 18599. The calculation method includes the thermal shell, lighting, appliances, heating, ventilation, cooling, and hot water supply. Energy demand of new buildings is calculated according to DIN18599 and for existing buildings the owner can to determine the energy demand of the building either according to DIN18599, too, or based on metered consumption. DIN 18599 does not impose any parameters to meet; it is rather a method to calculate a building's energy performance. The minimum level of energy efficiency performance is determined in the EnEV. The maximum of annual primary energy consumption of a residential building is dependent on various parameters such as its surface, geometry, orientation, etc. The primary energy demand takes into account the amount of fossil fuels needed to cover the total energy demand of the building. Furthermore the EnEV sets minimum requirements regarding the shell of the building with a definition of heat loss parameters.

The Renewable Heating Act (EEWärmeG) which came into force in 2009 mandates the use of renewable energy technologies in new building construction.[70] By this law, newly constructed buildings are required to use renewable energy technologies or sources to meet space and hot water needs from 15% to 50% (depending on the source) of a building's entire energy demand for these purposes. In case that the use of renewable energies is not feasible, compliance with the obligation is also given if a reduced primary energy demand and heat loss coefficient of 15% below the requirements as set out in the EnEV is achieved. The German government also subsidizes the instal-

[68] Directive 2010/31/EU.
[69] EnEV (2009).
[70] EEWärmeG (2009) applies to new buildings with an effective area of more than 50 square meters.

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laion of measures to use renewable energies for heating purposes: The market incentive program was set up to financially support homeowners for the installation and extension of solar panels, pellet ovens, and thermal heat pumps. These subsidies are granted in dependency of the kind of installation and capacity.

The German Kreditanstalt für Wiederaufbau (KfW) has been a main source for funding of energy-efficient buildings since 2001. The KfW as a public-law institution offers programs related to energy-efficient constructions and modernizations, providing loans with favorable interest rates. Buildings with an annual primary energy consumption and heat loss coefficient of 40% (primary energy consumption) / 55% (heat loss coefficient), 55% / 70% or 70% / 85% of the EnEV requirements are being funded.

Moreover, in the Combined Heat and Power Act last amended in 2008, the government supports the installation and modernization of combined heat and power generation to generate higher overall efficiency compared to central power plants.[71] Governmental support is granted with feed-in tariffs per kWh for a maximum of 10 years.

10.3.1.5 Barriers to Energy Efficiency

10.3.1.5.1 Defining the Efficiency Gap

A rational investor minimizes the overall costs for the provision of a given amount of energy services. These costs comprise the initial investments as well as maintenance and costs associated with energy consumption accruing over the entire lifetime of the equipment; future financial flows are discounted to their net present value. An investment in better energy efficiency is made by a rational investor if the additional investment costs are outweighed by the present value of the resulting energy cost savings.

As shown in section 2, several studies identify various energy conservation measures in the buildings sector that are assumed to be cost-effective, i.e., the achievable energy cost savings exceed the implementation costs of the measure. The existence of such potentials for cost-efficient reductions of energy consumption in the buildings sector suggests that the optimal level of energy efficiency is not realized by the market participants as yet. The difference between the optimal and the actually realized energy efficiency level is often labeled the efficiency gap.

One has to distinguish between a narrow or private and a social efficiency gap. The private efficiency gap refers to energy efficiency improvements that are not implemented, although they would be beneficial – given current prices. The presence of a private efficiency gap implies that investors discount energy efficiency investments at discount rates that are not in accordance with "normal" private discount rates usually applied by private consumers. Such high implicit discount rates are supposed to occur not only in building related energy efficiency decisions, but were also calculated for the purchase of other energy consuming goods.[72]

The social efficiency gap refers to the difference between the actual energy efficiency and the efficiency level that would be optimal from a societal perspective. The societal perspective also accounts for external effects, that is costs and benefits that accrue to others than the investor and remain without financial compensation. Such externalities can lead to deviations from the social

[71] KWKG §1 Abs. 1.

[72] See e.g., Howarth, R. B. / Sanstad, A. H. (1995); Dubin, J. A. (1992.); Atonides, G. / Wunderink, S. R. (2001); Moxnes, E. (2004); Hausman, J. (1979); Gately, D. (1980).

optimum even if the buildings market works without frictions and biases (except for externalities), and if market participants in the buildings market act individually completely rational. Externalities distort the price system so that the market mechanism yields results that are regularly not in line with the socially desired outcome.

In this section we will explore possible causes for the opening of energy efficiency gaps. We begin with illustrating the most important negative and positive externalities that may be relevant in the buildings sector with regards to energy efficiency. Subsequently, we will illuminate potential explanations for the private efficiency gap. The next section will evaluate contemplable policy responses to narrow both the private and the social efficiency gap in a social welfare increasing manner.

10.3.1.5.2 Negative Externalities: Energy Market Failures

The pivotal issue in energy market failures is that energy prices do not reflect the true marginal social cost of energy consumption, either through environmental externalities, national security externalities or average cost pricing.[73]

Environmental externalities associated with the production and consumption of many sources of energy lead to emissions of GHG and other air pollutants (e.g., nitrous oxides, sulfur dioxide, and fine particulate matter) resulting in costs that are borne by others than the emitter; that is they are external costs (as they are not internalized by the energy consumer). If an adequate policy is absent, an environmental externality leads to an overuse of energy and an underinvestment in energy efficiency equipment relative to the social optimum.

Although the general existence of environmental externalities is uncontested, there is no widely accepted agreement on their magnitude (and their degree of internalization). With regard to GHG, many economists have attempted to estimate the future damages from global warming.[74] The estimates of the discounted cost of current carbon dioxide emissions range from $20 to $311 per ton of carbon.[75] The large disparities in these estimates are explained to a significant extent by different assumptions regarding the social discount rate; given the fact that most damages occur many decades or even centuries from now, the discount rate has a great impact on the present value of future climate damages.

Some authors – however, mainly in the United States – have suggested that there are national security external costs from the dependence on certain energy sources, particularly oil, from unstable regions of the world. As consumers may not face such costs in the energy prices they would not take them into account in their energy use and energy efficiency decisions.[76] While these concerns are associated primarily with transportation-related consumption of oil, they are also relevant to building-related energy consumption of heating oil (and natural) gas as well as with regards to the link between the natural gas and oil markets. A long-term larger reduction of the consumption of these fossil fuels may reduce the costs related to such national security risks. To the extent these risks are not fully reflected in the price of relevant energy resources, there will be a resulting underinvestment in energy efficiency.

[73] Gillingham, K. et al. (2009).
[74] See e.g., Stern, N. (2006); Nordhaus, W. (2006); Pearce, D. (2005); Tol, R. (2005).
[75] One ton of carbon is equivalent to approximately 3.67 tons of carbon dioxide. Hence, the costs per ton of carbon dioxide range from $5.5 to $85.
[76] See e.g., Harrington, W. et al. (2007); Bohi, D. R. / Toman, M. A. (1996).

Beyond the energy consumption externalities mentioned afore, energetic improvements could entail further external effects. For instance, a better indoor climate may avoid societal costs caused by illness or by loss of earnings. The main focus of our analysis, however, is put on the climate externalities caused by excessive energy consumption.

10.3.1.5.3 Positive Externalities: Spill-overs

Some investments related to energy efficiency exhibit a public good character that often implies a suboptimal provision of the respective good/activity. Public goods are characterized by non-rivalry and non-excludability from their benefits. Particularly the latter characteristic brings about that a certain good will not be provided by the private sector to the optimal extent since the resulting benefits cannot be appropriated entirely to the investor, i.e., they spill-over to others.[77]

10.3.1.5.3.1 Research and Development Spill-overs

Research and Development (R&D) spill-overs, i.e., positive external effects of “green” technology innovations, can lead to a suboptimal extent of R&D investments in energy-efficient products and processes if know-how disperses without adequate compensation. For instance, building equipment manufacturers will invest in energy-efficient and low-carbon products only if they actually receive the benefits from the investments, e.g., in the form of increased demand for their energy-efficient products.[78] If competitors can adopt technological innovations at relatively low efforts and without bearing the costs of the initial investment, there are only relatively low incentives for such dispersing green investments. Conversely, manufacturers may look forward to benefiting from positive spill-overs from their competitors and will therefore omit early investments of their own in energy-efficient technologies. In consequence, the socially optimal level of investment will not be achieved.

Intellectual property rights have been developed to allow more of the benefits from R&D investments to be appropriated by those who fund the investments, thereby strengthening the R&D investment incentives. Yet, such rights can limit the dispersion of the technology, thereby limiting the potential environmental gains. Since a widespread distribution of low-emission technologies results in a reduction of global emission abatement costs, the question arises as to whether the public should (co-)fund such research. However, it has to be recognized that measures such as publicly financed R&D subsidies create their own critical issues. As a rule, government funding of basic research, which is far from actual market maturity and offers a wide range of potential applications, may be easier to justify than the funding of more readily applicable research.

[77] It should be noted that control of climate change and environmental protection as a whole are by their basic character (international) public goods that constitute the need for governmental and intergovernmental environmental policy.

[78] Actually, the social rate of return to R&D investments is estimated to be two to four times higher than the private rate of return. Griliches, Z. (1995); Hall, B. (1996); Nadiri, I. M. (1993).

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10.3.1.5.3.2 Experience-curve / Learning-curve Effects

Experience-curve or learning-curve effects refer to the empirical observation that as cumulative production of new technologies increases, the production costs tend to decline as the firm learns from experience how to reduce its costs. These effects comprise economies of scale and of learning. Economies of scale refer to unit cost reductions resulting from production level increases at which higher operational efficiencies can be achieved and the fixed costs spread over a greater production amount. Learning curve effects usually refer to the phenomenon that unit production costs typically decrease over time. The term learning-curve is sometimes used synonymously with experience-curve, and sometimes learning-curve effects are considered to be restricted to learning effects of the workforce, in contrast to experience-curve effects that comprise learning effects of the whole firm (including technical and product design improvements). Jakob, M. / Madlener, R. (2004) have identified significant experience-curve / learning-curve effects and further cost reduction potentials in the buildings sector.

Table **21** provides an overview of the relative importance of different aspects of experience-curve / learning-curve effects of energy efficiency technologies used for buildings.[79] Beyond cost reductions of energy-efficient products and materials, learning-curve effects may also apply to services related to energy efficiency, e.g., productivity increases of the labor of craftsmen and architects with regard to energy-efficient building projects.

Experience-curve / learning-curve effects do not create a market failure per se, but they can be associated with a market failure if the learning creates knowledge that spills over to other firms in the industry, lowering the costs for others without compensation.[80] Similar to R&D, these experience-curve spill-overs create a greater societal value than the benefits accruing to the firm generating the experience. The existence of such spill-overs can therefore impede or delay the socially optimal uptake of innovative energy-efficient technologies.[81] This problem gains relevance considering that innovative technologies often require a certain market penetration to become economically viable; moving infant industries/technologies to market maturity might be not accomplishable by a single market player without governmental support.

[79] Jakob, M. / Madlener, R. (2004).
[80] Fischer, C. / Newell, R. G. (2008); van Benthem, A. et al. (2008).
[81] Ansar, J. / Sparks, R. (2008).

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Table 21: Assessment of the Actual and Future (until 2020) Cost Reduction Impacts of Selected Investments in Thermal Insulation and Energy Conversion Technologies

Technology categories and selected examples	Learning effects*	Economies of mass production	Economies of plant scale
Building envelope / Heat insulation			
'Traditional' insulation materials (mineral fibres, polystyrene/polyurethane foams)	+	+	+
'Traditional' window glazing (double/triple)**	+	+ (double) ++ (triple)	+
Innovative window glazing (vacuum- or foil-based)	++	+	+
Design and on-site application of insulation materials, components, and auxiliaries	+++	++	+
Pre-fabrication of construction elements (e.g. walls and roofs for wooden buildings)	++	++	+
Window frames (compound materials)	+++	++	+
Passive energy houses	+++	++	+
Vacuum insulation elements	+++	+++	+
Energy conversion			
Boilers, burners	++	+	+
Air renewal systems with heat recovery	++	++	+
Heat pumps	++	+++	+

* Assuming targeted searches for efficiency improvement potentials.

** Improvements concern mainly the optimisation of the ratio between solar energy gain and thermal conductivity/heat loss; further heat loss reductions of the glass can only be achieved with innovative window glazing.

(+++ = major, ++ = medium, + = minor)

Source: Jakob, M. / Madlener, R. (2004).

There is a further type of positive learning externalities that can amplify the impact of governmental programs to support sustainable and energy-efficient building procedures. Spill-overs associated with learning-by-using can exist where the adopter of a new energy-efficient product creates knowledge about the respective product through its use; others may freely benefit from the information generated about the existence, characteristics, and the performance of the product.[82] Learning-by-using spill-overs can be distinguished into free-drivers and program spill-overs.[83] Free-drivers are non-participants of a (governmental) efficiency support program who nevertheless install energy-efficient products due to hearing about them from program participants. Program spill-overs occur when the household participating in a support program installs – beyond the supported goods – additional energy-efficient products, without financial support, due to the information they learned through participation in the program.

Ultimately, the problem of socially suboptimal investment levels due to both types of positive externalities, R&D and experience-curve / learning-curve spill-overs, traces back to the existence of transaction costs. In theory, it is conceivable that the innovating firm conclude contracts with all other benefiting firms, arranging for financial compensations for the spill-over innovation benefits. Similar agreements could theoretically be designed for experience-curve / learning curve spill-

[82] Gillingham, K. et al (2009).

[83] Blumstein, C. / Harris, J. (1993); Eto, J. et al. (1996).

overs. Firms and investors that enable future cost reductions through their present investment in energy-efficient technologies – which are currently possibly still more expensive than "conventional" buildings – enter into an agreement with all potential future beneficiaries of now induced future cost reductions. Upon actually benefiting from the early energy efficiency investment the later beneficiaries of the experience-curve / learning-curve effects have to pay a financial compensation to the "early investors". Thereby the positive externalities would be internalized and an efficient level of R&D investments and technology uptake could be achieved. Yet, it is obvious that such an internalization of the R&D and experience-curve / learning-curve spill-overs founders on the prohibitively high transactions costs of the necessary agreements between a multitude of parties. Thus, environmental policy has to take appropriate action to incentivize the socially optimal level of energy efficiency technology uptake and R&D efforts.

10.3.1.5.4 Information Problems

In order to take an optimal decision on the energy efficiency of an energy consuming durable good – ranging from small household appliance to the building envelope – the investor needs sufficient information about the initial investment as well as the future operating costs of the available alternatives. A lack of such cost (and performance) information may lead to suboptimal efficiency levels. If the investment costs of more-efficient and less-efficient variants are well visible while the operating costs are very vague, investors will tend to opt for the good with the lower upfront payment that regularly entails a lower efficiency level.

Information problems can trace back to different causes. First, the required information is generally not available; this situation will be analyzed in more depth in the subsection on uncertainty. Second, the information is available, but distributed asymmetrically between parties; this is part of the split-incentive problem. Third, the necessary information for an optimal decision is in principle acquirable, but the acquisition and processing of the information comes at a cost. We will now start to evaluate the related implications of the latter case in the subsection on bounded rationality.

10.3.1.5.4.1 Bounded Rationality

In a market without transaction costs and with perfectly rational actors, merely pricing of carbon emissions would ensure that the market participants choose the optimal energy efficiency level for their buildings. Under consideration of all available information, they will invest in the efficiency level that minimizes the sum of the initial investment and the discounted operating cost, mainly fuel costs, occurring over the building's life-time. Yet, given the complexities of real world decisions as well as the existence of transaction costs, time constraints, and limited information processing capacities, the concept of bounded rationality seems to be more realistic to describe human behavior than perfect rationality.[84] If investors or consumers have to take a complex multidimensional decision, they cannot optimize on each variable at reasonable cost. Rational consumers will balance the potential benefits against the effort and time costs of making a precisely optimal decision; after reaching a certain level of the respective investment good characteristic that is considered acceptable, no more effort is invested in further optimization. This behavior – called satisficing behavior – is rational from the individual's perspective as benefits from further optimization are more

[84] The concept of bounded rationality goes back to Herbert A. Simon. See Simon, H. A. (1957, 1972, 1976).

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than offset by the transaction costs of coming to an optimal decision. However, from the social perspective such individually rational behavior may be undesired, because the deviation from the optimum in each individual decision could accumulate to a significant loss in social welfare.

For instance, when purchasing an owner-occupied flat the prospective buyer has to decide on a variety of attributes such as price, size, floor plan, neighborhood, interior design, comfort level, equipment, energy efficiency, and more. Instead of investigating each attribute in every detail, the buyer will choose a flat that satisfies his minimum requirements in each category and performs rather well in categories of higher importance for him. The energy efficiency level of the chosen flat may then be lower than if there were no restrictions on the information processing capacity.

The concept of heuristic decision making is closely related to bounded rationality and also encompasses decision strategies that differ from unbounded rationality. Surveys find that consumers' use of simple heuristics lead to overconsumption of energy and underinvestment in energy efficiency.[85] Underinvestment might also stem from the salience effect, according to which consumers give disproportionate decision weight to well observable attributes of an investment object.[86] If the initial investment costs are considerably more salient than future energy costs, overemphasis may be given to the initial cost.

If such a collective deviation from the optimum entails substantial welfare losses, a centralized assessment of crucial attributes – here energy efficiency – by public authorities, which possibly have better expertise and more funds at their disposal, can be reasonable; a subsequent regulation based on the acquired expertise could yield all-in-all net gains in social welfare, although the individual freedom of decision is restricted.

10.3.1.5.4.2 Split Incentives

Generally, split incentives occur when participants in an economic exchange have different goals or incentives. The landlord-tenant-problem is a typical example for split incentives that can lead to less than optimal investment in energy efficiency. The landlord provides the tenant with a certain level of energy efficiency (insulation, water boilers, appliances, etc.), but the tenant is responsible for paying the energy bills. In this case, landlords and tenants face different goals: the landlord typically wants to minimize the capital cost of the property (implying reluctance to make investments in better energy efficiency), while the tenant strives to minimize the operational costs, mainly the energy costs (that are determined by the consumption of energy services and the energy efficiency level).

This constellation is also referred to as a principal-agent problem: A principal (here the tenant) pays an agent (here the landlord) to provide some good or service (here living space). The principal-agent theory assumes self-interested behavior of the agent. Thus, the landlord has no incentive to make efficiency investments because only the tenant benefits from the reduced. A further central assumption of principal agent problems is that information is distributed asymmetrically. Information asymmetry exists when one party to an economic transaction holds more information than the other party.

In case of fully informed, i.e., in absence of information asymmetry, and perfectly rational economic actors, split incentives would not entail the choice of suboptimal energy efficiency levels on the part of the agent. If fully informed about the future operating cost, the tenant would choose

[85] Kempton, W. et al. (1992); Kempton, W. / Montgomery, L. (1982).
[86] Yates, S. / Aronson, E. (1983); Wilson, C. / Dowlatabadi, H. (2007).

a flat that minimizes the sum of rent and energy payments. The landlord would anticipate the tenant's choice and invest in the overall cost minimizing energy efficiency level; otherwise, the landlord is squeezed out of the rental flat market by its competitors. In the presence of asymmetric information adverse selection may take place.[87] If agents who install highly efficient building components and equipment are unable to fully transfer the information on prospective energy cost savings to the principals,[88] underinvestment in energy efficiency will be the consequence. Potential tenants will not be willing to pay higher rents if they cannot validate the agents' energy consumption specifications; thus, landlords would have problems to recoup their energy efficiency investments.

An asymmetric distribution of relevant information may not always result from the unwillingness or inability to transfer the information, but also from transaction costs of transferring and evaluation of the information.[89] For instance, a potential tenant could request an energy pass or obtain information on the energy costs of the previous tenant, but these may diverge from his prospective energy costs due to different energy consumption patterns. In the latter example, the ex-ante existing information asymmetry vanishes ex-post, after the tenant gets the first energy cost billings. Yet, this ex-post clearness does not solve the split incentives problem: Even if the operational costs turn out to be higher than expected, the tenant will not always sanction the landlord with move-out as a tenancy changeover is associated with significant (transaction) costs. Hence, the presence of ex-ante information asymmetry in combination with diverging incentives between principal and agent lays the foundation for insufficient investments in energy efficiency.

The principal-agent problem related to the landlord-tenant constellation and its implications for energy efficiency apply in similar way to newly constructed buildings. In this situation the property developer is the agent that makes many energy-related decisions, including the insulation quality, the efficiency of the heating system and of the windows, and the building's resistance to air infiltration. The buyer of a turn-key dwelling is the principal who will pay the energy bills. Since the more energy-efficient alternatives usually increase the construction cost, the property developer has certain incentives to avoid these measures, particularly if the benefits of the measures are hardly visible to prospective buyers.

Table 22 gives an overview of potential split incentive problems in the housing market. In case 1 the principal and the agent are the same. The person or entity that decides on the energy efficiency of the building also pays the subsequent energy costs. In absence of other market barriers, the investor will choose an optimal energy efficiency level that minimizes the sum of initial investment and (discounted) operating costs. Case 2 represents the landlord-tenant-problem and property developer-buyer-problem described afore. In case 3 the building user does not pay for its metered energy consumption, but a lump sum energy charge is included in the rent.[90] This implies a twofold incentive to waste of energy. On the one hand, users are tempted to overuse energy services; they consume more energy services than they would if they faced the actual marginal cost of their consumption. On the other hand, when purchasing energy consuming equipment, users will not be willing to invest in higher energy efficiency as they do not benefit from the achievable energy cost savings. They will rather strive for good performance in other product characteristics or a low pur

[87] Akerlof, G. (1970).
[88] On the other hand, landlords of properties with poor energy efficiency performance will be interested to disguise the true expected energy costs. For instance, they might – as far as legally possible – set the energy cost prepayment lower than the actually expected energy costs in let the apartment appear more attractive.
[89] For a formal model of the impact of transactions costs of information transfer on underinvestment in energy efficiency see Howarth, R / Andersson, B. (1993).
[90] In the United States, it is not unusual that the building owner pays the energy bills while the users of apartments and condominiums pay a lump sum charge for their energy consumption to the building owner.

