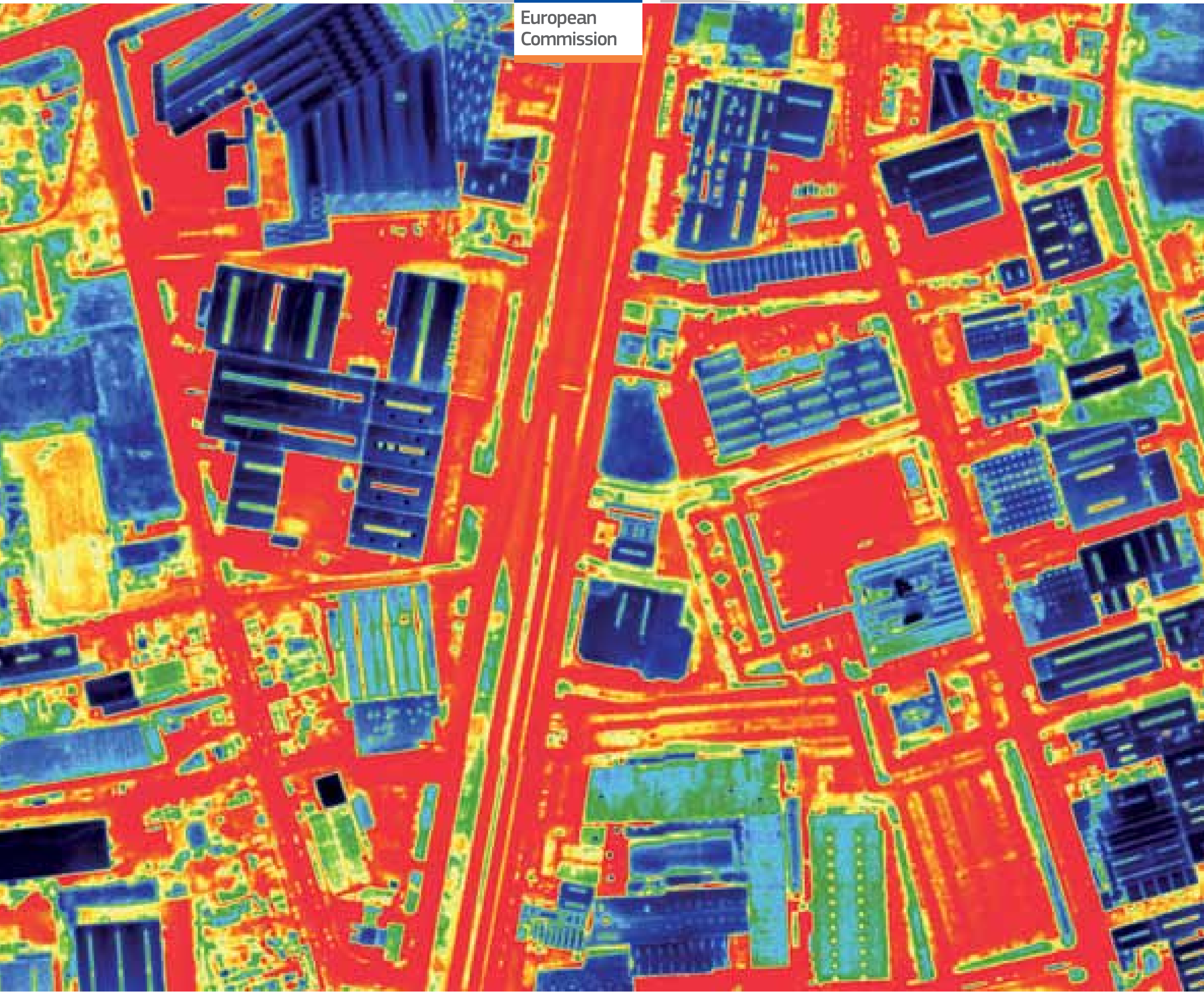
European Commission



Energy Solutions for Smart Cities and Communities

Recommendations for Policy Makers