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chase price. Case 4 refers again to a situation in which the user pays a lump sum energy charge instead of being charged for its actual, metered energy consumption, but the decision on the energy efficiency is now taken by the provider of the living space.[91] While the users have an incentive to overuse energy services similar to case 3, the building owner will tend to "overinvest" in energy efficiency performance. This overinvestment is a reaction to the overuse incentives faced by the users; by installing highly efficient technologies the building owner attempts to minimize the energy input (and the related energy costs) for the excessive consumption of energy services. In the economic optimum, the level of energy service consumption as well as the installed level of energy efficiency would be lower than those realized in case 4.[92] In the analysis of policy instruments we will focus on the situation represented by case 2.

Table 22: Split Incentive Problems in the Housing Market

	End-user chooses energy technology	**End-user does not choose the energy technology**
End-user pays the energy bill	Case 1: No split incentive problems	Case 2: Underinvestment in energy efficiency
End-user does not pay the energy bill	Case 3: Overuse of energy services, underinvestment in energy efficiency	Case 4: Overuse of energy services, overinvestment in energy efficiency

Source: Own Illustration.

10.3.1.5.5 Uncertainty

10.3.1.5.5.1 Risk Aversion

Another potential investment barrier related to information problems is uncertainty combined with risk aversion.[93] Risk-averse decision makers demand a higher rate of return in case that the future financial flows of an investment are uncertain. This uncertainty induced rise of the discount rate reduces the investment's present value, implying a lower probability of its actual realization. In the field of energy efficiency investments several uncertainties are present, e.g., prospective energy prices, future climate policy, actual performance and service life of the investment, etc; yet, not all of these uncertainties provide arguments in the same direction.

At a first glance, the most salient uncertainty relates to future energy prices. The risk of drastic energy price increases argues for better energy efficiency of the building to be invested in. The additional upfront cost for improved efficiency properties of the building could be interpreted as a premium for an insurance against energy price risks. The energy price risk also encompasses

[91] As in case 3, this situation may be given again for apartments and condominiums in the United States. While case 3 mainly applies to the use and purchase of electric appliances, case 4 rather applies to building-wide investment decision such as the implemented insulation level or the installed heating system.
[92] IEA (2007) provides a comprehensive overview of principal-agent problems in energy efficiency.
[93] The here discussed uncertainty problem deals with the implications of the unavailability of relevant information, while the previous section explored the asymmetric distribution or insufficient processing of generally available information.

climate policy risks if they are linked to the costs of energy consumption, e.g., uncertainty regarding the imposition of additional energy/carbon taxes or the inclusion of heating oil/gas consumed in households into the European carbon trading scheme.

Figure 36: Price Development of Imported Energy Carriers (excl. tax)

Source: BMWI (2009).

However, there are other uncertainties that provide rational explanations for reluctance to bear higher upfront costs in exchange for better energy efficiency. We start with regard to the intertemporal nature of the decision. The randomness of the physical/economic service life of the investment or the entire building gives argument for the purchase of a cheaper and less efficient endowment.[94] If the actual lifetime is variable around a certain expected lifetime, the expected net present value of an investment in better energy efficiency is lower than for a deterministic lifetime. The rationale behind this argument is that the loss incurred by an early failure – requiring an early replacement investment – is discounted less than the benefit from a late failure, assuming any positive discount rate. This effect also occurs if the lifetime probability distribution as perceived by investors is identical for both “conventional” and energy-efficient residential buildings: The latter imply a higher share of capital costs to be paid upfront, while “conventional” buildings have a higher share of operational costs.[95] The higher the (perceived) variance of the lifetime probability distribution, the greater is the magnitude of this effect. It is important to emphasize that a reluctant attitude towards investments with uncertainty regarding their lifetime is rational for any con

[94] Kooreman, P. (1995, 1996).
[95] Of course, this effect is amplified if consumers attribute higher lifetime volatility to innovative and less established technologies.

sumer with a positive discount rate, widely independent from the consumer's attitude towards risks.[96]

Beyond this discounting effect, a variable service life renders an efficiency investment less attractive for a risk-averse investor since uncertainty regarding the net present value increases with an uncertain length of the payoff period. In this respect, the service-life does not necessarily equal the physical lifetime of the building or of the installed efficiency equipment. The same consideration takes effect, i.e., limited incentives to invest in efficiency measures if potential investors are uncertain about the duration of their stay in the building and doubt that the property market will incorporate the investment adequately in the resale price.

Another uncertainty often mentioned in the energy efficiency literature refers to possible deviations of the actual technical performance of the investment from the expected performance. Uncertainty regarding the actually achievable energy savings undermines the insurance function of an energy efficiency investment, thereby weakening its appeal to risk-averse investors.[97]

Whether, to what extent, and into which direction these uncertainties influence an investors decision regarding the implementation of energy efficiency measures depends on the economic impacts and the (perceived) probability distribution of the risks as well as on the legal and market circumstances.[98]

It has to be noted that the previously mentioned risks and uncertainties are not independent from each other. In particular the energy price risk and the lifetime risk are correlated; the longer the actual lifetime, the greater is the amplitude of possible energy prices.

10.3.1.5.5.2 Option Value

In the previous section we focused on the attitude of risk-averse investors towards several uncertainties related to energy efficiency investments. The concept of option values, in contrast, is independent from risk-aversion. According to option value theory it may be rational to delay an investment in energy efficiency even if its net present value is positive. [99] Many investments in higher building efficiency – such as better thermal insulation or solar panels – are characterized by irreversibility, i.e. the investment costs cannot be regained or only at very high discounts. In combination with the already mentioned uncertainties this implies that waiting for additional information provides the decision-maker with the possibility of obtaining even higher net present values. A short hypothetical example can illustrate the concept of option values: Given current, recently increasing – yet highly volatile – heating oil prices, the investment in a solar thermal heating system may have a positive net present value. However, delaying the investment would allow observing the future price trend and incorporating that information in the investment decision. If the prices stabilize or further increase, the investment is made; if the energy prices drop back to a level that renders the solar panel not beneficial anymore, the investment is waived. The expected presente value of taking the decision after receiving more information is greater than the expected present value of an immediate investment; the delay provides an option[100] value to the investors.

[96] The previous argument holds true also for risk-neutral investors. Only for very risk seeking individuals an increase of the lifetime variance could be welfare utility increasing, i.e., in cases where the discounting effect is dominated by a strong risk preference.
[97] Uncertainties regarding the actually achievable energy savings that stem from changed circumstances (e.g., climate, number of household members, etc.), on the other hand, amplify the insurance function of energy efficiency investments.
[98] For instance, legal obligations for extensive warranties may reduce the lifetime and performance risks.
[99] Hassett, K. A. / Metcalf, G. E. (1993); Metcalf, G. E. (1994).
[100] The investor keeps the option to undertake the investment or not until having a better informational basis.

Yet, the option value argument presented afore is rather valid for energetic refurbishments than for new buildings. In case of a refurbishment the building does already exist and can be used relatively independent from the decision to implement an energetic improvement measure; thus, the investor is freer in its decision on the time of a refurbishment. With new buildings the case is different, because the point of time for the investment in better energy efficiency cannot be chosen as discretely: If the general decision to construct a building is already taken, the time for the investment is somewhat pre-determined since it is substantially more expensive (up to a factor of 3) to install thermal insulation subsequently.[101] Therefore, the highly efficient insulation measures should be carried out with the initial investment or – if not done at the time of construction – not until the first major renovation; an energetic refurbishment soon after the initial construction of the building will be hardly economical.

Reluctance to energy investments or their delay due to risk aversion and option value may be fully rational from an individual investor's perspective and does not per se justify policy interventions in the buildings market. Nevertheless, in combination with other market barriers (e.g., positive externalities) the investment reluctance induced by uncertainty could give reason for environmental policy to take action. Moreover, by means of coordinating and bundling individual risks public policy can reduce the uncertainty of individual investors; assuming a lower risk aversion of the public than of individual investors such risk redistribution may be social welfare enhancing.[102]

10.3.1.5.6 Capital Market Imperfections

Capital market imperfections that hinder access to appropriate financing can be an important barrier to investment in energy efficiency technology.[103] If potential investors lack access to credit financing at reasonable conditions, they may be forced to choose less energy-efficient technology than they would have chosen if they had sufficient funds at their disposal. Generally, it is more costly for an individual residential builder or flat buyer to get access to debt capital than for large businesses.[104] However, higher financing costs for private investors are not necessarily a market failure; they may just represent higher credit default risks and higher administrative costs.

Yet, in coincidence with other market failures – in particular information problems – liquidity constraints can make a case for policy interventions. In a world of perfect information investments in better energy efficiency should increase the resale value of a building and – if the resulting energy cost saving exceed the annualized investment costs – increase the borrowers financial ability to repay the loan. In reality – characterized by information deficiencies as well as transaction costs of information gathering, transferring, and processing – these links are not warranted. Especially for institutions that are unfamiliar with energy efficiency investments it can be difficult to quantify all of the benefits from the investment. Excessive interest rates or unavailability of sufficient funds resulting from such capital market imperfection can inhibit the achievement of the optimal energy efficiency level.

101 Jakob, M. (2006).

102 For instance, fixed feed-in tariffs that are paid by the entirety of electricity consumers reduce the risk of investors in renewable electricity generation systems.

103 Blumstein, C. et al. (1980).

104 Higher financing costs are not necessarily due to higher interest rates as these also strongly depend on the loan securities, but the transaction costs of the credit financing – relative to the amount of the loan – will regularly be higher than for large businesses.

For instance, in case of asymmetric information where potential investors are unable to transfer information to their lenders about the relative certainty of energy cost savings from an efficiency investment, the borrowers will have to pay higher interest rates than economically justified.[105] Facing these increased interest rates, builders will underinvest in energy efficiency. If the lender does not expect that an investment in improved energy efficiency is reflected in a higher attainable resale price of the building, he will not raise the available mortgage loan; thus; the borrower might not be able to finance the investment due to lacking capital even if the generated energy cost saving would suffice to pay for higher interest rates.

10.3.1.5.7 Behavioral Anomalies

As recognized, the decision on the energy efficiency of a building is an intertemporal decision problem involving several uncertainties. In the traditional neoclassical manner such a problem would be analyzed by means of expected utility theory: Consumers decide between different final outcomes that are discounted to their present value and weighed with their respective probabilities. However, the evolving field of behavioral economics – drawing on cognitive psychology and other disciplines – found in vast empirical and experimental evidence that human behavior often proves to be not in accordance with traditional theory. We will now assess the implications of this alternative view on consumer behavior on investments in energy efficiency in order to derive potential justifications for regulatory interventions.

A major supposition of behavioral economics is that people think of different prospects usually not in terms of final states of wealth (as done by classic microeconomics), but rather in terms of gains or losses, measured around a certain reference point.[106] In the consumers' valuation losses loom larger than gains, i.e. they are loss aversive. Furthermore, the decision weights consumers attribute to certain outcomes do not equal their objective probabilities: moderate and high probabilities are underweighed compared to certain outcomes. This so-called prospect theory gives a first hint towards the presumed relatively low valuation of energy efficiency. Consumers attribute a relatively great disutility to the certain loss of the upfront payment for better efficiency technologies, while they give a relatively low utility value to the likely outcome of substantial future energy cost savings that could well yield net gains by more than recouping the initial investment costs.

The aversion to losses as well as the preference for certain outcomes have further implications for a multi-dimensional decision such as the choice of a new owner-occupied flat. The consumer normally does not decide between flats that are exactly identical except for their energy efficiency, but they can choose between flats with a variety of different features (size, interior design, floor level, price, etc.). Thus, forgoing rather certain flat attributes (e.g., a balcony, additional room, large windows) in exchange for more uncertain energy cost savings appears unattractive to consumers; this holds particularly true if the consumers have already adopted such amenities into their reference point so that an abandonment of these already anticipated attributes is framed as a loss. [107]

[105] Golove, W. / Eto, J. (1996).
[106] The following is essentially based on the theory of prospect and its implications. See e.g., Kahnemann, D. / Tversky, A. (1992, 1984, 1979); Tversky, A. / Kahnemann, D. (1986); Thaler, R. H. (1999, 1980); Kahnemann, D. et al. (1991).
[107] Greene, D. L. et al. (2009) make that case for the choice of supposedly too low levels of vehicle fuel economy.

So far we merely focused on the implications of behavioral economics on the uncertainty component of the energy efficiency decision. Yet, with regard to the intertemporal choice component, anomalies in consumer behavior – i.e., deviations from discounted utility theory – can be also observed, many of them similar to those described in prospect theory.[108] Analogously, the individual investor does not integrate new alternatives with existing plans, but the alternatives are rather valued isolated as gains and losses measured against a reference point; hence, the valuation of future payments and other (dis-)utility providing events is greatly context dependent. Two properties of this approach to explain human behavior in intertemporal decisions are of particular importance for the realized level of energy efficiency. First, future losses are discounted at a lower rate than future gains. Second, the discount rate of future payments depends on their magnitude; the lower the magnitude of the payment, the greater is the applied discount rate.[109] The return to an investment in better energy efficiency accrues in the form of relatively small savings on the energy bill, distributed over many years. These savings – framed as gains compared to the reference scenario without the efficiency investment – are therefore discounted at a relatively high discount rate. Consequently, their present value appears lower than standard discounted utility theory suggest; the investment in improved energy efficiency seems relatively unattractive to the potential investor.[110]

This behavioral anomalies depicted afore apply primarily to consumers and individual investors. Although studies suggest that firms and professional investors might be subject to the same biases, competitive forces serve to moderate the significance of these behavioral anomalies.[111]

Finally it has to be noted that it often proves difficult to disentangle the effect of the behavioral anomalies described afore from the impact of the market barriers depicted in the previous sections; rather the combination of several market barriers that may interact and interfere with each other than a single explanation may determine the actually observed consumer behavior in energy efficiency markets.

10.3.1.5.8 Conclusions

This section depicted a variety of potential market barriers that can potentially impede the uptake of energy-efficient technologies in the buildings sector, thereby explaining the postulated efficiency gap. Yet, not all of the discussed potential market barriers are market failures in a sense that they necessarily call for correction through governmental policy interventions. For instance, risk costs are real costs to prospective investors and may justify their reluctance to acquire energy-efficient goods associated with uncertainties and higher upfront costs.

While risk costs may be reduced to a certain degree by governmental action, there are costs that are hard to influence by environmental policy and that constitute actual private as well as social cost; attributing these costs to further open the efficiency gap would be misleading. For instance, technology adoption costs are a cost component that is often overlooked in engineering-driven cost-effectiveness calculations. It is by no means costless to learn how an energy-efficient technological improvement fits into one's home or to learn about reliable suppliers; thus, the purchase

[108] Loewenstein, G. / Prelec, D. (1992); Frederick, S. et al. (2002); Loewenstein, G. / Thaler, R. H. (1989).
[109] Thaler, R. H. (1981); Holcom, J. H. / Nelson, P. S. (1992).
[110] This argument may remain valid even if the efficiency equipment is not purchased with a down-payment, but by means of an installment purchase. If the installment payments and the energy cost savings, which are uncertain in their magnitude, are accounted/evaluated separately, the expenses for the investment will be discounted at a lower rate and therefore loom larger than its benefits.
[111] Shogren, J. / Taylor, L. (2008).

price of a new product is only a lower bound on its entire cost. Another fully rational explanation for a slower uptake than suggested by economic-engineering studies is provided by the possibility that qualitative attributes of new technologies may make them less desirable than existing, less efficient technologies. For instance, buildings that are highly insulated and widely resistant to air infiltration may have an increased susceptibility to mold; another example is the difference in hue between fluorescent and incandescent lighting.[112]

Nevertheless, there remain market barriers that give reason for policy interventions, although it has to be noted that these interventions also come at a cost; rational environmental policy has to balance benefits and costs of policy action. If the purpose of an efficiency gap analysis is to identify desirable government policy measures, then it is necessary to know whether the market barriers that cause slow uptake of energy efficiency technologies can be mitigated by government intervention in such a way that the overall welfare is improved. In this light, the optimal level of efficiency is that which is consistent with efficient overall resource use, including efficient use of government resources required for the implementation of environmental policy. In the next section, we will assess the most important potential policy instruments for the buildings sector in this regard.

10.3.1.6 Policy Instruments to Increase the Energy Efficiency in the Residential Buildings Sector

10.3.1.6.1 Assessment Criteria

For an overall assessment of potential instruments for cutting emissions in the buildings sector different assessment criteria are relevant. First of all, policy instruments should be economically efficient so that no unnecessary burdens are placed on the economy. At the same time, they should be environmentally effective, i.e. yield significant and controllable reductions in energy consumption and CO_2 emissions; this also includes that CO_2 emissions do not leak from activities covered by climate policies to activities not covered. If an instrument is considered both economically efficient and environmentally effective to a sufficient extent, the political feasibility of an instrument is decisive for its actual implementation. The political feasibility of a policy measure is, among other things, determined by its distributive effects, i.e., who has to bear the costs and who may benefit. Each of these criteria is of vital importance for the development and assessment of a climate policy strategy for the buildings sector. However, in the instrument analysis in this section we will focus on those criteria which are particularly relevant for the respective instrument.

10.3.1.6.1.1 Economic Efficiency

To evaluate the regarded policy measures according to the criterion of economic efficiency different sub-categories have to be analyzed: The cost directly incurred in reducing energy consumption and CO_2 emissions (static efficiency), but also the costs of establishing and enforcing regulation (transaction costs) as well as non CO_2 effects induced (side effects). Furthermore, the capability of inducing innovations directed to low-carbon technologies (dynamic efficiency) is part of the overall economic efficiency.

[112] Jaffe, A. B. / Stavins, R. N. (1994b).

10.3.1.6.1.1.1 Static Efficiency

Static efficiency is achieved if a given environmental target, here a certain reduction of energy consumption and CO_2 emissions from the buildings sector, is reached at the least possible macroeconomic costs. For the criterion of static economic efficiency we only refer to costs (and benefits) directly related to the reduction of energy consumption and CO_2 emissions. Besides costs for technical modifications, this also includes changes in the energy and operational costs over the lifetime of the building.

10.3.1.6.1.1.2 Transaction Costs

Beyond the costs immediately linked to energy saving activities there are also costs associated to the regulation itself. These transaction costs are the costs incurred through the establishment of institutional and contractual arrangements for the implementation of environmental regulations. The transaction costs accruing to the regulator for instance include costs for the introduction of climate policy instruments as well as control and enforcement costs, which are the costs of making sure that the regulated parties conform to the regulation and costs of taking appropriate action if this turns out not to be the case. The transaction costs borne by the market participants subjected to climate policies include search and information costs, bargaining and decision-making costs, and adjustment costs. Transaction costs are a crucial criterion in assessing environmental policies as the assets of a statically efficient but complicated regulation may be outweighed by disproportionate transaction costs.

10.3.1.6.1.1.3 Side Effects

This criterion covers effects that result from an environmental regulation, but are not in the primary scope of the regulation. These effects are either unintended, e.g., due to imperfect foresight of the regulator, or at least deemed acceptable for achieving the primary goals of the regulation. Regulators might also strive for these side effects as minor targets. Thus, side effects can provide utility as well as disutility. Examples of the former might be improved living comfort through stable room temperature or reduced exposure to external noise; examples of the latter might encompass excessive interior humidity in well sealed buildings or perceived discomfort of the suggestion not to open windows in passive houses.[113]

Alternatively, side effects could be included in the static efficiency criterion, if this criterion is defined in a broader sense. Eventually, one has to include all costs and benefits of an environmental policy instrument in the assessment process.

10.3.1.6.1.1.4 Dynamic Efficiency: Incentives for Environmental Innovation

While the static efficiency criterion focuses on cost minimization at a certain point in time, dynamic efficiency evaluates the capability of a policy instrument to induce environmental innovation for the purpose of lowering abatement costs in the future. In other words, static efficiency implies equalizing the current marginal abatement cost of different market participants, while dynamic ef-

[113] See e.g.,Jakob, M. (2006).

ficiency aims at lowering them through the improvement of reduction technologies. In order to achieve such improvements, environmental policy instruments have to provide appropriate incentives for the development and implementation of innovative technologies. To induce technical progress, innovators have to benefit to an appropriate extent from their efforts; a dispersion of the innovation benefits without compensation to the innovator weakens the incentives for R&D investments.

10.3.1.6.1.2 Environmental Effectiveness

In assessing environmental regulations, economic efficiency is not the only consideration, but it is also important whether a specific instrument is capable of achieving its environmental targets. This is a major issue especially for pollutants with critical threshold levels or if there are politically binding target levels for the emissions reduction (for instance the Kyoto targets). The environmental effectiveness criterion therefore evaluates the absolute magnitude of emission reductions and particularly the precision of an instrument in controlling emissions. Typically, environmental effectiveness also includes the ability to control the spatial and temporal distribution of emissions or emission reductions. However, as carbon dioxide affects the atmosphere by accumulation, the problem of spatial and temporal hotspots is negligible; for climate change policy the limitation of absolute global CO_2 concentrations in the atmosphere matters.

10.3.1.6.1.3 Substitution and Leakage

Even if a policy measure's immediately targeted objective – in terms of energy savings or CO_2 reductions – is achieved, it may happen that only modest improvements to the global climate ensue due to substitution and leakage effects. An activity causing emissions that is avoided as a result of environmental policy might be substituted by another activity that is just as environmentally harmful but not covered by environmental policy measures; this may comprise a sectoral shift or a spatial shift of emissions to countries without an equivalent environmental policy regime.[114] The above criterion of environmental effectiveness applies only to the emissions a policy measure directly regulates,[115] but it does not focus on global emission impacts. Therefore, environmentally counterproductive adjustment reactions outside the direct scope of the regulation have to be considered when assessing policy instruments. To distinguish the leakage and side effects criteria from one another, it is important to note that leakage covers solely a shift of emissions of the same type – in this case CO_2 – from regulated sources to not regulated emission sources.

10.3.1.6.1.4 Distributive Effects

Generally, environmental policy has a distributive impact as well. As emission reductions are regularly not costless, for the development of well-balanced policy strategies an assessment of potential winners and losers of specific policy packages is needed. The essential groups within an economy, who eventually bear the cost of regulation or may benefit from it, are property developers, building owners, tenants, building companies, and energy (service) suppliers. One has to regard the

[114] Especially the latter case is an issue intensively discussed in the context of the European Emission Trading Scheme (EU ETS). Energy-intensive industries with a high sensitivity to high carbon prices, for instance the cement and steel sectors, are particularly vulnerable to leakage of emissions to Non-ETS-countries.
[115] Here the emissions of the buildings sector.

distribution between these groups and within these groups. Regarding these distributive dimensions policy makers should always strive for a well-balanced burden-sharing in order to improve the acceptance of policy measures. In turn, this criterion gains particular importance if burden-sharing is very lopsided or if it leads to a significant asset re-distribution. Of course it is always true that the higher the absolute burden, the more important is its distribution. As regulatory measures should increase overall welfare, a (partial) redistribution of these gains might contribute to the reduction of distributive conflicts, even if the design of incentive compatible redistribution schemes might not be an easy task.

10.3.1.6.1.5 Political Feasibility

The distribution of costs is a major determinant for the political feasibility of policy measures. Even measures with favorable efficiency properties will be hardly viable in the political process if their distributive effects are perceived to be unfair. Lobbies of disproportionately burdened groups may be willing and able to influence the public opinion and policy makers in favor of their interests.[116] Furthermore, instruments that require considerable changes of behavioral patterns may also suffer from lacking public acceptance, which could hamper their realization. Beyond public acceptance, emission reduction measures have to be in line with current legislation at the national and the European level, with WTO law, and with international climate treaties. If legal conformity is not given and modifications of the respective legal norms are not achievable, the policy instrument is outside the scope of feasible policies.

Hence, political feasibility is eventually an essential criterion for policy analysis as each instrument – irrespective of its theoretical characteristics – has to conform to the relevant legal norms and it needs to be acceptable to the public in order to have a chance of actual implementation.

In the following, the most relevant policy instruments applicable to increase the energy efficiency in the residential buildings sector are described and evaluated according to the assessment criteria depicted afore.

10.3.1.6.2 Energy Taxes / Carbon Taxes

10.3.1.6.2.1 Idea

The combustion of fossil fuels – irrespective whether directly in the building or further upstream in an electricity generating plant – causes the emissions of substances harmful to health and the environment. To the extent that energy prices do not internalize these externalities, the market will provide a level of energy consumption that is too low from a societal point of view. The excessive energy consumption materializes in the demand for energy services exceeding the socially optimal level as well as in an energy efficiency level that is lower than optimal. Energy taxes or carbon taxes are a widely used and comprehensive tool to incentivize energy conservation and to mitigate energy related GHG emission. They address several levers for CO_2-emission reductions:

[116] On the contrary, the usual beneficiary of environmental regulation, the general public, is heterogeneous and hardly organized at all, and the individual benefit of the regulation for a single person may be rather small. So there are substantial asymmetries between winners and losers of environmental regulations regarding their incentives and abilities to influence political processes.

i) Demand for energy services: Energy taxes increase the consumer price of energy inputs. As the energy price increase is usually not (entirely) offset by an increase in energy efficiency of the same magnitude, the prices for energy services also increase. In reaction to higher energy service prices consumers will reduce their consumption of energy services.[117] The strength of this effect is given by the energy price elasticity of the demand for energy services, i.e., the percentage change in the demand for energy services in reaction to a one-percent change in the energy price.

ii) Energy Efficiency: Another strategy to cope with increasing prices for energy input is to improve the output of energy services per unit of energy input, i.e., to increase the energy efficiency of the energy consuming equipment. Better energy efficiency will cushion the cost increase of energy services. The strength of energy efficiency reaction is given again by elasticity: the energy price elasticity of the household's energy efficiency. In the long-run, consumers can build high-efficiency buildings, refurbish existing buildings, and buy energy-efficient equipment. Thus, the long-run price elasticity is considerably higher than the short-run elasticity.[118]

iii) Fuel switch: If the energy tax levels relate to the carbon content of the fuels,[119] incentives are provided to switch to less carbon-intensive fuel. For instance, wood pellets and also natural gas entails lower CO_2-emissions per kilowatt hour than heating oil. The objective of a carbon tax is rather to improve the carbon intensity than the energy intensity. Both intensities are not equivalent: A product might require a higher energy input (in terms of kilowatt hours) for providing a certain amount of energy services, but emit less CO_2 per energy service unit due to the use of fuel with a low carbon content.

Since the carbon content of fossil fuels can be determined relatively precisely, carbon taxes can facilitate an accurate taxation even of the CO_2 emitted in the building itself, allowing the holistic and precise implementation of the polluter-pays-principle. In an ideal market with perfect information and rationality, merely to price carbon emissions would ensure that the market players use all of the three mitigation levers in the most efficient, i.e. the aggregate cost minimizing, manner.

10.3.1.6.2.2 Benefits

As mentioned before, by internalizing environmental externalities energy taxes can address the consumption of energy services as well as the energy efficiency of the equipment, and they may – in case of carbon taxes – induce a switch to less carbon intensive fuels. The changes in energy efficiency tend to be limited in the short-run due to the long lifetimes and slow turnover of energy-consuming equipment and assets; this holds true in particular for assets such as the building envelope. Yet, if a tax-induced energy price increase is persistent, it is also more likely to significantly affect energy efficiency adoption, as consumers replace older capital equipment and firms have time to develop new innovative products and processes. Studies find a substantial degree of responsiveness of energy utilization, energy-efficient technology adoption, and innovation to changes in energy prices.[120]

[117] Consumers could reduce the room temperatures, switch the light off when leaving a room, or by means of a more intelligent lighting behaviour.
[118] Empirical data is rare, though.
[119] An energy tax that links the tax rate to the carbon content is usually referred to as a carbon tax.
[120] Gillingham, K. et al. (2009); Anderson, S. / Newell, R. (2004); Hassett, K. A. / Metcalf, G. E. (1995); Jaffe, A. et al. (1995); Newell, R. et al. (1999); Popp, D. (2002).

In contrast to most other energy efficiency policy measures, energy or carbon pricing can be utilized to address the so-called rebound effect. The rebound effect refers to an increasing demand for energy services in response to energy efficiency improvements, which decrease the marginal cost of energy service consumption. In consequence, the actually achieved reduction in energy consumption is less than proportional to the increase in energy efficiency. By increasing the price for energy inputs, energy or carbon pricing stabilizes the per unit price of energy services.

From an overall welfare economic perspective, energy taxes have an attractive fiscal appeal. The revenues generated by energy taxes can be used to lower other distorting taxes, for instance labor taxes. If the good that benefits from the lowered tax features lower price elasticity than the demand for energy, the levy of the energy tax will yield social welfare gains. With regards to economy-wide climate policy targets, uniform carbon taxes may help to minimize the macroeconomic CO_2-emission reduction costs – at least in a static setting (see Box 1).

Box 1: Static Efficiency of Carbon Pricing Instruments

As a general rule, a certain emission reduction target is achieved at the least cost if the marginal abatement costs (MAC) are equalized across all emitting facilities in the economy. Otherwise, shifts of reduction obligations from emission sources with relatively high MAC to those with lower MAC yield cost savings without missing the overall target.[121] Thus, if sector-specific policies are employed, these have to be defined in a manner that equalizes the marginal abatement costs in each sector subjected to climate policy in order to achieve maximum economic efficiency. Yet, the definition of such policies that equalize the sectoral MAC is far from being trivial since there is a high degree of uncertainty regarding the correct magnitude of a sector's MAC. There are a variety of different abatement options for each sector, the sum of these carbon mitigation options within a sector determining its aggregate marginal abatement cost function. The task to assign sectoral policies that equalize MAC is further complicated by the fact that there are several approaches to estimate the MAC for a particular abatement option, reaching from technology-driven bottom-up approaches to indirect derivation methods through price signals (top-down approaches). Hence, the assignment of sector specific targets and policies that ensure equal MAC across different measures and sectors will not normally be achievable. Contrary to sectoral policies, cross-sectoral policy instruments setting a uniform carbon price are in principle capable of equalizing the MAC across all sectors. Assuming that the relevant players (industry, service providers, and consumers) know best about the cheapest ways of mitigating carbon emissions, they will reduce their emissions until their MAC are equal to the uniform carbon price.

The carbon price may be given exogenously through price instruments (e.g., energy taxes or carbon taxes) or be determined in a carbon market within an emission trading scheme. Both quantity instruments and price instruments are principally capable of equalizing the MAC; yet, the latter do not allow of a precise control of aggregate emissions, but they limit the financial burdens to the obligators.

However, it is essential to note that the previous argument assumes the absence of market failures and that all market players behave rationally. Thus, a reality-oriented policy analysis has to be aware of the prevailing market barriers, and take a dynamic rather than a static perspective. Nevertheless, it provides some insights into the advantages and general rationale of energy and carbon prices.

[121] Vice versa, by equalizing the MAC higher absolute emission reductions are achievable at the same cost.

10.3.1.6.2.3 Problems

Referring to the market barriers depicted in the previous section, energy and carbon taxes correct only the market failure of energy externalities. By internalizing these externalities energy taxes can provide the "right" prices to the decision makers, i.e., prices that reflect the full social costs of energy consumption. Other market barriers remain widely unaffected from energy taxation. In the presence of such other market barriers, the cost-minimizing energy efficiency might not be achieved even if the environmental (and energy security) externalities are entirely internalized in the energy prices. If the remaining market barriers distort the energy efficiency decisions towards levels lower than optimal, the actual energy price elasticity of equipment efficiency is too low.

If energy taxes amounting to the "true" external costs of energy consumption do not suffice to achieve the socially optimal energy efficiency level, policy makers could suggest increasing the tax rate up to an amount that induces decision makers to realize the "ex ante" optimal energy efficiency level. Yet, thereby derived excessive tax rates could cause severe losses of social welfare. While increasing the energy efficiency only modestly, rapidly increasing energy taxes may lead to considerable cuts in energy service consumption; The finally resulting consumption of – utility providing – energy services can well fall below the optimal level.[122]

10.3.1.6.2.4 Policy Recommendations

Energy pricing is an indispensable pillar of a sustainable energy use strategy. A socially optimal energy consumption pattern is achievable only if the energy prices reflect the full costs of energy consumption, including environmental damage costs. Incentivizing the adoption of high efficiency equipment, however, is only one aspect of the rationale for energy or carbon taxes. A major asset of a tax policy that internalizes these environmental externalities is to direct the consumption of energy services towards a – from the societal perspective – more economical manner. With regards to energy efficiency, the presence of market barriers can inhibit the realization of economically optimal efficiency levels even if the consumers face the full costs of energy consumption. In case that the energy efficiency response to increasing energy prices is deemed to be insufficient; i.e., the energy price elasticity of equipment efficiency is lower than optimal, further policy intervention may be justifiable on economic and environmental grounds.

Beyond their impact on energy consumption behavior, energy taxes are an attractive source of public revenues. The relatively low price elasticity of energy consumption means that energy taxation causes only modest substitution effects, which in turn implies relatively little taxation induced welfare losses in the domain of energy consumption.[123] If the energy tax revenues are used to lower more distortionary taxes, the overall social welfare can be increased by means of a

[122] The optimal level of energy efficiency is obviously dependent on the amount of energy services consumed. The lower the energy service consumption, the lower is the optimal energy efficiency since lower energy service consumption implies lower achievable energy cost savings. Thus, the "ex ante" socially optimal energy efficiency level is regularly not optimal anymore after significant tax increases.

[123] Generally, taxation induced welfare losses depend on the responsiveness of the demand for a commodity to changes in the commodity price as faced by the consumers. A high price elasticity of the demand implies a considerable cut in consumption in reaction to increasing tax rates, causing a substantial loss of consumer utility. In turn, a very low elasticity means that a tax increase leaves the demand widely unaffected so that the loss of consumer utility also remains small.

tax shift. Thus, tax rates on energy consumption that exceed the magnitude of (environmental) externalities to be internalized may be justifiable on fiscal reasons. The mark-up on energy tax rates that is imposed for fiscal reasons should be determined according to the price elasticity of the demand for the respective energy carrier. However, the scope for welfare-increasing taxation shifts towards energy taxes is not infinite; after surpassing a certain threshold, overall social welfare will start to decrease with further rising energy tax rates. The tax rate necessary to achieve a certain pre-determined energy efficiency level only by means of energy taxes may already be well above this turning point. Thus, energy or carbon taxes are an important instrument within a sustainable energy use strategy, but with regards to energy efficiency objectives additional measures seem appropriate.

10.3.1.6.3 Carbon Trading

10.3.1.6.3.1 Idea

A GHG or carbon trading scheme sets an upper limit to the emission of GHG. Entities subject to a GHG emission trading scheme have to obtain and surrender emission allowances to cover their respective GHG exhaust. Allowances may be distributed for free based on past emissions (“Grandfathering”), allocated based on an output-based benchmark, or auctioned off. An allowance usually represents 1 ton of CO_2- equivalent. The EU has established the largest emission trading scheme worldwide. The European Union Greenhouse Gas Emission Trading System (EU ETS) commenced operation in January 2005. It covers emissions from stationary emission sources in the industry and electricity generation sector, by 2012 aviation emissions will be also included. As yet, fuels that are combusted in buildings remain outside the scope of the EU ETS.

There are basically two approaches conceivable to integrate fuels combusted at the building site (“building fuels”) into the EU ETS. In the downstream approach each building user or owner has to surrender allowances for the CO_2 emitted through combustion processes at the building site.[124] Being directly confronted with their environmental costs, building users will adjust their energy consumption behavior to the new cost structures. Yet, the prohibitively high transaction costs of the downstream approach render it a practically unfeasible option.

The administratively far less complicated option to introduce emission trading in the buildings sector is the upstream approach. Fuel suppliers are subject to the obligation to surrender allowances for the carbon content of their sold fuels. The appropriate certificate coverage can be verified relatively easily in the context of existing energy taxation schemes. Thus, the transaction costs of an upstream trading scheme are small. A price signal is passed on indirectly by transmitting the certificate costs to the fuel consumers, who will then respond to the increased energy price by adjusting their energy consumption and their equipment’s energy efficiency.

For an individual building user, the incentive effects of a carbon tax and an inclusion of building fuels into the EU ETS are very similar in many respects. Both approach internalize the external costs of energy consumption and thereby increase the price of fossil energy inputs. Within an emission trading scheme, the allowance price is determined endogenously in a carbon market, while the carbon price is given exogenously with a carbon tax. The first allow a precise control of aggregate GHG emissions, while the latter limit the financial burdens to the obligors.

[124] In single family houses, presumably the user – irrespective of its ownership of the house – will surrender the allowances. In multi-family houses, the allowance administration will be rather managed by the owner or the property management.

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10.3.1.6.3.2 Benefits

Carbon trading and carbon or energy taxes share many features. By internalizing the external cost of energy consumption they steer the demand for energy services, energy efficiency decisions as well as the fuel choice towards a more sustainable – and economically more rational – direction. Both instruments are capable of equalizing the marginal CO_2 abatement costs across different emitters. And both approaches can be used to generate public revenues; in case of carbon trading this requires auctioning off the emission allowances instead of a free allocation.Yet, there are also differences between carbon taxation and carbon trading. Only the latter ensures by setting a cap that the targeted emission reductions are reached with certainty: First, the quantitative response of consumers' fossil fuel demand to the imposition of carbon taxes is not known with certainty ex-ante; second, the suppliers of fossil fuels may accelerate the extraction of fossil resources in reaction to upcoming carbon taxes (see Box 2). In the long-run, there is a strong argument in favor of deploying the precautionary principle in the sense of setting a global cap on CO_2 emissions: the structural uncertainty of climate change and its welfare implications. The current state of knowledge cannot set sufficiently narrow bounds on overall climate change damages; a potential catastrophe with disastrous consequences cannot be excluded with certainty. This small, but still existent chance of a detrimental catastrophe can justify a stringent climate policy that sets a strict cap on overall GHG emissions.[125]

Box 2: Carbon Trading vs. Carbon Taxes: The Supply Side Perspective

Broadening the scope of the analysis beyond the demand side and also considering the supply side, a further distinction between price and quantity approaches becomes apparent with important implications for the emission pathway. The market for exhaustible fossil resources is not comparable with the markets for normal commodities, since the owners receive a scarcity rent for their resources. The owners extract their resources along the time path so that they maximize the present value of their revenues. If the owners expect a declining demand for their resource – implying diminishing profits – in the future (e.g., due to carbon pricing), they have an incentive to accelerate the extraction of their resources. The substitution elasticity of fossil fuels and therefore the carbon pricing-induced decline of the demand is assumed to be greater in the long-run than in the short-run; hence, expectations of a declining demand can speed up the accumulation of CO_2 in the atmosphere. Here lies the difference between carbon taxes and emission trading: A global emission trading scheme sets an absolute limit to the consumption of carbon – independent of the temporal allocation of the consumption, while carbon taxes reduce the demand by increasing the price of carbon consumption without setting an absolute cap. In case of a completely inelastic supply, the carbon tax would have no impact on the aggregate carbon consumption, but only on its allocation along the time path. Consequently, emission trading seems to be clearly favorable to carbon taxes with regard to the supply side. Although one cannot suppose that the resource owners act fully in line with what pure economic theory suggests as the resource supply is determined by various factors, the general logic of the argument still holds true.

However, emission trading can fully unfold its efficiency only if it covers a significant fraction of the global carbon consumption. Otherwise, the reduced consumption in some regions could be offset by an increased consumption in other regions of the world – induced by decreasing prices through the climate policy. The problem of price induced emission leakage is inherent in all measures that reduce the demand for fossil fuels only in certain regions and/or sectors. Thus, mentioning it in the context of carbon pricing does not mean at all that other measures do not imply the problem of emission leakage.

[125] Weitzman, M. L. (2007).

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10.3.1.6.3.3 Problems

An often stated problem concerning carbon trading is uncertainty about the development of allowances prices and thus of the gross energy prices. Within an emission trading scheme the carbon price is determined endogenously by the demand and supply of allowances. While policy can set the supply of allowances, the demand is determined by factors not controlled by the environmental authorities such as economic activity, available abatement technology, weather[126], etc. Consequently, carbon trading – in contrast to carbon taxes – does not allow for a (precise) control of the CO_2 mark-up on energy prices. It is argued that allowance price uncertainty in addition to the general energy price risk would aggravate the uncertainty of gross energy prices (including the carbon mark-up), which is finally relevant for the investor. Thus, applying carbon trading to building fuels would amplify the uncertainty related market barriers to energy efficiency, e.g., increasing risk costs.

Notwithstanding, there are also interactions between the CO_2 allowance market and the fossil fuel market that argue for a cushioning or even offsetting of this uncertainty amplifying effect. With regards to changes in the demand for fossil fuels carbon trading will unambiguously increase the gross energy price volatility compared to carbon taxes. Regarding changes in the supply of fossil fuels, however, carbon trading implies lower gross energy price volatility; the price of emission allowances works as a buffer to the gross energy price.[127] The net effect depends of the relative weight of demand and supply curve volatilities as well as on the respective price elasticities.

A second problem of including building fuels into the EU ETS is potential leakage effects. Besides indirect leakage induced by decreasing (world) market prices for fossil fuels through reduced domestic demand, which is inherent to all climate policy measures that cut demand only nationally/regionally, direct leakage may be amplified by the inclusion. Assuming a relatively low price elasticity of building fuels, integrating them in the EU ETS could lead to an increase of allowance prices. This would increase the economic pressure on stationary CO_2 sources in energy intensive industries, implying stronger relocation incentives in carbon price sensitive industries. Consequently, a tendency towards higher global emissions is stimulated: While the overall domestic carbon demand remains constant (at the fixed cap), the demand for fossil fuels in regions not covered by the EU ETS grows through resettled industrial facilities. In case the supply reacts to the higher demand, the integration of the transport sector into spatially limited emission trading schemes may contribute to an expansion of global CO_2 emissions. Yet, there are policy measures available to attenuate such leakage problems: Border tax adjustments, which are however disputable under WTO rules, or free allocation of emission allowances to domestic carbon price sensitive industries reduce their relocation incentives.