from the 58 Pilots of the CONCERTO Initiative

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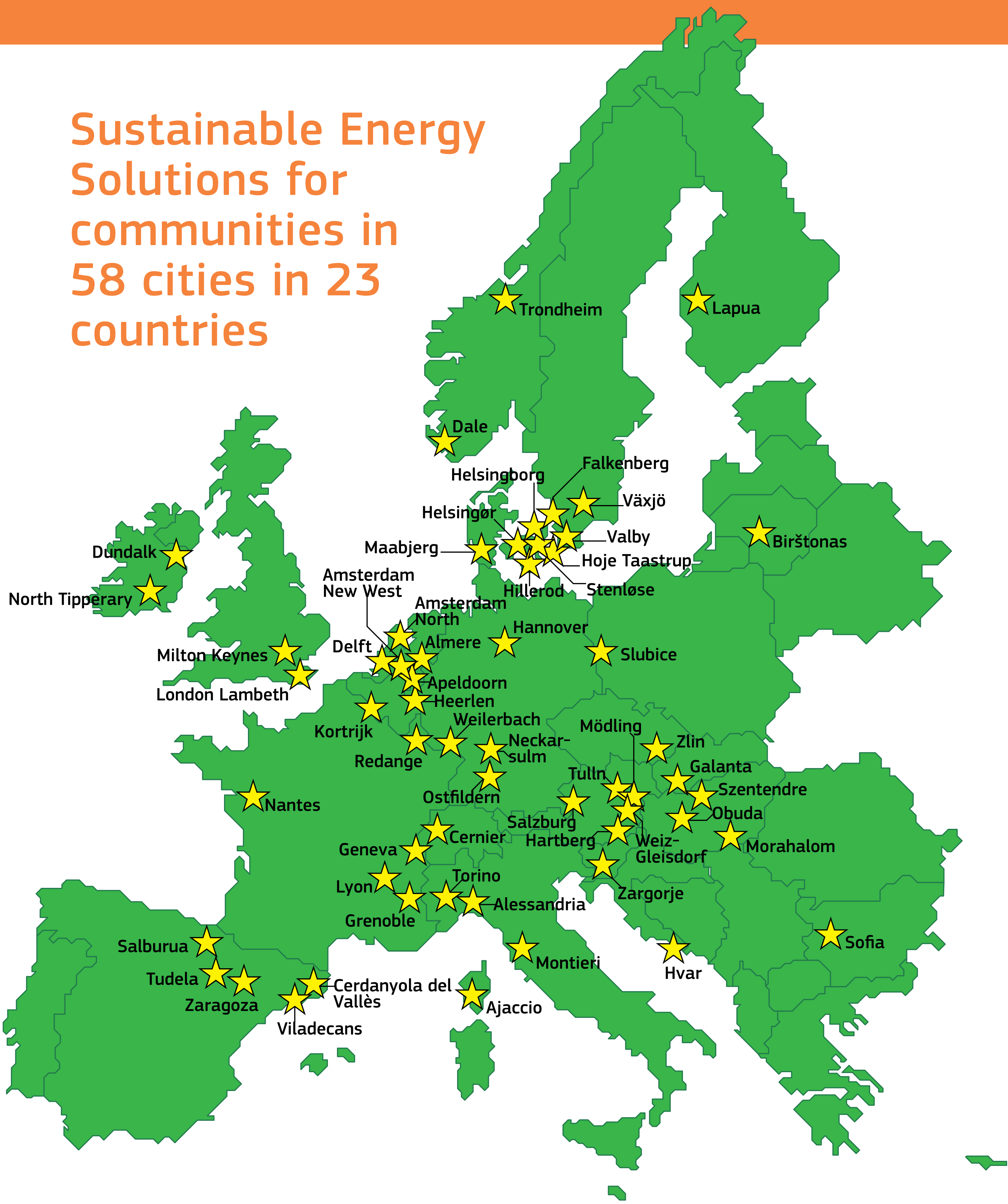
Energy