10.3.1.6.3.4 Policy Recommendations

In order to pave the way for a global comprehensive emission GHG trading scheme, all relevant emitting sectors should be subordinated to a common quantitative control. Electricity used in buildings is already captured by the EU ETS. Including fuels that are combusted at the building site

[126] The weather is determinant for the supply of carbon-free renewable energy sources (such as solar power, wind, and biomass) as well as of the energy demand (demand for heat and cooling).
[127] A shift of the supply curve of fossil fuels does not change the consumption of these fuels since it is determined by the cap. Given a stable demand curve, the gross energy price remains stable; the price of emission allowances decreases/ increases in case of a declining/expanding supply. With carbon taxes, on the other hand, the gross energy prices increases/decreases with a declining/expanding supply of fossil fuels.

into the EU ETS seems to be an appropriate step – in the mid-term – to create a coherent climate policy framework. To mitigate uncertainty regarding the development of (gross) energy prices environmental policy should ensure the intertemporal transferability of emission allowances and support the consolidation of carbon allowance future markets, providing long-term signals about prospective carbon prices.128

Given current and expected allowances price levels, the created price signal will not suffice to bring about energy efficiency levels that are deemed efficient from a social welfare point of view. Additional measures particularly focused on energy efficiency seem indicated in order to overcome market barriers other than environmental externalities. The inclusion of buildings fuels into the EU ETS does not necessarily preclude the imposition of energy taxes. Energy taxes may still be a useful supplement to carbon trading, serving mainly fiscal purposes.

10.3.1.6.4 Energy Service Contracting

10.3.1.6.4.1 Idea

Before we turn to direct policy intervention, we begin with a potential remedy to several of the market barriers mentioned afore that still relies on private market mechanisms. Energy performance contracts can be used to utilize the professional know-how as well as human and financial resources of specialized energy service companies in order to tap otherwise dissipated energy saving potentials.

Most of the existing energy service contracts may be termed supply contracts, since they cover one or more streams of useful energy (e.g., supply of heating oil, gas, or electricity) but do not cover final energy services. The supplier has control over primary conversion equipment, but little or no control over either secondary conversion equipment or the demand for final energy services. In contrast to supply contracts, energy service or energy performance contracts cover one or more final energy services. The contractor has some control over secondary conversion equipment, such as heating systems, radiators, and lights; the contractor may also be involved in further decision determining the demand for final energy services (e.g. insulation, acquisition of solar thermal or photovoltaic systems). Therefore, the contractor gains a certain control over the demand for useful and delivered energy. An energy service contract establishes a link between contractual payments and equipment performance as the contractor’s remuneration is generated by achieved energy cost savings; thus, contractual payments are scheduled at intervals over a long-term period. This provides the contractor with a long-term incentive to optimize the efficiency of energy service provision and to continuously maintain and improve equipment performance.129

In an energy service contract, the contractor – i.e., the ESCO – may:

- Plan and install/replace building systems and/or components (energy conversion, distribution and/or control equipment) at the client site
- Finance the required investments, or assist in obtaining finance for the client
- Assume property rights over some of the assets required to provide energy services

[128] Transferability of allowances between different compliance periods („banking“ and possible „borrowing“) avoids drastic price surges at the end of a compliance period.
[129] Sorrell, S. (2007).

- Process planning permissions or applications for subsidies
- Operate and maintain building systems
- Assume decision rights over a significant proportion of the useful energy streams and final energy services within the host site or over a significant proportion of the organizational activities required to provide these energy services
- Guarantee a particular level of savings in energy consumption or energy costs
- Take on the majority of the risks related to the provision of energy services, including equipment performance risk, energy price risk and credit risk

According to Directive 2006/32/EC on Energy End-use Efficiency and Energy Services an energy service company (ESCO) is defined as "a natural or legal person that delivers energy services and/or other energy efficiency improvement measures in a user's facility or premises, and accepts some degree of financial risk in so doing. The payment for the services delivered is based (either wholly or in part) on the achievement of energy efficiency improvements and on the meeting of the other agreed performance criteria"; and energy performance contracting is defined as "a contractual arrangement between the beneficiary and the provider (normally an ESCO) of an energy efficiency improvement measure, where investments in that measure are paid for in relation to a contractually agreed level of energy efficiency improvement".

The precise contractual design depends on the context and the contracting parties.130 An energy performance contracting scheme designed particularly for residential buildings is proposed by the UK Green Building Council. According to the "pay as you save" concept (PAYS), a low-energy equipment/refurbishment provider uses finance from a third party to cover the upfront costs of the energy efficiency improving measures. The obligation to repay the initial investment is linked to the property instead of the user of the building; at change of occupancy the obligation to pay for the measures as well as their benefits is transferred to the new householder. The repayments (PAYS charge) are calculated to be less than the savings that will be made on the fuel bills. The PAYS charge could be collected via the energy bill or alternatively by the local authorities through council taxes.131

10.3.1.6.4.2 Benefits

Energy Performance Contracting can overcome several market barriers, among them:

- Lacking information / bounded rationality: In particular individuals may lack information of the energy saving potentials and costs of different efficiency improving measures; moreover, they regularly do not have the necessary skills required to implement cost-efficient measures. On the other hand, ESCOs are specialized on identifying cost-efficient energy saving potentials, bring in know-how regarding the planning and implementation process, and they have established business connections to service companies and equipment suppliers.

[130] The contractual design will vary according to the covered energy streams or whether the contract applies to a commercial, municipal, or residential building.
[131] UKGBC (2009).

- Liquidity constraints: Beneficial energy efficiency investments may founder on the unavailability of funds on the part of the prospective home owner, even if the payback period is short. Energy performance contracting can remove the barrier of required upfront payments as the initial investment costs are borne by the ESCO. The energy cost savings generated by the investment are used to repay the investment costs.

  Professional ESCOs may have better access to the capital market than private investors, in particular individuals. An ESCO with a portfolio of several diverse clients bundles different risks and could therefore negotiate lower (risk-dependent) interest rates; yet, this holds true only for unsystematic risk. On the other hand, some risks – i.e., systematic risks – are correlated and are more difficult to reduce significantly by means of diversification. For instance energy price risks apply to all clients at the same time.

- Risk aversion: Given the high volatility of energy prices over recent years, energy price risks are an important issue for risk-averse actors in the housing market. By means of energy performance contracting these risks can be shared between the contractor and the client. The remaining risk to be borne by the building users is determined by the precise contract details. If the client pays a fixed amount to the contractor for providing the whole set of demanded energy services, there remains essentially no energy price risk on the part of the client. With a "pay as you save" contract the client also reduces its energy price risk, but it can still benefit from falling energy prices. Also risks regarding the performance or duration of the energy saving equipment are at least partially transferred to the ESCO; as these risks are rather uncorrelated, the risk pooling within the ESCO reduces the social risk cost, too. All in all, energy performance contracting generally implies a risk reduction on the part of the building user and therefore it seems attractive to risk-averse individuals.

- Loss aversion / risk aversion: As explained in the previous section on market barriers, the required upfront payments to improve building efficiency may be framed by individuals as an immediate certain loss, while the resulting later savings are uncertain in their extent. Transferring the responsibility for the required initial spending to the ESCO helps resolving the behavioral barrier of loss aversion. Moreover, "pay as you save" energy performance contracts completely eliminate of suffering a loss compared to the situation without energy performance contracting.

- Split incentives: Energy performance contracting may also help to remedy split incentive problems. If property developers are reluctant to invest in energy efficiency improving measures, ESCOs could take the place of the property developer. To refinance the upfront investments of the ESCO, an obligation to – partially – pass on resulting energy cost savings to the ESCO could be established; this obligation should then be linked to the building or the flat rather than to the owners or tenants. Maybe the ESCO could even take over the entire energy supply, so that the users of the building pay for energy services only to the ESCO. For the users this would mean solely a change of the energy provider, switching from a mere supplier of energy streams to the ESCO that provides an entire energy concept including investments in energy saving equipment.[132] These payments to the ESCO include charges for the remaining demand for useful energy streams as well as remuneration for the conducted energy saving measures.

[132] The ESCO, in turn, may get the remaining demand for useful energy streams from an established energy supplier.

10.3.1.6.4.3 Problems

So far, energy performance contracting has been applied rather in the MUSH (municipalities, universities, schools, hospitals) and the commercial sector than for residential buildings. The main obstacle to a broader use of energy performance contracting in the residential housing market is the transaction costs (costs incurred for search and information, bargaining and decision,

supervision and enforcement) linked to the use of energy performance contracts.[133] An important source of transactions costs is the determination of actually achieved energy cost savings: These are calculated by subtracting the energy costs after efficiency improvements from the baseline energy costs, i.e., the “business-as-usual” cost without enhancement of the energy efficiency. The baseline energy consumption is influenced by factors such as the climate within a respective year or the number of occupants; changes in these parameters imply changes in the financial flows. Therefore, in order to avoid renegotiations energy performance contracts need to be defined relatively comprehensively and require provision to adjust to such changes.

The sums at stake, i.e., the potential (additional) energy cost savings, in residential buildings seem often insufficient to outweigh the transactions costs of energy performance contracts. This holds in particular true if the ESCO contracts with single-family home owners or individual flat owners. For residential multi-storey apartment houses the ratio of achievable cost savings and related transactions costs is more favorable for energy performance contracting, because a single contract for several flats could be used. As with PAYS contracts the obligation to pay for the delivered energy services would be linked to the apartment and remains also after a change of ownership.[134]

Depending on the risk-sharing agreements between clients and contractors, ESCOs may face high financing costs if they are burdened with the entire systematic risks. However, there exist contractual designs that entail a fair risk-sharing, reducing the clients’ vulnerability to energy price increases and offering good business prospects to the ESCOs at the same time.

10.3.1.6.4.4 Policy Recommendations

Energy performance contracting is not a policy intervention, but a market response to bridge the observed efficiency gap in the buildings sector. Both parties, clients and contractors, benefit from tapping the potentials for energy costs savings. Notwithstanding, policy can create a legal and institutional environment that facilitates the uses of mutually beneficial energy service contracts.

A further definition and a certain standardization of energy service products and energy performance contracts in the residential sector increases transparency particularly on part of the clients and standardized terms reduce the transaction costs of energy performance contracting. For instance, a widely standardized PAYS concept (e.g., regarding the calculation and billing of actual energy cost savings) could reduce the complexity of this instrument for individual home owners and tenants, thereby rising their acceptance and uptake of energy performance contracting. With regard to changing owners and tenants of dwellings, legal certainty is of particular importance concerning the linkage of energy performance contracts to the building/flat itself rather than its owner. Higher transparency and lower transactions costs, mainly reduced search and information

[133] For a more detailed analysis of the transaction costs of energy service contract see Sorrell, S. (2007).
[134] The energy service contract between the ESCO and the property developer needs to be signed before selling the apartments; otherwise approval of the potentially diverse owners is required, leading to higher transactions costs.

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cost, could be also supported by providing a better knowledge basis through publicly financed information campaigns and energy consulting in consumer advice centers.

Moreover, environmental policy might also foster the use of energy performance contracts by providing financial incentives. For instance, some form of subsidies in the form of favorable loans or direct financial assistance could be possibly granted.[135] Credit guarantees by public bodies would help ensure that the asked interest rates for the required initial investments are held relatively low in order to contribute to an increasing demand for such services. It is also conceivable to apply the reduced VAT rate to energy performance contracts. Yet, it has to be assured that bandwagon effects are minimized

Summing up, energy performance contracting offers a market-based service that can contribute to overcoming several market barriers to energy efficiency; its specific strength is that it releases the residential home owners from the required initial investment in efficiency improving equipment. Thus, public policy should support the market penetration of energy performance contraction, particularly be providing a proper legal and institutional infrastructure. However, energy performance contracting seems to be rather appropriate for energy-efficient refurbishments of existing buildings and only to a lesser extent for financing the energetic enhancement of new residential buildings.[136] Therefore, additional environmental policy regulations are needed to tap the full potential for cost-effective energy savings in the new buildings sector.

10.3.1.6.5 Building Codes / Efficiency Standards

10.3.1.6.5.1 Idea

Efficiency standards set a minimum level of energy efficiency that all products in the regulated product category have to meet. In some case, the efficiency requirements of these standards may be differentiated in accordance to certain attributes of the good. A differentiation of efficiency standards seems appropriate particularly for very heterogeneous goods such as residential buildings. Residential buildings do not represent a widely homogeneous category of energy end-use, but they can be rather thought of as a complex package of technologies and energy end-uses.

With regards to the buildings sector, we have to differentiate between overall performance-based efficiency standards for the entire building and a number of prescriptive codes that set separate performance levels for major envelope and integral equipment components, such as the minimum thermal resistance of walls or windows. Performance-based standards that require compliance with an overall efficiency target for the entire building provide more compliance flexibility to the builder and may provide more incentives for innovation, but require a higher level of education of building officials and inspectors.[137]

In regular time intervals, policy should re-assess the buildings codes and efficiency standards and upgrade them if indicated by technology improvements and/or declining costs of energy-efficient equipment.

[135] An assessment of these financial policy interventions is provided in the following chapters.
[136] For instance, it appears to be more difficult to convince the users of a building of the energy cost savings achievable through energy performance contracting without having a comparison to an actually measured counterfactual.
[137] Gann, D. M. et al. (1998); Hui, S. C. M. (2002).

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10.3.1.6.5.2 Benefits

Building codes cannot remedy the market barriers described in the previous section, but they are capable of effectively correcting their outcomes. Building codes do not internalize environmental externalities and spill-overs, they do not harmonize split incentives, they do not provide additional capital, and they do not change behavioral attitudes. But by curtailing the builder's freedom of decision, they can prevent these market barriers to lead to energy efficiency choices that are deemed suboptimal.

Governmental authorities attempt to determine the socially optimal level of building energy efficiency – taking account of external costs and benefits as well as biases and market imperfection that would otherwise distort the energy efficiency decision taken by private investors. Hence, building codes and efficiency standards are the most direct and most effective way of improving the energy efficiency of residential buildings. Builders are immediately obliged to undertake technical measures that enhance the energy efficiency of their buildings, otherwise they will be sanctioned. In contrast, most other policy instruments are only indirectly – by means of financial incentives or information provision/awareness rising – capable of influencing the efficiency of new residential buildings.

As mentioned, building codes and energy efficiency standards have a direct impact on the market outcomes, but leave the price and cost structures widely unchanged. However, one cost category may be directly affected by that regulatory approach: Efficiency standards can reduce the risk costs of an investment in high energy efficiency. If a property developer is unconfident whether he can recoup the additional cost of an investment in superior energy efficiency, he bears a financial risk that constitutes real cost, i.e., risk costs. These risk costs materialize in the form of higher capital costs, irrespective whether the investment is financed by debt or equity capital. If all competitors are legally obliged to also implement similar energy efficiency levels, the market risk of efficiency investments is mitigated.

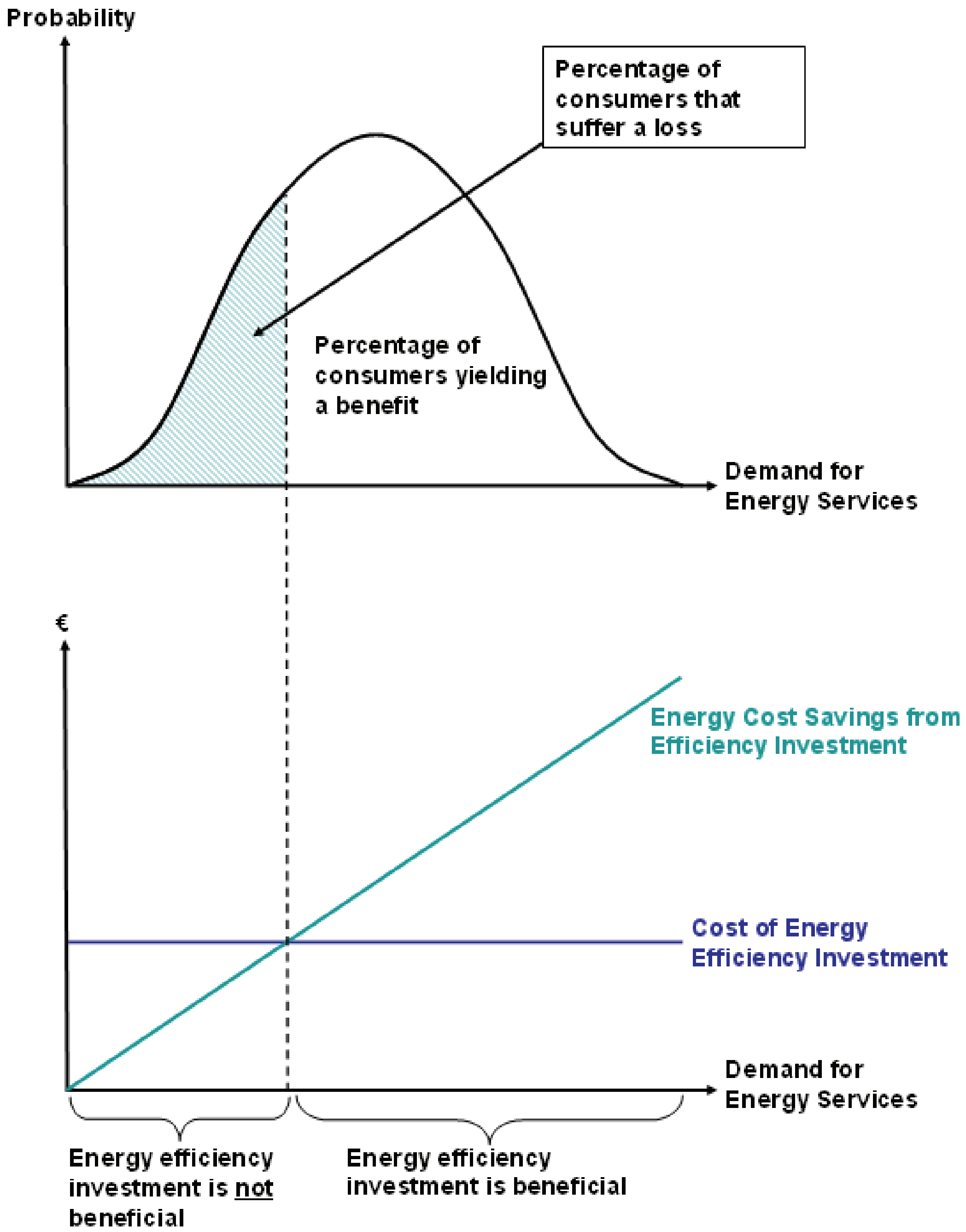
10.3.1.6.5.3 Problems

A principal drawback of mandatory building codes as well as appliance standards is founded in the heterogeneity of energy consumers. Among the entirety of building users, there are some that have higher and some that have a lower demand for energy services than the mean user.[138] If the regulatory authorities set a standard that is optimal for the average household, this can still entail losses for households with a relatively low demand for energy services. Figure 37 illustrates this problem. The lower graph shows the fix costs for the energy efficiency investment and the resulting energy cost savings that depend on the amount of energy services consumed; obviously, a higher consumption of energy services implies greater energy cost savings as the absolute energy input saved also increases. The intercept of both lines marks the break-even point. All users with a demand greater than the break-even amount of energy services benefit from the mandated building code / efficiency standard, while those with a lower demand are worse off as the energy costs are of lower relevance for them. The shares of households that belong to the "winners" and to the "losers" of the regulatory policy are determined by the probability distribution of households regarding their demand for energy services (upper graph). The greater the variance of the probability distribution (i.e., the disparities between different households), the less even are the distributional consequences of mandatory building codes or standards. It has to be noted that a uniform effi

[138] There may be differences between consumers regarding the preferred room temperature, hot water consumption, use of electric appliances, etc.

ciency standard is not optimal for consumers with a high demand for energy services either; for those users a further increase of the efficiency level implying higher upfront cost but also greater energy cost savings (that exceed the efficiency investment) would be optimal. Although building codes can be differentiated to certain extent,[139] they cannot (fully) take account of personal preferences of the users regarding their consumption of energy services.

Figure 37: Distribution of “Winners” and “Losers” of Efficiency Standards



Source: Own Illustration.

[139] For instance, the building codes applicable for vacation homes may be less strict. As they are occupied only for a certain fraction of the year, their energy service demand and consequently the energy cost savings achievable by better efficiency are lower than for a normal residential building.

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An analogues problem of building codes refers to differences in the costs incurred for the required energy efficiency measures to comply with mandatory building codes. As these costs can vary from building to building, a certain building code may improve the economic situation of the majority of obliged home-builders, while others – those with higher implementation costs – suffer a loss. Despite the fact that the respective regulations often provide some flexibility, building codes are obviously not capable to determine the optimal energy efficiency level for each building due to lacking information as well as prohibitive transaction costs.The problem of insufficient information is valid in a more general sense. While usually bureaucrats in public authorities decide on the design and strictness of building codes and appliance standards, private market actors in the industry regularly have better information on the performance and costs of energy conservation technologies. Lacking this information, the regulator might adopt standards that are either weaker than optimal or too strict. In the first case, the building codes are widely ineffective at the worst; in the latter case, the regulation could burden excessive costs to the buildings sector if the cost required to comply with the building codes exceed the net present values of the achievable energy savings.

This, in turn, leads to the possible problem of regulatory capture. If the regulatory authorities are reliant – to a certain extent – on external information, lobby groups will likely attempt to bring their specific objectives into the regulation. Compared to more general pricing instruments, sector-specific policies such as building codes and efficiency standards offer a wider scope for favoring regulations. Politicians and bureaucrats who have a wider decision-making range are invariably subject to lobbying and pressure of interest groups pursuing their own interests. They will try to configure the regulation's design details in a way that minimizes their costs or maximizes their benefits,[140] but may affect then overall social welfare adversely.

Box 3: Top-runner Approach

In the field of electric appliances, Japan employs a variant of energy efficiency standards that shifts the decision on the targeted standard from the environmental authorities to the market participants, more precisely to the technology leaders. According to the so-called top-runner approach the valid standard for a particular appliance class is determined by the manufacturer with the best energy efficiency. Its competitors are required to achieve this standard within a given time frame, otherwise they have to pay a fine or their products are possibly even banned from the market. The energy efficiency standards are adjusted in regular time intervals and not ad-hoc after each technology leap in order to provide planning reliability to the manufacturers.

The shift of the decision on the valid standard from governmental bodies to the top-runner, i.e., the technology leader, has oppositional effects on the environmental effectiveness and on the potential costs of the regulation. On the one hand, the environmental authorities have no more direct control over the current efficiency standard. Thence, it could happen that most R&D efforts of the industry are directed to an improvement of attributes other than energy efficiency. On the other hand, the risk of excessive costs burdened to the industry due to inappropriately set standards is alleviated by the top-runner approach. It is not to be expected that any manufacturer will implement exceptionally ambitious and therefore cost-intensive energy conservation technologies in order to set its competitors under pressure. Firstly, the top-runner is the first to incur expenses for the introduction of the new technology, while some time is granted to its competitors to react. Furthermore, the competitors may benefit from technology spill-overs, which potentially mitigate their adjustment costs.

[140] Such efforts may range from attempts of property developers to generally weaken the efficiency standards to endeavours of renewable energy equipment suppliers to achieve a favorable treatment of renewable energy sources.

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The practical and political feasibility as well as the transaction costs of the top-runner approach are essentially determined by its concrete design. The public acceptance might be rather higher than for other approaches as the emission targets origin from the industry itself and have thereby proven to be achievable.

While the top-runner approach seems feasible for electric appliances or vehicle fuel economy, it remains doubtful whether this approach is viable to regulate the energy efficiency of a building, too. As residential buildings are clearly less standardized and more heterogeneous than electrical appliances, the regulation would need a significantly higher comprehensiveness; the thereby arising transaction costs may render that approach unattractive for the buildings sector.

10.3.1.6.5.4 Policy Recommendations

Building codes and efficiency standards are the most direct and most effective way of improving the energy efficiency of residential buildings, but not necessarily the most cost-efficient way. Thus, building codes should be an important pillar of an energy efficiency strategy for the residential buildings sector. Considering the heterogeneity of buildings and users, however, efficiency standards should not be set in manner that maximizes the expected net energy cost savings of the mean building/user, but instead to a level that ensures benefits for the vast majority of buildings. This will leave some potential for further net energy cost savings in a fraction of the new building stock; to tap these potentials complementary policy instruments need to be employed.

An overall performance-based efficiency standard that mandates minimum energy efficiency for the entire building provides greater flexibility to the builders, allowing them to implement the most cost-efficient technologies that assure compliance with the standard. In order not to cause excessive costs through inappropriate standards, the regulation should furthermore take account of the specifics of different buildings. Yet, the implementation of such complex building codes and appliance standards in practice needs to be carefully enforced, monitored, and verified to be effective; the benefits of a more comprehensive standard design have to be balanced with the associated transactions costs. Separate codes for single building components should be prescribed only as far as they are proven to be cost-efficient for (almost) all building types.

10.3.1.6.6 Financial Incentives

10.3.1.6.6.1 Idea

Financial incentive programs aim at an accelerated introduction and market penetration of energy-efficient technologies. They provide financial motivation for energy efficiency investments through

- direct subsidies (e.g., R&D subsidies, capital subsidies,
- tax credits,
- guaranteed remunerations for renewable energies above market price levels,
- or subsidized loans[141].

Direct subsidies and also tax credits usually grant financial assistance at the point of investment or soon thereafter, while guaranteed remuneration such as feed-in tariffs spread the grants over the

[141] Subsidized loans will be treated separately in the next subchapter.

service life of the equipment. Depending on the concrete program design, these programs can respond to several market barriers such as capital constraints, uncertainty, and behavioral anomalies.

An incentive mechanism further reaching than subsidies and tax credits, which is used in the transport sector to stimulate higher energy efficiency of vehicles, is a so-called “feebate” scheme. This regulatory approach would grant publicly financed rebates on the purchase or construction of highly energy-efficient dwellings, while imposing additional fees/taxes on energy-intensive buildings. Such a scheme might be designed neutral for the public budget, so that the sum of granted rebates equals the imposed fees. Although providing even stronger financial incentive for implementing ambitious energy efficiency levels, this instrument could suffer from lacking political feasibility. The higher complexity of accurately determining a buildings precise energy demand – compared to vehicles, for instance – may bring along a number of lawsuits in reaction to requests for payment of the fee.

10.3.1.6.6.2 Benefits

Financial incentive programs address several market barriers, which are:

- Spill-overs: A one-time subsidy or tax credit for the adoption of energy efficiency technologies can be interpreted as the imposition of a negative tax on the purchase of an energy-efficient commodity. Thereby, such subsidies are generally capable of internalizing positive externalities. The buyer is financially compensated for the positive spill-overs (e.g., triggered innovation and experience-curve / learning curve effects) he creates by acquiring a highly energy-efficient home or equipment. If the amount of the subsidy meets the monetized value of the created positive externalities, the subsidy scheme would – in the absence of other market barriers – bring about a socially optimal level of energy efficiency investments.

  Analogously, the reasoning for R&D subsidies is to compensate innovative firms for the knowledge they create and that disperses otherwise uncompensated to other firms. In the field of (residential) buildings, R&D support may not only encompass basic research but also demonstration projects to prove the technical feasibility and economic viability of sustainable and energy-efficient housing concepts.

  Moreover, financial incentive programs may create positive spill-overs by themselves. These program spill-overs occur when the participating investors install – beyond the supported goods and without financial support – additional energy-efficient products due to the information they learned through participation in the program.

- Information problems: Given the importance of word-of-mouth information dissemination, financial support for “pioneering” investments in energy-efficiency could help to inform and convince potential investors – beyond the program participants – of the advantages of an energy-efficient design of their dwelling. Energy efficiency investments undertaken by these “free-drivers” could be also framed as a positive externality of the financial incentive program.

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- Uncertainty: Regarding the capability of financial incentive programs to reduce uncertainty, we have to distinguish between those that grant a one-time payment and those that guarantee current receipts. The first represent a lump-sum transfer contingent on making a certain energy efficiency investment, leaving the variance of possible payoffs of the investment itself unchanged.[142]

  Guaranteed current receipts – such as feed-in tariffs for electricity generated by renewables – can mitigate or even eliminate uncertainties regarding the future energy price path. They allow for a more certain prediction of future payment flows, thereby reducing the investor's risk costs.[143] For instance, the availability of (low interest) debt capital for financing photovoltaic systems clearly benefited from reduced uncertainty provided by the scheme of fixed feed-in tariffs. Sometimes the entitlement to receive the fixed remuneration already suffices as loan security.

- Capital market imperfections: It is obvious that the provision of subsidies help to overcome capital constraints, which may hamper investments in better energy efficiency that require higher upfront payments. Yet, if capital constraints are the only barrier to energy efficiency, public loan programs are certainly more suitable than direct subsidies or tax credits.

- Behavioral Anomalies: If potential investors' decisions are biased by behavioral anomalies, i.e., they overemphasize the initial costs and give relatively low weight to future returns, (direct) subsidies could possibly cancel out this bias and direct the investors towards are – privately and socially – optimal investment decision.

To sum up, tax credits and capital subsidies can play a valuable role in stimulating the market introduction and early market penetration of energy-efficient residential buildings and high-efficiency equipment.[144]

10.3.1.6.6.3 Problems

The fact that several financial incentive programs proved successful in increasing the adoption of energy efficiency technology does not necessarily imply that they were cost-effective. It is in the nature of subsidy and tax credit schemes that they are costly to the public budget; a system of long-term guaranteed feed-in tariffs constitutes considerable financial obligations that fall due in the future. Taking account of given budget constraints, expenses for financial incentive programs in the field of energy efficiency imply tax increases or spending cuts elsewhere; both counterbalancing measures will likely cause societal costs. These costs have to be balanced with the benefits of incentive program.

Besides budgetary crowding-out effects, subsidies may cause losses of social welfare due to a resource misallocation. If the amount of the granted subsidy exceeds the positive externalities of the subsidized commodity, then its price as faced by the consumers (i.e., net off the subsidy) can fall below the commodity's real costs. Facing a price lower than the commodity's real, consumers may consume a greater amount of the subsidized commodity than socially optimal. The probability of such an overconsumption increases with the size of the subsidy. Yet, in the presence of other market barriers than spill-overs, e.g., an undervaluation of future energy costs, such a gap between the real costs and the purchase price of the commodity may be required in order to incentivize the so-

[142] The risk costs may be slightly reduced due to a higher overall consumption level, but they remain widely unchanged.
[143] Other uncertainties such as the performance risk or the lifetime risk remain unaffected by the feed-in tariffs, but producer warranties may address these risks.
[144] Quinlan, P. (2001).

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cially optimal investment level. The “right” amount of the subsidy is dependent on various factors such as the magnitude of spill-overs to internalize, strength of behavioral anomalies, etc. The information requirements of the environmental authorities to find the socially optimal level of financial assistance are extremely high. Thus, the risk of governmental failure and regulatory failure is substantial.

When conducting a cost-benefit-analysis, the benefits need to be netted off free-riders. Free-riders are consumers who would have invested in energy efficiency even absent the subsidy policy, but receive additional benefits from the policy.[145] Benefits from such free-riders should not be included in the benefits from the policy, but costs that are not simply transfers should be counted as costs of the policy. Determining the share of free-riders within the group of program participants is also an extremely difficult task.[146]

10.3.1.6.6.4 Policy Recommendations

Financial incentive programs have several valuable capabilities, but at the same time they are associated with serious risk. Thus, their use is recommended but has to be planned with great care, and needs to be well-coordinated with other policy measures taken. Financial incentives can be an applicable policy instrument to stimulate greater energy efficiency in building wherein efficiency levels beyond mandatory building codes yield net benefits.

In order to be effective, financial incentive programs should be accompanied by appropriate information campaigns to induce initial interest, and they have to be designed (easily) understandable. A study of the World Energy Council found that potential investors who were eligible to receive a subsidy did not actually use it because they were not aware of the existence of the program or because they found the procedures to obtain the subsidy to be too bureaucratic.[147]

Especially, with regards to programs that guarantee payments to investors over a long time horizon current decision-makers have to be aware of the long-term financial obligations they enter into.[148] For instance, the German feed-in tariff scheme for renewable electricity already incurred a liability of several billion Euros to be paid over the next twenty years by German electricity consumers. Policy-makers have to be clear about their objectives and policy scope. Great shares of the photovoltaic systems installed in Germany are produced in China, which essentially implies that German electricity consumers finance experience-curve / learning curve effects accruing in China. Taking a global perspective that focuses on developing cost-effective CO_2-abatment technologies worldwide, the billions of subsidies may be well-invested. From a purely national perspective, however, the cost-benefit-results are worse.

[145] Joskow, P. L. / Marron, D. B. (1992).
[146] Carpenter, E. H. / Chester, T. S. (1984) found that the share of free-riders in such financial incentive programs could be substantial.
[147] WEC (2004).
[148] It has to be noted, however, that guaranteed feed-in tariffs as those used in Germany do not strain the public budget; their impacts rather equal a tax levied on electricity consumption and that is dedicated to the purpose of promoting the expansion of renewables.

10.3.1.6.7 Subsidized Loans

10.3.1.6.7.1 Idea

A rather indirect financial incentive instrument to induce energy efficiency investments is a favorable loans program: Usually a public bank grants favorable loan conditions, e.g., interest rates below market level and possibly delayed repayments, to investors contingent on compliance of the investment with certain energy efficiency criteria. While such favorable interest rates appear to be a subsidy from the investor's perspective, they do not incur necessarily budgetary expense for the state since the state gets better refinancing conditions than private lenders.[149]

Such favorable loan programs can apply to various energy-efficient and low-carbon investments such as

- new residential buildings upon low primary energy consumption, low final energy demand, low transmission losses or combinations of parameters,
- building refurbishments improving the energy efficiency of the building,
- energy-efficient equipment or appliances (e.g., heating systems),
- equipment utilizing renewable energy sources for energy-efficient appliances.

10.3.1.6.7.2 Benefits

The main asset of subsidized loan programs is to overcome capital constraints in the buildings market. As depicted in the previous section, information problems and risk aversion of private lenders can inhibit the provision of the required funds to finance the higher upfront costs of very energy-efficient residential buildings. The low interest rates provide an additional (financial) stimulus to invest in higher energy efficiency properties.

Aside from administrative costs, the capital costs of the favorable loan programs are low since states usually have access to funds at lowest interest rates as well as lower risk costs than private investors/lenders. The problem of free-riders, who get access to favorable loan conditions although they would have invested in better energy efficiency anyways, is of minor importance. In contrast to the financial incentive programs described afore, loan programs do not burden the normal public budget if the program only transmits the favorable financing conditions to the private borrowers.; thus, free-riders cause no or only relatively low opportunity costs (in terms of expenditure cuts required in other domains of public spending).

10.3.1.6.7.3 Problems

The actual effect of favorable loan programs on the amount of credit financing available to the investor is dependent on the credit rank-order. If private bank credits are lower-ranking than the subsidized loans, private lenders will likely cut back their borrowing limit. In consequence, the overall capital available to the investor might increase – if at all – only slightly through the provision of subsidized loans. In case of subordinated subsidized loans, private banks may even extend their credit lines because the collateral increases in value while the banks' credits keep priority. If both

149 Loan programs are to be classified unambiguously as subsidies if the allow for repayment rebates, too.

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state and private credit are equally ranking, it is to expect that private banks somewhat reduce their borrowing limit but lesser than in the case of low priority of their loans;[150] still, the overall amount of available funds for the investors is likely to increase. At the same time as reducing their borrowing limits with lower priority of their loans, they may also raise their demanded interest rates.

Private banking companies are generally assumed to have advantages compared to public banks (like reconstruction loan corporations) with regards to checking credit risks. Based on that assumption, there is a trade-off between the provision of additional funds for energy efficiency investments and the diligence of credit checks for such housing investments. If private-credits are prior-ranking, the overall available investment budget is maximized, but at the same time the

incentive for the private bank to check the credit risks with high diligence is low; due to the priority of the private bank's credit its default risk is low. Given a lower diligence level in credit checking in combination with a lower credit ranking, the default risk for the public lender is relatively high. Low diligence levels facilitate investments that cannot recoup their initial cost when a resale is required to repay the credit; this could be due to very specific preferences of the initial builder, low quality, etc. From a welfare economic perspective, such resource misallocation constitute real costs to the economy, lowering overall social welfare.

10.3.1.6.7.4 Policy Recommendations

Favorable loan programs are the by far most effective approach to overcome capital constraint related barriers to energy efficiency. Thus, energy policy should take advantage of the low refinancing conditions of government bodies and pass them on to investors in highly energy-efficient residential buildings.

Concerning the trade-off between the provision of additional capital for investments in higher energy efficiency and the level of diligence for credit checks, the right balance has to be found. It seems appropriate to determine the amount of the favorable loan according to the additional upfront costs required for upgrading the residential building from the expected energy efficiency without subsidized loans to the energy efficiency level deemed socially optimal. If the subsidized loan can be defined subordinated to private loans, the investor will likely get the necessary funds. At the same time, the loan is small enough not to crowd out other debt capital. In consequence, private lenders will probably maintain an acceptable level of credit check diligence.[151] Of course, in practice it is not feasible to estimate the additional investment costs of the energy efficiency enhancement for each credit application – at least not at acceptable transaction cost. Yet, the previous considerations should provide a rough guideline for designing subsidized loan programs.

Regarding the cost-effectiveness of subsidized loan programs one has to distinguish between the capital costs and the administration costs. As mentioned before, the capital costs of funds backed by the state are low; the administration costs depend on the organization of the program. Obviously, it should be designed in a manner that minimizes the operational costs. In this regard, it seems appropriate to integrate the application for favorable energy efficiency loans with the credit application procedures for the remaining capital requirements at a private bank.

[150] Additional state credits increase the ratio of debt capital; thus, the risk for the lenders also increases.
[151] Moreover, private banks will react to a subordinated subsidized loan not solely by reducing their diligence level, but also by offering lower interest rates. Ceteris paribus, a lower interest rate is compensated by a lower risk acceptance, which in turn limits the decline in credit check diligence.

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10.3.1.6.8 Information Provision

10.3.1.6.8.1 Idea

Information provision programs are motivated by the informational problems noted earlier. They aim to induce energy efficiency investments by providing information about the energy efficiency of energy consuming goods, potential energy savings, available energy conservation technologies, and more. The intention is that by providing greater and more reliable information, issues of asymmetric information and high transaction costs related to information gathering may be lessened; additional information may also lower the cognitive cost of energy decision making. Information programs can also include programs to raise awareness regarding the environmental consequences of energy consumption.

Information programs show a great variety and may comprise amongst others:

- Mandatory or voluntary certification programs for buildings
- Mandatory or voluntary labeling programs for electric appliances
- Energy passes for buildings
- Awareness raising and education campaigns
- Information and energy consulting services in (public) consumer advice centers
- Online services, e.g., and energy cost saving calculation tools

10.3.1.6.8.2 Benefits

If presented in a manner comprehensible to the potential investor, information provision programs can be valuable in improving buildings' energy efficiency. Although, the evidence of the effectiveness of information provision programs is mixed, a majority finds that these programs contributed successfully to increasing energy efficiency investments and to achieving energy savings.[152] Furthermore, information programs may create positive spill-overs if information spills via word-of-mouth communication. Besides effects on the adoption of energy-efficient equipment, information programs may also stimulate innovation towards higher energy efficiency; a study found that the responsiveness of energy-efficient product innovation to energy prices increased substantially after product labeling was required.[153] Firms may be apprehensive of competitive disadvantages if poor energy efficiency is revealed by mandatory labeling.

Also with regards to overcoming behavioral / psychological barriers to energy efficiency, information programs appear to be a prospective approach. By means of a more prominent information disclosure the salience and therefore the decision weight of energy efficiency properties and future energy cost can be increased. Psychological studies find that the avoidance of losses is rather decision-guiding than the prospect of gains.[154] Thus, information campaigns should prepare and present the information in a manner that gives emphasis to the risk of considerably rising expenses for energy services due to increasing energy prices if energy efficiency investments are omitted. This conclusion is in line with the predictions of prospect theory that asserts that losses loom larger

[152] Dias, R. / Mattos, C. / Balesieri, J. (2004); Howarth, R. B. et al. (2000); Ueno, T. et al. (2006); Levine, M. et al. (1995); Webber, C. A. et al. (2000); Weil, S. / McMahon, J. (2003).
[153] Newell, R. et al. (1999).
[154] Benz, I. (2009).

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than gains for an individual's decision under uncertainty. In view of potentially rising energy prices, framing additional energy costs in case of an omitted energy efficiency investment as losses instead of framing the energy cost savings of conducted energy efficiency investments as gains would increase the probability of an investment.

In some cases, information programs may be required to even raise awareness for the full implications of energy efficiency. Interestingly, surveys on the motivations for energy efficiency improving refurbishments found that economic viability is only quite rarely stated as a driver as well as a barrier; general convictions and attitudes towards sustainability and energy conservation seemed to have a greater impact on the decision to invest or not than economic considerations.[155] These findings reveal a lack of awareness of the potential energy cost savings resulting from improved energy efficiency properties. For policy action, this suggests exploiting the potency of awareness raising regarding i) the necessity of energy conservation for environmental protection, ii) the environmental benefits from improving energy efficiency, and iii) the potential private cost savings achievable with higher efficiency housing.

10.3.1.6.8.3 Problems

Basically, there are no significant drawbacks to be expected from information provision programs. Information programs by themselves address only market barriers related to information problems.[156] In case of bounded rationality due to insufficient information processing capacities or behavioral barriers the provision of information may widely fail in stimulating energy efficiency investments. If not designed properly, they may also turn out to be expansive and ineffective. Moreover, efficiency labels have to be regularly updated to recent technology developments in order not to lose information. For instance, if almost all models of a certain appliance type are labeled "A", consumers cannot distinguish the energy efficiency of different models at first glance; instead they need to search for the energy consumption figures at the tag.

10.3.1.6.8.4 Policy Recommendations

Embedded into a properly designed policy mix, information programs can be a highly cost-efficient instrument to support energy efficiency in the buildings sector. The effectiveness of almost all instruments discussed here can be improved if accompanied by appropriate information and education programs.[157] Vice versa, the effectiveness of information provision programs is increased if applied in combination with other policy instruments such as carbon pricing or financial incentives. Of course and as with any other policy instruments, for each information program it has to be assessed whether the benefits of the program justify its costs.

For highly complex products such as buildings the mandatory provided information should encompass both detailed specifications of the energy consumption, differentiated by energy carrier and energy service, and easy-to-catch labels. Energy passes could serve both purposes. Yet, the currently available energy passes should be complemented by another component. With regards to

[155] Jakob, M. (2007).
[156] Notwithstanding, combined with further policy instruments information provision programs can help to overcome other market barriers, too.
[157] Ürge-Vorsatz, D. et al. (2007).

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limited information processing capacities particularly of individual users / investors, energy consumption figures should be displayed not only in technical terms (i.e., annual kilowatt hours per square meter) but also in financial terms; the latter should comprise expected energy costs per year and for the expected service life of the investment, potentially even supplemented by a “high energy price scenario”. Given the higher decision weight of potential losses than prospective gains, the cost information displayed in the energy pass may comprise the additional energy costs implied by the building´s actual energy efficiency compared to the maximum (economically) feasible efficiency level. In order to broaden the appraisal of a building to include further sustainability criteria, (voluntary) certificates appear adequate. To maintain their informational value and to continuously stimulate innovations labels and certificates should be adjusted in regular time intervals in the wake of technological developments.

The provision of detailed information remains widely ineffective if the (private) decision-makers are not entirely aware of the environmental and economic impacts of their energy efficiency decisions. Programs to raise general awareness of energy efficiency issues increase the receptiveness for more detailed technology and cost information, and can promote long-term behavioral changes; thus, awareness raising programs should be integral element of the information provision strategy.