Sustainable Energy Solutions for communities in 58 cities in 23 countries



www.concerto.eu

Funding Round	Site name	Project	country	new build units	refurbished units	Biogas	Geo	Liquid Biofuel	Solid Biomass	Sun	Waste	Water	Wind	electricity [MW]	heating [MW]	cooling [MW]	HDD 15,18 [Kd]	CDD 18 [Kd]	Solar radiation [kWh/m2a]	start date	end date
1	Ajaccio	cRRescendo	FR	1900	47300					X				0,019	0,255	0,000	1640	372	1513	01.08.05	31.07.12
2	Alessandria	Concerto AL Piano	IT	n.d.	n.d.				X	X							1679	770	1354	01.09.07	31.08.13
1	Almere	cRRescendo	NL	60900	n.d.					X				0,212	2,638	0,000	2703	82	1013	01.08.05	31.07.12
1	Amsterdam New West	ECOSTILER	NL	n.d.	41000	X				X	X			4,061	5,700	0,000	2669	77	1037	01.09.05	31.08.12
2	Amsterdam-Noord	STACCATO	NL	n.d.	n.d.					X				0,218	0,861	0,000	2669	77	1021	08.11.07	07.11.14
2	Apeldoorn	SORCER	NL	115000	n.d.	X			X	X	X			0,278	2,800	0,000	2870	99	1005	01.05.07	31.10.13
3	Birštonas	Eco-Life	LT	n.d.	27200		X	X	X	X	X			0,000	0,000	0,000	3890	119	1023	29.12.09	28.12.16
1	Cerdanyola del Vallès	POLYCITY	ES	13800	n.d.	X			X	X				20,050	9,300	23,327	1507	612	1432	06.05.05	05.05.11
3	Cernier	SOLUTION	CH	300	2200	X	X		X	X				0,299	0,535	0,000	3589	75	1199	01.11.09	31.10.14
1	Delft	SESAC	NL	16200	8300		X			X	X			0,013	0,008	0,000	2596	69	1024	25.05.05	24.05.11
2	Dundalk	HOLISTIC	IE	22900	45900				X	X	X		X	1,725	0,396	0,000	3071	5	914	01.06.07	31.05.13
1	Falkenberg	Energy in Minds!	SE	14700	47400				X	X			X	0,000	7,302	0,000	3550	55	824	30.05.05	29.05.10
3	Galanta	GEOCOM	SK	n.d.	n.d.	X	X		X	X				0,005	0,050	0,000	2832	155	1240	01.01.11	31.12.14
1	Geneva	TetraEner	CH	93300	545700		X			X		X					2959	178	1291	01.11.05	01.11.10
1	Grenoble	SESAC	FR	59400	400		X		X	X				0,990	1,793	0,000	3139	127	1338	25.05.05	24.05.11
1	Hannover	act2	DE	n.d.	40100				X	X				0,174	1,498	0,000	2915	146	1009	01.01.06	31.12.12
3	Hartberg	SOLUTION	AT	1000	1900	X			X	X				0,183	0,065	0,140	3553	105	1184	01.11.09	31.10.14
2	Heerlen	Remining-Lowex	NL	91000	41000	X	X			X							2672	142	1033	18.06.07	17.06.14
1	Helsingborg	Eco-City	SE	32700	7100	X	X		X	X	X		X				3345	60	996	11.10.05	10.12.12
1	Helsingør	Eco-City	DK	n.d.	38200				X	X				0,043	5,500	0,000	3345	60	996	11.10.05	10.12.12
2	Hillerød	SORCER	DK	35800	3000				X	X				0,059	2,100	0,000	3215	75	1008	01.05.07	30.04.13
3	Høje-Taastrup	Eco-Life	DK	8000	n.d.	X	X			X	X		X				3126	84	1029	29.12.09	28.12.16
3	Hvar	SOLUTION	HR	300	1500	X			X	X	X			1,380	0,453	0,000	1444	815	1460	01.11.09	31.10.14
3	Kortrijk	Eco-Life	BE	n.d.	n.d.			X		X				0,000	0,000	0,000	2610	92	967	29.12.09	28.12.16
3	Lapua	SOLUTION	FI	2600	1900	X	X		X		X		X	0,000	1,820	0,000	5039	39	847	01.11.09	31.10.14
1	Lambeth	ECOSTILER	UK	n.d.	43000	X				X			X	0,420	0,416	0,000	2471	67	954	01.09.05	31.08.12
1	Lyon	RENAISSANCE	FR	62900	n.d.		X		X	X				0,262	2,335	0,005	2414	294	1332	17.11.05	17.11.12