10.3.1.6.9 Overview of Policy Instruments

In the chapter “Residential and Commercial Buildings” of its fourth assessment report the IPCC provides an overview of the policy instruments potentially applicable to the entire buildings sector. We present the results relevant for the residential building in Table 24. It has to be noted that the studies used as sources for the IPCC overview are not always well comparable due to different approaches and methodologies.

The authors of this report would like to add a remark in particular regarding the appraisal of energy taxes. Although rated poorly in terms of effectiveness and cost-effectiveness in the IPCC overview, the authors of this report recommend the use to energy taxes as part of the energy policy strategy for the (residential) buildings sector. Taking account of the (opportunity) costs of raising public funds, energy taxes have the appeal to generate public revenues with relatively low distortionary effects due to the low price elasticity of the residential energy demand while at the same time still contributing to a certain extent to achieving energy conservation and GHG abatement targets.

Table 24: The Impact and Effectiveness of Various Policy Instruments Aimed to Mitigate GHG Emission in the Buildings Sector

Policy instrument	Examples of countries	Effectiveness	Energy or emission reductions for selected best practices	Cost-effectiveness	Cost of GHG emission reduction for selected best practices	Special conditions for success, major strengths and limitations, co-benefits	References
Taxation (on CO2 or household fuels)	NO, DE, GB, NL, DK, CH	Low	DE: household consumption reduced by 0.9%.	Low	n.a.	Effect depends on price elasticity. Revenues can be earmarked for further efficiency. More effective when combined with other tools.	World Energy Council (2001); Kohlhaas, M. (2005)
Energy performance contracting	DE, AT, FR, SE, FI, US, JP, HU	High	FR, SE, US, FI: 20–40% of buildings energy saved; EU:40–55MtCO2 by 2010; US: 3.2 MtCO2/yr.	Medium	EU: mostly at no cost, rest at <22 $/tCO2; US: Public sector: B/C ratio 1.6, Priv. sector: 2.1	Strength: no need for public spending or market intervention, co-benefit of improved competitiveness.	ECCP (2003); OPET network (2004); Singer, T. (2002); IEA (2003a); World Energy Council (2004); Goldman, C. et al. (2005).
Building codes	SG, PH, DZ, EG, US, GB, CN, EU	High	HK: 1% of total electricity saved; US: 79.6 MtCO2 in 2000; EU: 35–45 MtCO2, max 60% energy savings in new buildings.	Medium	NL: from –189 $/tCO2 to –5 $/tCO2 for end-users, 6–109 $/tCO2 for society.	No incentive to improve beyond target. Only effective if enforced.	World Energy Council (2001); Lee, W. L. / Yik, F. W. (2004); Schaefer, C. et al. (2000); Joosen, S.et al. (2004); Geller H. et al. (2006); ECCP (2001).
Appliance standards	EU, US, JP, AU, BR, CN	High	JP: 31 M tCO2 in 2010; CN: 240 MtCO2 in 10 yrs; US: 2.5% of electricity use in 2000 = 65 MtCO2, 6.5% = 223.87 MtCO2 in 2010.	High	AU: –15 $/tCO2 in 2012; US: –65 $/tCO2 in 2020; EU: –194 $/tCO2 in 2020.	Factors for success: periodical update of standards, independent control, information, communication and education.	IEA, (2005); Schlomann, B. et al. (2001); Gillingham, K. et al. (2004); ECS (2002); World Energy Council (2004); Australian Greenhouse Office (2005); IEA (2003a); Fridley, D. / Lin, J. (2004).
Tax exemptions / reductions	US, FR, NL, KO	High	US: 88 MtCO2 in 2006.	High	Overall B/C ratio – Commercial buildings: 5.4 – New homes: 1.6.	If properly structured, stimulate introduction of highly efficient equipment and new buildings.	Quinlan P. et al. (2001); Geller H. / Attali, S. (2005).

Policy instrument	Examples of countries	Effectiveness	Energy or emission reductions for selected best practices	Cost-effectiveness	Cost of GHG emission reduction for selected best practices	Special conditions for success, major strengths and limitations, co-benefits	References
Capital subsidies, grants, subsidized loans	JP, SI, NL, DE, CH, US, HK, GB	High	SI: up to 24% energy savings for buildings, GB: 3.3 $MtCO_2$; US:29.1 Mio BTU/yr gas savings.	Low	NL: 41–105 US$/$tCO_2$ for soc; GB:29 US$/$tCO_2$ for soc, –66 $/$tCO_2$ for end-user.	Positive for low-income households, risk of free-riders, may induce pioneering investments.	Martin, Y.et al. (1998); Schaefer, C. et al. (2000); Geller, H.et al. (2006); Berry, L. /Schweitzer, M. (2003); Joosen S. et al. (2004); Shorrock, L. (2001).
Mandatory labelling and certification programmes	US, CA, AU, JP, MX, CN, CR, EU	High	AU: 5 M tCO_2 savings 1992–2000; DK: 3.568 $MtCO_2$.	High	AU: –30 $/$tCO_2$ abated.	Effectiveness can be boosted by combination with other instrument and regular updates.	World Energy Council (2001); OPET network (2004); Holt, S. / Harrington, L. (2003).
Voluntary certification and labelling	DE, CH, US, TH, BR, FR	Medium/ High	BR: 169.6 $ktCO_2$ in 1998, US: 13.2 $MtCO_2$ in 2004, 2.1 bio tCO_2-eq in total by 2010; TH: 192 tCO_2.	High	BR: US$ 20 million saved.	Effective with financial incentives, voluntary agreements and regulations.	OPET network (2004); Word Energy Council (2001); Geller, H.et al. (2006); Egan, C. et al. (2000); Webber, C. et al. (2003).
Awareness raising, education / information campaigns	DK, US, GB, CA, BR, JP	Low/ Medium	GB: Energy Efficiency Advice Centres: 10.4 K tCO_2 annually.	High	BR: –66 US$/ tCO_2; GB: 8 US$/ tCO_2 (for all programmes of Energy Trust).	More applicable in residential sector than commercial.	Bender, L. et al. (2004); Dias, R. et al. (2004); Darby, S. (2006); IEA (2005); Lutzenhiser, L. (1993); Ueno, T. et al. (2006); Energy Saving Trust (2005).
Detailed billing and disclosure programmes	ON, IT, SE, FI, JP, NO, CL	Medium	Up to 20% energy savings.	Medium	n.a.	Success conditions: combination with other measures and periodic evaluation. Comparability with other households is positive.	Crossley D. et al. (2000); Darby, S. (2000); Roberts, S. / Baker, W. (2003); Energywatch (2005).

Source: Levine, D. M. et al. (2007).

10.3.1.7 Case Studies

In this section an attempt is undertaken to compare the five Baltic Sea region countries involved in the Longlife project (Denmark, Germany, Lithuania, Poland, and Russia) with regards to their respective general framework conditions for achieving sustainable energy efficiency levels in the residential buildings sector. In tabular form, we briefly assess the susceptibility to the market barriers depicted earlier, highlight the currently implemented policy instruments to foster energy efficiency, and finally suggest fields for further policy action. At the time of compilation of this report, the informational basis was not yet sufficiently ample to conduct comprehensive case studies. Most information was delivered by Longlife project partners in the form of responses to different questionnaires, which can be found in the Longlife deliverables. In view of the currently available information, the following table can provide only first indications regarding the susceptibility to market barrier problems and the policy responses taken; thus, the derived recommendations for policy action are provisory and under reserve.

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Table 25: Comparison of Susceptibility to Energy Efficiency Market Barriers and Policy Instruments across Baltic Sea Region Countries

	Denmark	Germany	Lithuania	Poland	Russia
Potential Market Barriers[1]					
Capital Market Problems	No information available.	Credit duration times are usually 20-30 years for private home-builders and buyers → amortization time might be longer than the credit duration Bridgeover finance (up to 100% debt capital) for the construction buildings to be sold as owner-occupied flats → incentives of project developers for rather low investments	Duration time of credits for private home-builders and buyers is approx. 20 years → capital market problem can occur regarding longer amortization times for energy-efficient buildings	Credit duration times are usually 20-30 years for private home-builders and buyers → amortization time might be longer than the credit duration Up to 100% equity capital for the construction buildings to be sold as owner-occupied flats → incentives of project developers for rather low investments	No information available
Energy Market Failures	Energy prices are high and mainly consumption-based → investments in energy efficiency measures turn to account	Energy prices are relatively high (but significantly lower than in Denmark) and mainly consumption-based → investments in energy efficiency measures often turn to account	Energy prices are below Danish and German price levels, but energy-efficient measures may still pay off		Low energy costs → investments in ambitious energy efficiency measures do often not pay off.

[1] Here, we focus on capital market problems, energy market failures, split incentives, and information problems. Spill-overs, uncertainty problems, and behavioral anomalies are hard to measure and will presumably be of similar relevance across the regarded countries.

Split Incentives	46% rental share [2] → high potential impact of the split incentives problem Provision of refrigerator and oven in rental and sold dwellings → reduced incentive of the owner/seller to invest in energy-efficient appliances Usually consumption-based allocation of energy costs (metered by consumption counters) → attenuated impact of split incentives on the energy efficiency	58.4% rental share → high potential impact of the split incentives problem In some cases appliances are part of the rented/sold dwelling → here the split incentive problem occurs Usually consumption-based allocation of energy costs (metered by consumption counters) → attenuated impact of split incentives on the energy efficiency	2.5% rental share, private ownership rate of 97.2% → low potential for the landlord-tenant problem In some cases a complete fitted kitchen (dishwasher, oven, washing machines, and refrigerator) is supplied → in these cases the split incentives problem takes effect Usually consumption-based allocation of energy costs (metered by consumption counters) → attenuated impact of split incentives on the energy efficiency	22% rental share → moderate potential of the landlord-tenant problem Provision of refrigerator and oven in rental flats → reduced incentive of the owner/seller to invest in energy-efficient appliances Usually consumption-based allocation of energy costs (metered by consumption counters) → attenuated impact of split incentives on the energy efficiency	No information available

[2] IUT (2009).

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Information Problems	Cost of expected energy consumption for heating and hot water production are included to the energy certificates → reduced information problem regarding the future energy cost performance of the dwelling (→ attenuated impact of the split incentives problem)	No monetary information given for regarding the energy efficiency of buildings (energy performance certificates in physical terms) → energy passes reduce the information problem, but are of limited value for the end-user due to lacking explicit information on future energy costs → bounded rationality problem	Energy performance certificates are implemented to reduce information asymmetries	Cost of expected energy consumption for heating and hot water production are included to the energy certificates → reduced information problem regarding the future energy cost performance of the dwelling (→ attenuated impact of the split incentives problem)	Information regarding the energy efficiency of buildings are not necessarily provided; no obligation to provide energy performance certificates or green building certificates Adverse selection; No method to calculate energy demand is implemented
Applied and Planned Policy Instruments					
Carbon Pricing (Energy Taxes and Carbon Trading)	The EU ETS covers emissions from central combustion plants (generation of electricity and heat) Additional energy taxes	The EU ETS covers emissions from central combustion plants (generation of electricity and heat) Additional energy taxes	The EU ETS covers emissions from central combustion plants (generation of electricity and heat)	The EU ETS covers emissions from central combustion plants (generation of electricity and heat)	No information available

Building Codes	Minimum requirements regarding energy efficiency: maximum energy demand for space heating, domestic hot water, cooling, pumps and fans Maximum heat loss coefficients for walls, roof, and windows are defined	Minimum requirements regarding energy efficiency related to size, geometry, orientation etc. of the building Maximal heat loss coefficients are defined The Renewable Energies for Heat Act mandates to use district heating (from CHP (combined heat and power)) or renewable energy for heating purposes, a waiver of this obligation is granted if the building exceeds the minimum requirements for primary energy consumption and heat losses by more than 15%	Minimum requirements regarding energy efficiency and thermal technique of the building envelope	Minimum requirements regarding energy efficiency: maximum value of EP annual index of computational demand for non-renewable primary heating energy, ventilation, hot usable water preparation, and cooling	Building codes for energy efficiency of buildings exist and regulate the specific heat consumption and required heat-transfer No energy efficiency requirements for fans, pumps, and temperature efficiency of heat recovery exist.
Financial Incentives and Subsidized Loans	Promotion of the use of renewable (solar) energy sources	Feed-in tariffs (electricity) and subsidies (heat) for the use of renewable energies and CHP Subsidized loan programs to promote the energy efficiency of resiresidential buildings			No information available

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Information Provision	Energy performance certificates include cost of heating and hot water and are required for new buildings as well as buildings that are rented out or sold	Energy performance certificates are required for new buildings as well as buildings that are rented out or sold, but include information on the primary and final energy demand only in physical terms	Energy performance certificates are obligatory	Energy performance certificates include cost of heating and hot water production, and thereby reduce information asymmetries for potential tenants and buyers	No information available
Provisory Policy Recommendations					
	Favorable loan programs could overcome potential capital market problems	Mandatory provision of energy performance information including expected energy costs	Favorable loan programs could overcome potential capital market problems Mandatory provision of energy performance information including expected energy costs	Favorable loan programs could overcome potential capital market problems	Accelerated introduction of consumption-based energy billing, installation of consumption counters Tax policy shift towards increased use of energy taxes (energy consumption metering required in order to achieve behavioral changes) Provision of financial incentives for energy-efficient refurbishments/building (recycling of energy tax revenues)

10.3.1.8 Conclusions and Policy Recommendations

The problem of anthropogenic climate change, triggered by ever rising energy consumption, and its environmental and economic consequences has attracted increased public attention during recent years. Buildings, which account for roughly 40 percent of today's energy demand – needed for heating, cooling, and powering the buildings – will play a critical role in the required transformation process towards a low-carbon and resource-saving economy. Energy efficiency is identified as the essential lever to bring down the buildings sector's energy consumption and GHG emission. Improving the energy efficiency of residential buildings is identified by several studies as one of the cheapest ways to save (fossil) energy and cut CO_2-emissions. From an economic perspective, energy efficiency enhancing investments usually involve a trade-off: Better energy efficiency properties require higher upfront costs but facilitate lesser operational and energy costs during the service life of the investment. It is asserted that various available energy efficiency options yield net gains for the investor, i.e., the energy conservation comes at negative costs.

The question arises why supposedly cost-effective measures, providing net benefits to the investor, are not taken by the relevant actors in the buildings sector. In this report we discussed several potential explanations for this seemingly irrational behaviour. Prevailing market conditions as well as behavioural patterns of individual decision-makers were revealed as possible market barriers that may inhibit the realization of higher energy efficiency levels. The difference between the actually realized level of energy efficiency and the level deemed optimal creates the so-called energy efficiency gap.

One has to distinguish between a narrow or private and a social efficiency gap. The private efficiency gap refers to energy efficiency improvements that are not implemented, although they would be beneficial – given current prices. The presence of a private efficiency gap implies that investors discount energy efficiency investments at discount rates that are not in accordance with "normal" private discount rates as usually applied by private consumers. Facing asymmetrically distributed information, limited cognitive capacities, transaction costs, and imperfect capital markets, decision-makers in the residential buildings market may tend to underinvest in energy efficiency. Moreover, behavioral anomalies could distort the investor's decision towards lower efficiency levels. Correcting all of these market barriers would lead to the privately rational energy efficiency level as illustrated in Figure 38.

The social efficiency gap refers to the difference between the actual energy efficiency and the efficiency level that would be optimal from a societal perspective. The societal perspective also accounts for external effects, which comprise costs and benefits that accrue to others than the investor and remain without financial compensation. As such externalities distort the price system the market mechanism can lead to deviations from the socially desired outcome even if the buildings market works without frictions and the market participants act individually rational. Internalizing the external costs (mainly environmental externalities) as well as the positive externalities (learning-curve effects) would yield the theoretical socially optimal energy efficiency level.[158]

Yet, it has to be noted that policy interventions to close the efficiency gap come at a cost. Costs are incurred for the design, implementation, and enforcement of the policy measures. Furthermore, policy interventions always entail the risk of governmental failure. Rational environmental and climate policy has to balance the benefits and costs of policy action. In this light, the optimal level of efficiency is that which is consistent with efficient overall resource use, including efficient use of

[158] We assume that all market barriers that prevent achieving the privately rational energy efficiency level were corrected before internalizing the externalities.

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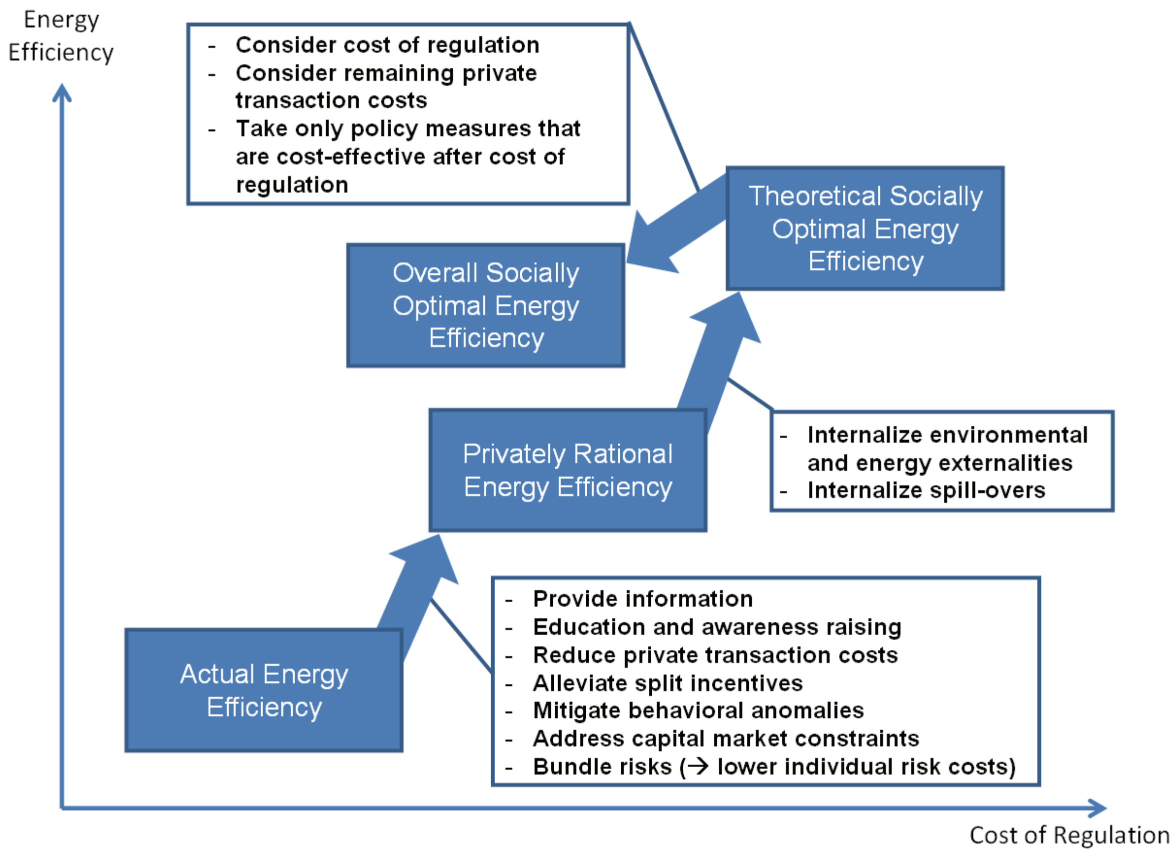
government resources required for the implementation of environmental policy.[159] Thus, reaching an economically optimal level of energy efficiency regularly does not imply to maximize the technically feasible level of energy efficiency.[160]

Figure 38: Illustration of Optimal Energy Efficiency Levels



Source: Own Illustration.

The optimal energy efficiency level and the appropriate energy policy strategy to achieve it differ across countries or even regions according to the diverging underlying circumstances (e.g., climate, availability of resources and technologies, institutional structures, etc.). Notwithstanding, some general conclusions about the assets at drawbacks of different policy instruments to address the energy efficiency gap can be drawn. We assessed a number of potential policy interventions regarding their general capabilities to attenuate market barriers, which cause a slow uptake of energy efficiency technologies, in an overall welfare improving manner. We conclude that no single policy instrument can capture the entire potential of cost-effective energy efficiency improvements in the residential buildings sector. In order to overcome the various market barriers in this sector a policy package comprising diverse instruments is required. Combined in a well aligned portfolio, the employed policy instruments can enfold synergetic effects and be mutually reinforcing.

[159] This is illustrated in Figure **38** by moving from the theoretical to the overall socially optimal energy efficiency level.
[160] Economic efficiency implies the minimization of the aggregate costs to the society for achieving given energy conservation and GHG mitigation targets.

Carbon pricing is an indispensable pillar of any climate policy and sustainable energy use strategy. A socially optimal energy consumption pattern is only achievable if energy prices reflect the full costs of energy consumption, including environmental damage costs. In order to create a coherent climate policy framework and to pave the way for a comprehensive global GHG trading scheme, fossil fuels that are combusted at the building site should be included – in the mid-term – into the EU ETS. This can be realized at lowest transaction costs by means of the so-called upstream approach. Besides incentivizing the adoption of highly energy-efficient equipment, carbon pricing directs the consumption of energy services towards a more economical manner. Beyond their impact on energy consumption behavior, energy taxes and revenues from auctioning off emission allowances are an attractive source of public revenues that facilitates the reduction of other – more distorting – taxes.

Amongst the policy instruments explicitly dedicated to increasing the level of energy efficiency in the residential buildings sector, building codes and efficiency standards are the mainstays of the recommended energy conservation strategy. Considering the heterogeneity of buildings and users, building codes should define the baseline for the buildings' energy efficiency that ensures benefits for the vast majority of buildings. In order to tap further potentials for cost-effective energy savings in specific types of buildings complementary policy instruments are to be used to provide incentives for additional energy efficiency measures.

Within the group of complementary policy measures financial support instruments can play a vital role in incentivizing investments in improved energy efficiency. Their economic justification rests mainly on their capability to internalize positive externalities, i.e., investors are financially compensated for the positive spill-overs (e.g., triggered innovation and experience-curve effects) they produce by developing and acquiring highly energy-efficient homes or equipment. While funding basic research to lay the foundations for technology innovations is widely accepted as a governmental task, public financial support for the acquisition of more-market ready technologies is not uncontentious. It is in the nature of subsidy and tax credit schemes that they are costly to the public budget; incurred opportunity costs of public funds and budgetary crowding-out effects may occasion societal costs.

Nevertheless, there are prudent arguments for subsidizing the market adoption of more mature energy efficiency technologies. Beyond triggering considerable experience-curve effects, financial incentive programs supporting the market penetration of sustainable and energy-efficient buildings may produce learning-by-using spill-overs that can amplify the environmental impact of the programs. Financial support for demonstration projects and "pioneering" investments in energy efficiency could help to inform and convince potential investors – beyond the program participants – of the advantages of an energy-efficient design of their dwelling.

With regard to the financial sums at stake in decisions concerning building investments, capital constraints can be a crucial issue for the adoption of energy-efficient technologies as they require higher upfront costs than less efficient alternatives. Favorable loan programs offer an effective approach to overcome capital constraint related barriers to energy efficiency. Thus, energy policy should take advantage of the low refinancing conditions of public loans and pass them on to investors in highly energy-efficient residential buildings. The granted amount should cover the additional upfront costs and may be defined subordinated to private loans in order to actually increase the available investment capital.

Finally, information, education, and awareness raising programs can be a highly cost-efficient instrument to support energy efficiency in the buildings sector if embedded into a properly designed policy mix. The effectiveness of almost all instruments discussed here can be improved if accompanied by appropriate information programs. For complex products such as buildings the mandatory

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provided information should encompass easy-to-catch labels, detailed specifications of the energy consumption, and expected energy costs per year and for the expected service life of the investment. In order to broaden the appraisal of a building to include further sustainability criteria, (voluntary) certificates appear adequate.

Yet, the provision of substantial information remains widely ineffective if the (private) decision-makers are not entirely aware of the environmental and economic impacts of their energy efficiency decisions.[161] Programs to raise general awareness of energy efficiency issues increase the instors' and energy consumers' receptiveness for detailed technology and cost information, and can promote long-term behavioral changes.

Psychological studies suggest that for the spreading of innovative technologies personal, experience-based information is often more important than non-personal information. Hence, the importance of word-of-mouth information dissemination provides further arguments for financial support for "early" adopters and demonstration projects that can serve as samples for the technical feasibility and economic viability of sustainable and energy-efficient housing concepts.

Notwithstanding, the use of environmental policy instruments always entails the risk of governmental failure. In order to reduce the necessity for regulatory interventions such as those mentioned afore, market forces can be utilized to narrow the energy efficiency gap identified in the buildings sector. Energy performance contracting can remedy or at least mitigate suboptimal energy efficiency investments caused by split incentives between building users and owners/property developers. Policy should create a legal and institutional environment that facilitates the use of mutually beneficial energy service contracts.

[161] For instance, due to greater salience of the consumption and billing process many consumers are significantly more aware of their vehicle fuel consumption than their household energy consumption.

10.3.2 Analysis, Comparison and Requirements on Funding Instruments, on preconditions of property Related Factors, on Conduction of Financial/ Planning Processes in Consideration of Sustainability for the Project Longlife

10.3.2.1 Overview

PP3 (PRO POTSDAM GmbH) made an tendering with the title “analysis, comparison and requirements on funding instruments, on preconditions of property related factors, on conduction of financial/planning processes in consideration of sustainability for the project Longlife”. A few companies have been directly scored, but none of them were able to participate in the tendering. Consequently we decided to the job ourself. Therefore we developed a questionnaire to get answers from all participating countries and to make our conclusions according to the tendering´s theme as follows.

The financing structure for multistorey residential buildings is normally composed of debt capital (50-100%) and equity capital (0-50%). In Germany and Poland the debt capital can be supported by special conditions.

There are no requirements to bring in a certain amount of equity capital to bring in by an investor but in practice in most cases a certain share of equity capital is necessary.

Debt financing is predominantly usual in the participating countries with an extent of 50-90%. The usual duration is 25-45 years. It seems to be dependent from the amount respectively from the share of the whole investment capital.

Regarding to the collaterals that are needed to have for a credit respectively financing instrument the minimum is to have land charges (in the amount of the debt capital or in the amount of a percentage of 50-60% of the estimated land price). Additional collaterals are possible.

In the financing costs (of the total financing volume) are always incurred the costs for providing security (e.g. notary, cadastre). Other costs can be possible, such as arrangement fees/bank charges (2-4%), disagio (3,63-5,33%), provision rates (3%) and interest rates plus margin of the bank. The costs cannot be unified for all countries.

Except in Denmark, financing costs reduce the taxable profit in the year of appearance.

The evaluation of buildings for financing aspects by a credit institute or an expert is orientated on the establishing of net values/market values. Variations can be possible.

As a result of the valuation of a building the estimated value has generally influence on the amount of the loan and its conditions and terms (interest rates, collaterals etc.)

The funding opportunities for new residential building projects changed in the last years. In Germany, it is harder for special investors to get a financing because of their rating. It is similar in Poland where they have a careful look to the projects and its conditions. In Lithuania, commercial banks even stopped financing of the construction sector. In general, the opportunities deteriorated varyingly strong.

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The support of residential building projects is very different in the participating countries. While you can get loans at reduced rates of interest in Germany, only social housing is supported in Lithuania and only the use of renewable energy sources in the construction is supported in Poland.

Because of economical (high material costs/investment costs cause high rents which are not payable by the tenants) and environmental reasons the support is necessary. As affairs now stand there are no incentives for the construction of sustainable buildings. Otherwise no sustainable aspects which will cause high investment costs at first can be considered for new building.

Regarding to specific financial support offered to advance sustainable and/or energetic new residential buildings, Germany offers loans at reduced rates of interest, while in Poland, you can also get such loans and you have additionally the possibility of a waiver of interest on half of the loan.

To improve the support of sustainable residential buildings the participating countries recommend the following possibilities:

- loans with reduced interest rates
- grants
- additional supports for tenants
- specific support for sustainability measurements

10.3.2.2	Composition of the financing of a typical multistorey residential building						
	Question	**Denmark**	**Germany**	**Lithuania**	**Poland**	**Russia**	**Summary/Benchmarks**
10.3.2.2.1	How is the **financing** structure composed for multistorey residential building projects ? **a)** debt capital in % **b)** equity in % **c)** support from funds in %	a) 91 % b) 2 % tennants c) 7 % support fra municipality	a) 60% debt capital b) 40% equity c) app. 1/2 of the debt capital is supported by loans at reduced rates of interest (max. 50.000 € per dwelling), the rest is not supported (no grants), normal loans with market interest rates	a) 50% debt capital b) 50 % equty capital	possibility to finance up to 100% of property value c) during 8 years State support half of the interest - the contracted credit, but only if you bought flat surface is not greater than 50 m², 70 m² family house		The financing structure is normally composed of **debt capital (50-100%)** and **equity capital (0-50%)**. In Denmark, Germany and Poland the debt capital can be supported by special conditions.
10.3.2.2.2	How much **equity** an investor usually has **to bring in for multistorey housing projects** in %?	n.a	There are no requirements by the promotional bank (KfW), but with regard to economy and securities for the debt capital 30-40% seem to be necessary.	There are no requirements by the local commercial banks, but with regard to economy and securities for the debt capital 20-50% seem to be necessary.	There are no requirements		There are no requirements to bring in a certain amount of equity capital but in practice in most cases **a certain share of equity capital is necessary**.
10.3.2.2.3	Is debt financing usual (with the typical collaterals)? To what extent?	yes 91 %	Yes, it is an usual financing instrument in Germany for housing projects. Extent: 60-70% of the costs	Yes, it is an usual financing instrument in Lithuania for housing projects. Extent: 50-90% of the costs	Yes, it is an usual financing instrument in Poland for housing projects. Extent: 50-90% of the costs.		Debt financing is usual with an **extent of 50-90%**.

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10.3.2.2 Composition of the financing of a typical multistorey residential building

10.3.2.2	Composition of the financing of a typical multistorey residential building						
	Question	Denmark	Germany	Lithuania	Poland	Russia	Summary/Benchmarks
10.3.2.2.4	What is the **usual duration** of the credit/financing instrument?	45 years	30 years	investor-project term, buyer - untill 25 year (depends on creditor age, motivation and etc)	30 years.		The usual duration is **25-45 years**. It seems to dependent from the amount respectively from the share of the whole investment capital.
10.3.2.2.5	What are the **collaterals** you need to have for a credit/financing instruments? (Advance on securities for credit/financing support)	only building when compleated	- at the minimum: land charges in the amount of the dept capital registered on the plot with the new building - dependant on the collateral value additional collaterals are possible: land charges on other plots, assignments of rent, guaranties	- land charges 50-60% of estimated land price, addditional guaranties	at the minimum: land charges in the amount of the dept capital registered on the plot with the new building		At the minimum you need **land charges** (in the amount of the debt capital or in the amount of a percentage of 50-60% of the estimated land price) respectively the building for use as collateral . **Additional collaterals are possible**.

10.3.2.2	Composition of the financing of a typical multistorey residential building						
	Question	Denmark	Germany	Lithuania	Poland	Russia	Summary/Benchmarks
10.3.2.2.6	How high are the financing costs in % of **the total financing volume**? (all costs e.g. for the acquisition of the bank credit/financing instrument, the commission for the procurement of a credit , the interest, the disagio)	about 7%	- costs, that are always incurred: costs for providing security (notary and cadastre, the amount is dependant on the amount of the land charge) - if other costs occur is dependant on the bank and the rating of the investor. These costs can be: arrangement fees, disagio (usually 4%), provision rates (usually 3%). - interest rates conform with the market interest rates plus margin of the bank (the amount is usually dependant on the investor´s rating, the duration of the loan and the fixed interest rate). By support of the KfW-bank the interest rate is below market interest rate.	- costs, that are always incurred: costs for providing security (notary and cadastre, the amount is dependant on the amount of the land charge and transaction cost) -Bank charges 2 % of loan price - interest rates VILIBOR (6 months or 3 months) or EUROLIBOR (6 months or 3 months)+bank margin (1-2 %)	- costs, that are always incurred: costs for providing security (notary and cadastre, the amount is dependant on the amount of the land charge) - if other costs occur is dependant on the bank and the rating of the investor. These costs can be: arrangement fees, disagio (betwen3,63%-5,33%), provision rates (usually 3%). - interest rates conform with the market interest rates plus margin of the bank (the amount is usually dependant on the investor´s rating, the duration of the loan and the fixed interest rate).		Costs, that are always incurred: **costs for providing security**. **Other costs can be possible**, such as arrangement fees/bank charges (2-4%), disagio (3,63-5,33%), provision rates (3%) and interest rates plus margin of the bank. **Costs cannot be unified for all countries**.

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10.3.2.2 Composition of the financing of a typical multistorey residential building

10.3.2.2	Composition of the financing of a typical multistorey residential building						
	Question	Denmark	Germany	Lithuania	Poland	Russia	Summary/Benchmarks
10.3.2.2.7	Is there a **deductibility** for the financing costs of the asset of a company?	n.a	In the German tax system financing costs are immediately deductible operating costs or advertising costs. They reduce the taxable profit in the year of appearence.	Regarding Lithuanian standarts financing costs reduce taxable profit in the same year that they occurred, exception if borrowed capital ratio to equity capital more than 4/1, interest for loan more then 4*equity are undertaxable	In Poland tax system financing costs are immediately deductible operating costs or advertising costs. They reduce the taxable profit in the year of appearence.		**Except in Denmark, financing costs reduce the taxable profit in the year of appearance.**

10.3.2.3	Valuation of a building						
	Question	Denmark	Germany	Lithuania	Poland	Russia	Summary/Benchmarks
10.3.2.3.1	How does a credit institute or appraiser/expert **evaluate** a **building for financing aspects**? Describe the typical (international) valuation standards.	market evaluation only	In Germany the BelWertV (ordinance for the establishing of collateral values) has to be considered. The establishing of collateral values orientates on the establishing of net values, but normally the establishment is much more strict. So assumptions such as the capitalisation interest rates are higher. The collateral value is always less than the net value.	In Lithuania private appraisers estimate market value of a building for credit institutions (methologdy depends on situation-comparative methods or future profit).	In general, indicated the estimated value of the property is subject to a tolerance and precision of estimation. It is commonly believed that the differences + / -20% of the two independent valuations for the same object, the results converge. Until recently, this limit also adopt the tax authorities, when determining the value of the property under appeal or control. Currently abroad, this shall be + / -33%.		The evaluation of buildings for financing aspects is orientated on the establishing of **net values/market values**. Variations can be possible.

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10.3.2.3 Valuation of a building

10.3.2.3	Valuation of a building						
	Question	Denmark	Germany	Lithuania	Poland	Russia	Summary/Benchmarks
10.3.2.3.2	What is the **result/influence** of the valuation of the building **for the credit approval process**?	bank has no influence on the building project - only the municipality!	The collateral value has influence on the margin of the bank and the necessary securities. If an investor has no other securities than the plot that has be built on, and the collateral value is less than the amount of the requested loan, it is highly probable that the investor will not get the loan in the requested amount but in a less amount.	Because of valuation mainly depends sum of loan, conditions and terms.	The collateral value has influence on the margin of the bank and the necessary securities. If an investor has no other securities than the plot that has be built on, and the collateral value is less than the amount of the requested loan, it is highly probable that the investor will not get the loan in the requested amount but in a less amount.		The estimated value of the building has influence **on the amount of the loan and its conditions and terms** (interest rates, collaterals etc.). In Denmark only the municipality has influence on the project not the bank.

10.3.2.4	Development of the financing modells						
	Question	Denmark	Germany	Lithuania	Poland	Russia	Summary/Benchmarks
10.3.2.4.1	Did the **funding opportunities** for new residential building projects **change** in the last years? (e.g. since the financial crises in 2008/2009)	no	Funding opportunities changed, especially for commercial investors and those who get worser ratings by bank. With regard to the financial crisis the margins of the banks increased but the refinancing costs of the credit institutes increased as well and these are passed on the investors.	Funding opportunities changed. Because of crise in nt market, it' very difficult to get investment for real estate projects and in practice commercial banks stopped financing of construction sector.	Funding for development of real estate requires careful consideration to the project, its market position and the time horizon of the recovery process outlays.		**Funding opportunities changed**. In Germany, it is harder for special investors to get a financing because of their rating. It is similar in Poland where they have a careful look to the projects and its conditions. In Lithuania, commercial banks even stopped financing of the construction sector.
10.3.2.4.2	Did the funding **opportunities** for **investors improved** or **deteriorated** significantly?	no problems for building associations	In general, the opportunities deteriorated varyingly strong. PRO POTSDAM GmbH has no problem to receive credits, but especially margins are higher than 2 years before.	In general, the opportunities deteriorated varyingly strong. Especially in real estate and relevant fields.	In general, the opportunities deteriorated varyingly strong.		In general, the **opportunities deteriorated varyingly strong**.

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10.3.2.5 Typical and essential supporting systems for housing projects

10.3.2.5	Typical and essential supporting systems for housing projects						
	Question	**Denmark**	**Germany**	**Lithuania**	**Poland**	**Russia**	**Summary/Benchmarks**
10.3.2.5.1	Is there a **general support** from **public funds** available for new residential building projects? (short description of the conditions and amount of funding)	only in the matter of municipality cofinancing regarding 7% of the total financing structure	Yes, there are federal means (loans with reduced interest rates) but no state means and funds or subsidies from local authorities. The KfW-program "Energy-Efficient Construction" has been described in work package 3.	no support for private construction companies for development of housing projects. Only for social housing. During economical crisis time there is a discount for loan (only 5% interest rate +VILIBOR)	No support for private construction companies for development of housing projects. Only The actions of state bodies and local means of obtaining funding for the use of renewable energy sources (RES) in the construction of your home and environment-friendly actions.		**The support of residential building projects is very different in the participating countries**. While you can get loans at reduced rates of interest in Germany, only social housing is supported in Lithuania and only the use of renewable energy sources in the construction is supported in Poland. In Denmark you have the possibility of being cofinanced by the municipality.

10.3.2.5	**Typical and essential supporting systems for housing projects**						
	Question	**Denmark**	**Germany**	**Lithuania**	**Poland**	**Russia**	**Summary/Benchmarks**
10.3.2.5.2	What is the **significance** of the **governmental support** for new **residential building** projects? (short discription **why** the support is **needed**)	none	In most German regions we do not have housing shortage. Without governmental support there is no incentive for the construction of new buildings especially sustainable new buildings. With regard to the actual building and material costs and due to economy high rents are needed. But the needed rents are not payable by the tenants. Also construction costs increased within the last years significantly. Therefore and because of economical and environmental reasons the support is necessary. Otherwise no sustainable aspects which will cause high investment costs at first can be considered for new building.	In Lithuania we have governmental support only for social housing, but not for private companies projects	In Poland we have governmental support only for energy-efficient home construction. Therefore of economical and environmental reasons the support is necessary.		Because of **economical** (high material costs/investment costs cause high rents which are not payable by the tenants) **and environmental reasons** the support is necessary. As affairs now stand there are no **incentives** for the construction of sustainable buildings. Otherwise no sustainable aspects which will cause high investment costs at first can be considered for new building.

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10.3.2.5 Typical and essential supporting systems for housing projects

10.3.2.5	Typical and essential supporting systems for housing projects						
	Question	Denmark	Germany	Lithuania	Poland	Russia	Summary/Benchmarks
10.3.2.5.3	What specific **financial support** is offered to advance **"sustainability"** and / or **"energetic new residential buildings"**? (short description of the conditions and amount of funding)	none	Energy efficient new buildings are supported by the KfW promotional bank (see also 10.3.4.1 and work package 3), but there is no special support for sustainability.	No specific support	Currently available funding instrument is a subsidized loan of the Bank of Environmental Protection, whose interest rate is even 2%, while allowing a waiver of interest on half of the loan. The repayment period is spread over eight years		Germany offers **loans at reduced rates of interest**. In Poland, you can also get such loans and you have additionally the possibilty of a **waiver of interest** on half of the loan.
10.3.2.5.4	What kind of **recommendations** can be given **to the states** and / or **the EU** to **improve the support of sustainable residential buildings?**	lower interest rates for sustainabel buildings	- loans with reduced interest rates (the maximum amount of 50.000 € per dwelling is not enough) - grants - additional supports for tenants - specific support for sustainability measurements	loans with reduced interest rates; additional support for teants; specific support for sustainability measurements	loans with reduced interest rates; additional support for teants; specific support for sustainability measurements		Possibilities for support are: - **loans with reduced interest rates** - **grants** - **additional supports for tenants** - **specific support for sustainability measurements**

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12.Glossary

Affordable housing

Affordable housing is a general term applied to public- and private-sector efforts to help low- and moderate-income people purchase homes, taking into consideration income, liabilities, available funds, mortgage type, home price and closing costs.

DE	Finanziell tragbares Bauen
DK	Billige boliger
LT	Prieinamas būstas
PL	Tanie mieszkania
RU	Доступное жилье

Annual Primary Energy Demand

The annual primary energy demand is energy which is needed to cover the annual demand of primary energy used for running the whole building system like heating, ventilating, heating water and the external process chain of the building.

DE	Jahresprimärenergiebedarf
DK	Årligt primær energiforbrug
LT	Metinis pirminės energijos poreikis
PL	Roczne zapotrzebowanie na energię pierwotną
RU	Удельный расход тепловой энергии на отопление здания за отопительный период

Anthropogenic Greenhouse Effect

CO_2 is the number one human-produced heat-trapping gas that contributes most to the increasing temperature on Earth. It is produced by fossil fuel burning, cement production and tropical deforestation.

DE	Anthropogener Treibhauseffekt
DK	Anthropogener Treibhauseffekt
LT	Antropogeninis šiltnamio efektas
PL	Antropogeniczny efekt cieplarniany
RU	Парниковый эффект

Atmospheric Greenhouse Effect

Certain gases (e.g. carbon dioxide, methane, water vapor, nitrous oxide) in the atmosphere cause a rise in temperature on earth. Without these gases the heat/energy of the sun would be emitted into space and the average temperature on earth would be colder.

DE	Atmosphärischer Treibhauseffekt
DK	Atmosfærisk drivhuseffekt
LT	Atmosferinis šiltnamio efektas
PL	Atmosferyczny efekt cieplarniany
RU	Парниковый эффект

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A/V surface-area-to-volume ratio

The calculation of surface-area-to-volume ratio helps to optimize the form of the building to minimize the thermal losses.

DE	A/V Verhältnis
DK	Areal-volumen forhold
LT	Išorės atitvarų ploto ir pastato tūrio santykis; A/V santykis
PL	A/V stosunek powierzchni do objętości
RU	Соотношение площади поверхности здания к его объему

Building Application

Request for a building permission in order to implement a building project.

DE	Bauantrag
DK	Byggeansøgning
LT	Statybos leidimo prašymas
PL	Pozwolenie na budowę
RU	Разрешение на строительство

Building Controll Authority

An office with the authority to control the approval of building plans. It ensures that these plans match the regulations and targets of the City and building regulations.