1	Måbjerg	ECOSTILER	DK	n.d.	n.d.	X					X			0,000	0,000	0,000	3119	57	1046	01.09.05	31.08.12
1	Milton Keynes	cRRescendo	UK	91800	n.d.		X			X				6,259	6,138	0,000	2619	57	943	01.08.05	31.07.12
2	Mödling	HOLISTIC	AT	2700	38200				X	X	X	X		5,410	39,250	0,000	2702	352	1007	01.06.07	31.05.13
3	Montieri	GEOCOM	IT	n.d.	n.d.		X			X				0,000	0,002	0,000	1808	490	1573	01.01.11	31.12.14
3	Mórahalom	GEOCOM	HU	n.d.	3100		X			X				0,003	0,034	0,000	2683	479	1365	01.01.11	31.12.14
1	Nantes	act2	FR	80900	16200		X			X	X			0,182	36,175	0,258	1890	191	1187	01.01.06	31.12.12
1	Neckarsulm	Energy in Minds!	DE	12600	14600		X		X	X				2,440	9,808	0,000	2876	194	1122	30.05.05	29.05.10
2	Neuchâtel	HOLISTIC	CH	47800	14000	X	X		X	X		X		1,181	2,717	0,000	3914	44	1199	01.06.07	31.05.13
2	North Tipperary	SERVE	IE	9500	66300				X	X			X	0,000	6,505	0,000	2874	7	963	01.11.07	31.10.12
2	Óbuda	STACCATO	HU	n.d.	54000					X				0,000	1,061	0,000	2723	417	1246	08.11.07	07.11.12
1	Ostfildern	POLYCITY	DE	18000	n.d.		X		X	X		X		1,085	7,728	0,105	3134	147	1162	06.05.05	05.05.11
2	Redange	SEMS	LU	n.d.	3400	X			X	X	X			0,000	5,114	0,000	3249	87	1025	01.06.07	31.05.13
2	Salzburg	Green Solar Cities	AT	57500	26100					X				0,050	1,520	0,000	3444	129	1069	01.06.07	31.05.13
3	Sandnes	PIME'S	NO	10000	n.d.				X	X		X					3500	23	772	01.12.09	30.11.14
2	Słubice	SEMS	PL	n.d.	12800				X	X			X	0,000	0,550	0,000	3165	165	968	01.06.07	31.05.13
2	Sofia	STACCATO	BU	n.d.	5900					X				0,000	0,124	0,000	3197	199	968	08.11.07	07.11.14
2	Stenløse	Class1	DK	8100	24000		X		X	X				0,010	1,054	0,000	3154	79	1029	01.11.07	31.10.13
3	Szentendre	PIME'S	HU	n.d.	n.d.									0,535	0,396	0,000	2723	417	1272	01.12.09	30.11.14
1	Torino	POLYCITY	IT	n.d.	47700					X				1,138	7,261	0,205	2234	463	1378	06.05.05	05.05.11
1	Trondheim	ECO-CIty	NO	34200	38700	X				X	X						4525	19	799	11.10.05	10.12.12
1	Tudela	ECO-City	ES	11500	4800					X			X	0,058	1,440	0,000	1680	668	1436	11.10.05	10.12.12
2	Tulln	SEMS	AT	n.d.	9300			X	X	X				0,140	1,115	0,000	2810	318	1080	01.06.07	31.05.12
2	Valby	Green Solar Cities	DK	42600	18600	X				X				0,402	0,707	0,000	3126	84	981	01.06.07	31.05.13
1	Växjö	SESAC	SE	31700	2700	X	X		X	X	X			0,420	0,400	6,000	3898	46	922	25.05.05	24.05.11
1	Viladecans	cRRescendo	ES	7600	1600					X				0,238	0,133	0,000	1379	668	1403	01.08.05	31.07.12
3	Vitoria-Gasteiz	PIME'S	ES	n.d.	n.d.		X		X	X		X	X	0,071	2,709	0,000	2423	171	1312	01.08.05	31.07.11
2	Weilerbach	SEMS	DE	19500	29800		X		X	X			X	1,109	1,727	0,000	2997	144	1086	01.06.07	31.05.12
1	Weiz-Gleisdorf	Energy in Minds!	AT	13000	35100	X		X	X	X	X			0,107	9,362	0,000	3116	197	1222	30.05.05	29.05.10
2	Zagorje	Remining-Lowex	SL	2000	2000	X	X			X				0,065	3,000	0,000	3115	204	1286	18.06.07	17.06.14
1	Zaragoza	RENAISSANCE	ES	70000	7700		X		X	X			X	0,037	0,532	0,000	1592	270	1652	17.11.05	17.11.12
1	Zlín	Energy in Minds!	CZ	5300	13400	X				X	X			0,772	0,273	0,000	3420	155	1120	30.05.05	29.05.10