DE	Bauaufsichtsbehörde
DK	Byggesagsafdeling
LT	Statybų kontrolės tarnyba
PL	Nadzór Budowlany
RU	Комитет по градостроительству и архитектуре

Climate Change

Climate change is a statistical change of weather patterns over a certain period of time. Climate Change can occur regionally or around the world and can appear as warmer or colder tempera-tures or as a change in the amount of the annual rainfall.

DE	Klimawandel
DK	Klimaændring
LT	Klimato kaita
PL	Zmiany klimatyczne
RU	Изменение климата

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Climate Responsive Building

Considering the local resources during the planning process and adjusting the building design to the local climate. The aim is an optimum of indoor temperature and to prevent damage caused by climatic circumstances.

DE	Klimagerechtes Bauen
DK	Klimarigtigt byggeri
LT	Palankus klimatui pastatas
PL	Zrównoważone budownictwo
RU	Застройка, отвечающая требованиям климатических характеристик

Comfort Zone

The state at which man can spend the minimum energy adjusting to his environment.

DE	Komfortzone
DK	Komfortzone
LT	Komforto sritis/zona
PL	Strefa komfortu
RU	Комфортные условия

Construction Area (CA)

The Construction Area (CA) is the total amount of floor space of the rising building elements. The dimensions of the construction components at the height of the floor, like external walls, internal walls, pillars, including plaster but no elements like skirting boards.

DE	Konstruktionsgrundfläche (KGF)
DK	-
LT	Užstatytas plotas
PL	Plac budowy
RU	Площадь застройки

Conversion (Redevelopment) Potential

The potential of a building to alternate from its previous use, respectively the possibility to modulate easily its original floor-plans in order to suit the requirements of the occupant. E.g. variable floor plans in case of children moving out or grandparents moving in.

DE	Umnutzungspotential
DK	Renoveringspotentiale
LT	Konversijos potencialas
PL	Możliwość przebudowy
RU	Реновационный (реконструкционный) потенциал здания

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Cost Efficient Architecture

Is a term that refers to the economical approach to design techniques in the field of architecture. It seeks to minimize construction and operation costs by enhancing efficiency and moderation in the use of material, energy and development space, yet it ensures high quality architecture.

DE	Kostengünstiges Bauen
DK	Totaløkonomisk projektering
LT	Ekonomiškai efektyvi architektūra
PL	Architektura opłacalna ekonomicznie
RU	Экономически эффективная застройка (архитектура)

Cubic Index

Cubic Index = Gross volume (m^3) ÷ plot area (m^2)

DE	Baumassenzahl
DK	Rumfang/volumen per m^2
LT	Kubo indeksas
PL	Współczynnik kubatury
RU	Отношение общего объема зданий к его общей площади (K2)

Downcycling

Downcycling is converting used materials into products of lower value, or the re-use of a product for alternative purposes. E.g. plastic recycling or the use of crippled masonry as flint in a concrete aggregate.

DE	Downcycling
DK	Nedbrydning / genanvendelighed
LT	Perdirbimas
PL	Downcycling
RU	Переработка отходов

Ecological Building

The attempt to assign principals of nature like circular flow and energy efficiency to the building industry.

DE	Ökologisches Bauen
DK	Økologisk Byggeri
LT	Ekologiškas pastatas
PL	Budownictwo ekologiczne
RU	Экологическое здание

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Ecology

Ecology is the interdisciplinary scientific study of the interactions between organisms.

DE	Ökologie
DK	Økologi
LT	Ekologija
PL	Ekologia
RU	Экология

Effective Area (EA)

The effective area (m²) is the area of the house which the occupant may actually use, in other words it is the area that serves buildings because of its purpose.

DE	Nutzfläche (NF)
DK	Anvendeligt boligareal
LT	Naudingasis plotas
PL	Powierzchnia użytkowa
RU	Полезная площадь (Sп)

Energy Efficiency

Energy efficiency is the optimal benefit of using energy, considering adequacy and ecological compatibility.

DE	Energieeffizienz
DK	Energieffektivitet
LT	Energinis efektyvumas
PL	Wydajność energetyczna
RU	Энергоэффективность

Energy Performance Certificate (EPC)

Energy Performance Certificates (EPCs) give information on how to reduce carbon dioxide emissions and improve the energy efficiency of a building. All houses bought, sold or rented should require an EPC.

DE	Energieausweis
DK	Energimærke
LT	Energinio naudingumo sertifikatas
PL	Świadectwo Charakterystyki Energetycznej
RU	Энергетический паспорт здания

Energy-Plus Building

A term applied to a house that produces a surplus of energy during a certain time of the year with zero net energy consumption.

DE	Plusenergiehaus
DK	Energi Plus bygning
LT	Energiją gaminantis pastatas
PL	Budynki Energy-Plus
RU	Экономически эффективная застройка

Energy Standard

The energy standard of a building defines the annual energy demand in relation to m² of living space of the evaluated house.

DE	Energiestandard
DK	Energistandard
LT	Energijos/Energetinis standartas
PL	Standard energetyczny
RU	Энергетический стандарт

Final Energy

Final energy is the actual portion of primary energy which reaches the consumer considering the loss of transmitting and converting energy. E.g. gas or electricity.

DE	Endenergie
DK	Bruttoenergi
LT	Galutinė energija
PL	Energia końcowa
RU	Энергия, поданная конечному потребителю

Final Energy Demand

Energy consumption of the entire building system in the house, including heating, ventilation, water heating and energy loss of the building systems. Climatic conditions and vacancy are considered.

DE	Endenergiebedarf
DK	Bruttoenergiforbrug
LT	Galutinės energijos poreikis
PL	Zapotrzebowanie na energię końcową
RU	Энергетическая потребность здания

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Flexibility

Flexibility is used as an attribute of various types of systems. In the field of engineering systems design, it refers to designs that can adapt when external changes occur. In the context of engineering design one can define flexibility as the ability of a system to respond to potential internal or external changes affecting its value delivery, in a timely and cost-effective manner.

DE	Flexibilität
DK	Fleksibilitet
LT	Lankstumo
PL	Elastyczność
RU	Способность к приспособляемости

Floor-Space Index (FSI)

Floor-space index = Floor space area (m²) ÷ plot area (m²)

DE	Geschoßflächenzahl (GFZ)
DK	Bebyggelsesprocent
LT	Užstatymo intensyvumo rodiklis
PL	Współczynnik powierzchni kondygnacji
RU	Коэффициент полезной площади застройки= площадь застройки(м²) /площадь участка(м²)

Functional Area (FA)

The functional area (m²) serves the placing of the technical installations in a building

DE	Funktionsfläche
DK	Funktionsområdeareal (FA)
LT	Funkcinis plotas
PL	Powierzchnia usługowa
RU	Функциональная зона (площадь технических помещений)

Global Warming

A term which relates to the increase in the average temperature of the near earth atmosphere and oceans, primarily caused by emitting heat-trapping gases, like CO_2, methane etc.

DE	Globale Erwärmung
DK	Global opvarmning
LT	Pasaulinis atšilimas
PL	Globalne ocieplenie
RU	Глобальное потепление

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Greywater

All the water that can’t be used for drinking and washing any more but can be reused a second time for toilet flushing. Rainwater is defined as greywater, too.

DE	Grauwasser
DK	Gråvand
LT	Nutekamieji vandenys
PL	Ścieki szare
RU	Greywater

Gross External Area (GEA)

Gross External Area (GEA) describes the total amount of m^2 of all floor plans of one building. The Gross External Area is to be calculated floor by floor.

DE	Brutto-Grundfläche (BGF)
DK	Bruttoetageareal
LT	Bendrasis išorinis plotas
PL	Kubatura brutto
RU	Общая площадь (Sобщ)

Gross Value

The total value of goods, products and services reduced by the amount of advanced input in the manufacturing process of an economic area.

DE	Bruttowertschöpfung
DK	Bruttoværdi
LT	Bendroji vertė
PL	Produkt krajowy bru�to
RU	Общая стоимость застройки

Integrated planning

Integrated planning - joint planning, exercise to ensure the participation of different specialists and affected departments to combine all economic, social, and environmental fields in order to determine appropriate most effective result.

DE	Integrierte Planung
DK	Integreret planlægning
LT	Kompleksinis planavimas
PL	Zintegrowane planowanie
RU	Централизованное планирование

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Internal Heat Source

Internal heat sources in a building can be humans, light bulbs, computers etc.

DE	Interne Wärmequelle
DK	Intern varmekilde
LT	Vidinis šilumos šaltinis
PL	Wewnętrzne źródło ciepła
RU	Внутренний тепловой источник

Land Development Plan

A map that defines the modalities and general land-use types of the planned building project. It can show lots, the building height etc.

DE	Bebauungsplan
DK	Strukturplan for byudviklingsområde
LT	Teritorijos plėtros planas/ Detalusis planas
PL	Plan zagospodarowania przestrzeni
RU	Генеральный план; проект развития территории

Life cycle of a building

Is the life span of a building, which involves the construction process, the utilization phase, the tearing down and the recycling of the building.

DE	Gebäude-Lebenszyklus
DK	Bygningslivscyklus
LT	Pastato gyvavimo trukmė
PL	Okres użytkowania budynku
RU	Жизненный цикл здания

Local Public Infrastucture

To make the site (building) accessible to the occupant, e.g. access to the road system, access to Electricity or water delivery system.

DE	Erschließung
DK	Byggemodning
LT	Vietinis viešasis transportas
PL	Infrastruktura transportowa
RU	Региональная (местная) инфраструктура

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Low-Energy House

A house with a low energy consumption which still requires some form of outside energy.

DE	Niedrigenergiehaus
DK	Lavenergi hus
LT	Mažai energijos vartojantis pastatas
PL	Budynek niskoenergetyczny
RU	Дом с низким энергопотреблением

Microclimate

A microclimate is a local atmospheric zone where the climate differs from the surrounding area. Microclimates can exist in urban areas where brick, concrete, and asphalt absorb the sun's energy, heat up, and radiate the heat to the surrounding air.

DE	Mikroklima
DK	Mikroklima
LT	Mikroklimatas
PL	Mikroklimat
RU	Микроклимат

Modularity

Modularity is a general system concept, typically defined as a continuum describing the degree to which a system's components may be separated and recombined.In architecture, modularity can refer to the construction of an object by joining together standardized units to form larger compositions, and/or to the use of a module as a standardized unit of measurement and proportion

DE	Baukastenprinzip
DK	Modularitet
LT	Moduliškumas
PL	Modułowość
RU	Модульная концепция

Net Internal Area

The net internal area (m^2) is the effective area beset with the construction components.

DE	Netto-Grundfläche (NGF)
DK	Nettoetageareal
LT	Vidaus plotas
PL	Powierzchnia wewnętrzna netto
RU	Внутренняя полезная площадь (Sвн)

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Net Floor Space Area (NFSA)

The net floor space area is a part of floor space area between surrounding and internal construction components. Net floor space area = Effective area + Functional area + and traffic area; (NFSA=EA+FA+TA)

	DE	Nettogeschossfläche (NGF)
	DK	-
	LT	Patalpų bendrasis plotas
	PL	Powierzchnia kondygnacji netto
	RU	Общая полезная площадь (Нетто)

Non-Profit Building Society

Is a term used for an association that has the aim to provide its members with low-prized living space.

	DE	Wohnungsbaugesellschaft
	DK	Boligselskaber
	LT	Ne-pelno siekianti statybų organizacija/bendrija
	PL	Wspólnota mieszkaniowa
	RU	Некоммерческая жилищно-строительная кооперация, общество с ограниченной ответственностью (ООО)

Passive House

Passive houses produce all the energy they consume (heat exchange: body heat, light-bulb heat, appliance heat). In addition, they are well insulated and ventilated.

	DE	Passivhaus
	DK	Passivhus
	LT	Pasyvus energijos vartojimui pastatas
	PL	Budynek pasywny
	RU	Пассивный дом

Pilot project

Pilot project is activity planned as a test or trial to proof a concept or a principle, to realize a certain method or idea(s) to demonstrate its feasibility, or to demonstrate in principle, whose purpose is to verify that some concept or theory is probably capable of being useful. A proof of concept of an idea is usually considered a milestone on the way to a fully functioning prototype.

	DE	Pilotprojekt
	DK	Pilotprojekt
	LT	Pilotinis projektas
	PL	Pilotaż
	RU	Пилотный проект

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Primary Energy

Primary energy is energy found in nature, like coal, gas or wind. It has not been subjected to other transformation processes.

DE	Primärenergie
DK	Primærenergi
LT	Pirminė energija
PL	Energia pierwotna
RU	Первичная энергия

Preparatory Land-Use Plan

A plan which shows the future urban planning targets of a township.

DE	Flächennutzungsplan
DK	Kommuneplan/lokalplan
LT	Paruošiamasis žemės panaudos planas
PL	Plan zagospodarowania przestrzeni
RU	Предварительная концепция планировки территории

Prototype

Prototype is an original type, form, or instance of something serving as a typical example, basis, or standard for other things of the same category. A prototype presents a technic for a functional and often simple experimental design model. It serves often as a preparement of a serial production, it can be also planned as a unique item, that presents a specific concept to examine a aestetical and ergonomical chracteristics.

DE	Prototyp
DK	Prototype
LT	Prototipas
PL	Prototyp
RU	Прототип

Recycling

Processing used materials into new products to prevent waste.

DE	Recycling
DK	Recycling- genanvende
LT	Perdirbimas
PL	Recykling / recyklizacja
RU	Переработка

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Resource

A resource can be any physical, energetic or virtual entity. For the most part the term refers to land, raw material, and energy, financial resources, or labour time.

DE	Ressource
DK	Ressource
LT	Ištekliai
PL	Zasób
RU	Ресурсы

Secondary Energy

Energy that has been subjected to other transformation processes (which causes an energy loss). E.g. Electricity

DE	Sekundärenergie
DK	Sekundær energi
LT	Antrinė anergija
PL	Energia wtórna
RU	Вторичная энергия

Site Occupancy Index (SOI)

Index which defines the maximum-area on site that can be build on. Site occupancy index = building area (m^2) ÷ plot area (m^2)

DE	Grundflächenzahl (GRZ)
DK	Bebyggelsesprocent
LT	Užstatymo tankumo indeksas
PL	Stopień zabudowy działki
RU	Плотность застройки

Social housing (Low Cost Housing)

Social housing is a general term referring to rental housing which may be owned and managed by the state, by non-profit organizations, usually with the aim of providing affordable / rent-controlled housing.

DE	Sozialer Wohnungsbau
DK	Alment boligbyggeri
LT	Socialinis būstas
PL	Budownictwo socjalne
RU	Социальное жилье

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Solar Gain

A term which refers to the increase in temperature in a space, object or structure that results from solar radiation. The solar gain increases with the strength of the sun, and with the ability of any material to transmit or resist the radiation.

DE	Solarer Gewinn
DK	Passiv solvarme
LT	Saulės energijos išgavimas
PL	Solarer Gewinn
RU	Солнечные теплопоступления

Solar House

A solar house uses solar technologies to convert sunlight into usable heat with little use of other energy sources.

DE	Solarhaus
DK	Solhuse
LT	Saulės energiją vartojantis namas
PL	B⍰dynek solarny
RU	Солнечный дом

Summer Heat Protection

Good insulation prevents the building from heat-overload, caused by solar radiation. As far as possible the improvement shall be made without air conditioning.

DE	Sommerlicher Wärmeschutz
DK	Undgåelse af overtemperaturer/overophedning
LT	Apsauga nuo vasaros karščio
PL	Ochrona przed ⍰rzegrzaniem budynku
RU	Защита от солнца

Sustainability

In a broad sense sustainability is the capacity to endure. For man it is the potential for long-term maintenance of wellbeing, which in turn depends on the responsible use of natural resources. There is a wide range of measures for sustainability like cultural acceptance, feasible technologies, generationally awareness, environmentally consciousness, viable financing etc.

DE	Nachhaltigkeit
DK	Bæredygtighed
LT	Tvarumas
PL	Rozwój zrównoważony
RU	Устойчивость, долговременность

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Thermal Comfort

Thermal Comfort is a state of mind that expresses satisfaction with the surrounding environment. Temperature, air moisture, airflow, air quality, clothes and building materials are important aspects of thermal comfort.

DE	Thermische Behaglichkeit
DK	Termisk komfort
LT	Šiluminis komfortas
PL	Komfort cieplny
RU	Тепловые комфортные условия

Thermal Resistance

Also known as coefficient of thermal insulation is the reciprocal of conductance. $(m^2 \cdot K)/W$

DE	Wärmedurchlaßwiderstand (d)
⍰ DK	Termisk modstand
LT	Terminis atsparumas
PL	Opór cieplny
RU	Теплоустойчивость (R_o)

Traffic Area (TA)

The traffic area (m^2) provides access to the rooms, and can be used as an emergency exit.

DE	Verkehrsfläche (VF)
DK	Gangområder
LT	Judėjimo plotas
PL	Powierzchnia ruchu
RU	Площадь для передвижения

Transmission coefficient / Overall Heat Transfer / U-Value

Measure of the amount of heat flow that will occur across a unit area of an enclosure system or other assembly for a unit temperature difference, i.e. a system conductance that includes both surface films. $W/(m^2 \cdot K)$

DE	Wärmedurchgangskoeffizient (U-Wert)
DK	Transmissionskoeficient - samlet varmetab⍰ta
LT	Šilumos perdavimo koeficientas
PL	Współczynnik przenikania ciepła
RU	Коэффицент теплоотдачи (α_{int})

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Upcycling

Upcycling is converting used materials into high quality products, or the re-use of a product with similar value. E.g. glass can usually be upcycled into the same quality as the original product.

DE	Upcycling
DK	Upcycling
LT	Perdirbimas
PL	Upcykling
RU	Переработка отходов

Zero-Energy Building

Zero energy buildings are autonomous from the energy grid supply. Energy is produced on-site. Not considered is the energy which has been used to build the house.

DE	Null-Energiehaus
DK	0-energi bygning
LT	Nulinės energijos pastatas
PL	Budynek zero-energetyczny
RU	Здание с нулевым энергопотреблением

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13.Abbreviations

Terms and Definitions:

symbol	unit	English
f	-	factor
η	-	performance ratio, efficiency, utilisation factor
B	m	width
L	m	length
A	m^2	area
V	m^3	volume
m	kg	mass
Q	kWh	energy
a	a	year
t	h, h/a	time, time period, hours
d	d, d/a	time, time period, days
Q	J	**Heat** is a form of energy associated with the movement of molecules. Units are as for energy.
Φ	W	**Heat flow** is heat transfered by time
q	W/m^2 or $J/(s{\cdot}m^2)$	**Heat flux** or density of the heat flow rate is the heat flow per unit area. The area is perpendicular to the direction of heat flow.
λ	W/m·K	**Thermal conductivity** is a material property that indicates the quantity of heat flow across a unit area, through a unit thickness for a temperature gradient of 1K.
Λ	$W/(m^2{\cdot}K)$	**Thermal conductance** is the time rate of heat flow through a unit area of a body induced by a unit temperature difference, or the conductivity of a material for given thickness.
R	$(m^2{\cdot}K)/W$	**Thermal resistance** (also coefficient of thermal insulation) is the reciprocal of conductance.
U	$W/(m^2{\cdot}K)$	**Transmission coefficient** (also overall heat transfer or U-Value) is a system of measure of the amount of heat flow that will occur across a unit area of an enclosure system or other assembly for a unit temperature difference, i.e.; a system conductance that includes both surface films.
C	J/K	**Heat capacity**
c	kJ/(kg·K) or J/(g·K)	**Specific heat capacity** is a measure of the amount of heta that a unit mass of dry material can store. It is defined as the heat energy required to raise the temperature of 1 g of material by 1 Kelvin.
µ	-	µ-value - **water vapor proof** is the resistance of the material used for the water vapor transfer.
ρ	$(kg{\bullet}m^{-3})$	ρ-value- **bulk density** is defined as the mass of many particles of the material divided by the total volume they occupy**.**
ϑ	°C	Celsius temperature
e	-	expenditure of energy
α	-	coverage part

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Indexes:

symbol	unit	English
V		ventilation
T		transmission
S		solar
I		internal
DHW		domestic hot water
H		heating
HE		heat energy demand
TE		thermal energy
AE		auxiliary energy
ce		control and emission
d		distribution
s		storage
g		generation
HR		heat recovery
reg		regenerative energy
aux		auxilary
tech		technical

Examples:

Q		annual heat energy demand
Q_p	kWh/a	annual primary energy (P) demand
Q_H	kWh/a	annual heat energy demand
Q_{DHW}	kWh/a	annual domestic hot water energy demand

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Areas:

shortcut	definition	English
FSI	floor space area (m^2)/plot area (m^2)	floor-space index
SOI	building area (m^2)/plot area (m^2)	site occupancy index
GV	m^3	Gross Volume
CI	gross volume (m^3)/plot area(m^2)	Cubic index
GEA	m^2	Gross External Area
		-
CA	ground-plan area (m^2) of construction components inside of floor space area (like external walls, internal walls, pillars)	construction area
		=
NIA	net internal area (m^2) is the effective area inside of the construction components	net internal area
		-
FA	functional area (m^2) serves for placing of technical installa-tions	functional area
		-
TA	traffic area (m^2) serves as access to the rooms, traffic inside of the building and as a emergency exit	traffic area
		=
EA	effective area (m^2) serves for the use of the building because of its purpose	effective area
NFSA	net floor space area is a part of floor space area between surrounding and internal construction components . It is the sum of effective area, functional area and traffic area (NFSA=EA+FA+TA)	net floor space area

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Other abbreviations:

LP Lead partner

WP Work Package

PP Project Partner

preEN preliminary Euro Norm

KfW Kreditanstalt für Wiederaufbau

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