*n.d.= no data

Abstract

„Energy Solutions for Smart Cities and Communities - Recommendations for Policy Makers from the 58 Pilots of the CONCERTO Initiative“ provides contributions and recommendations for the development of proposals for future policies at EU, national and local level regarding energy efficiency and use of renewable energy in buildings, urban development and sustainable communities in general. It is designed as a reference manual on key findings from CONCERTO, an EU-funding programme supporting energy efficiency and renewable energy projects at neighbourhood level within 58 sites in 23 countries. The projects have been analysed regarding their CO_2-reduction, energy efficiency and use of renewable energy. Resulting policy recommendations have been put into the context of six topical issues of the sustainable energy debate and related to building regulations and energy performance. These issues are the challenge posed by Europe's inefficient building stock, the special role of public buildings as role models, funding and business models for such projects, planning and social aspects. Further information on CONCERTO as well as the technical monitoring database can be found at

www.concerto.eu

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Acknowledgements

The Authors would like to extend their utmost gratitude to the following persons for their support:

We thank the entire CONCERTO Premium Team for collection and assessing of the technical project data that fed into this report and providing all necessary structures to do so – namely: Klaus-Rainer Bräutigam, Dan Gutu, Karoline Fath, Juliane Jörissen, Ulf Kroeher, Anette Mack, Milan Marinov, Russell McKenna, Erik Merkel, Melanie Oertel, Ellen Platt, Charlotte Schlicke, Silke Schnaidt, Kilian Seitz, Julian Stengel and Rebecca Volk under the guidance of Wolf Fichtner, Joachim Fuchs, Thomas Luetzkendorf, Frank Schultmann and Andreas Wagner. We would also like to thank our fantastic student assistants Lena Hertenberger and Nadhilah Zatalini.

Furthermore, we thank all those who reviewed and commented on this report: Valerie Bahr, Ursula Eicker, Ute Heda, Seamus Hoyne, Henrik Johannsson, Sylvain Koch-Matthian, Rudy Rooth.

Our special thanks go to all CONCERTO project coordinators and other contact persons, who provided technical data, were available for interviews and/or answered our policy survey and finally, to our project officer Sven Dammann at DG-ENER for his kind and constructive support throughout.

Design and layout have been created by Jung Visuelle Kommunikation, Stuttgart, Germany.

ISBN: 978-92-79-33693-5
doi: 10.2833/17772
Printed in Germany

Dear colleagues, friends,

Developing our cities into intelligent and sustainable environments is one of the biggest challenges of our times. More than half of the world`s population lives in cities – a share that is expected to rise to 70 % by 2050. Already now, cities produce 70 % of all $CO_2$ emissions. Cities are therefore faced with the challenge of ensuring their inhabitants` quality of life whilst moving away from fossil fuels towards more renewable energy sources and to more efficient and smarter energy systems. Smarter energy systems play a key role in meeting the EU's energy policy targets for 2020 – consuming 20 % less energy, increasing the share of renewable energy to 20 %, reducing greenhouse gas emissions by 20 %. Meeting these targets will set up the EU for its long-term objective of reducing greenhouse gas emissions to at least 80 % below the 1990 levels by 2050, as set by the European Council.

The detailed evaluation of 58 pilot cities and communities in 23 countries in the EU CONCERTO Initiative impressively documents how innovative thinking on a larger scale can bring not just individual buildings, but entire communities to the level of the latest technological advancements in low-carbon energy systems. Thanks to their size and ambition, these projects have played a pivotal role in mainstreaming energy efficiency and renewable energy technologies in a number of Member States. These pilot cities have shown that innovative technologies are available and ready to be used. They have proven that the built environment can cut its CO_2 emissions by up to 80 % already now and that renewable energy sources can well be integrated into the urban environment. Building on these experiences, several of the CONCERTO cities are now broadening their scope to tackle smart energy, sustainable mobility and ICT as enabling technology in an integrated way under the European Union's Smart Cities and Communities European Innovation Partnership, launched in July 2012.

This publication provides a wealth of valuable, evidence-based lessons for those who want to set the right policy framework and conditions for smarter, future-proof cities and communities.

I thank all partners who have contributed to the strong examples and their detailed analysis. I hope this publication inspires many to follow suit and work for a replication of the demonstrated solutions in their own countries, regions and cities.

Günther H. Oettinger
European Commissioner for Energy

The analysis made in this publication is based on the most recent and most reliable data, which in general date from September 2013. It should be noted that some of the projects mentioned here are still on-going and may be subject to changes during the lifespan of their activities.
A great deal of additional information on CONCERTO is available at www.concerto.eu and further information on the European Union's energy policy can be accessed through the website of DG Energy (http://ec.europa.eu/energy/index_en.htm).

How to Read this Document

The Executive summary in the beginning highlights the most important issues addressed in this document.

Each chapter starts with a short introduction to the subject matter and with a short synopsis on the relevant EU context, concentrating on relevant directives. These are followed by subtopics that draw on CONCERTO experiences and the wider debate in the field of energy. Specific recommendations are stated, where they arise from the context and are summarised again at the end of each chapter.
Each recommendation is assigned to at least one of the three underlying general perspectives and marked accordingly:

L local level,

N national level,

EU EU level.

Recommendations can be related to the legislative authority of these instances as much as to their role in making funding decisions. Wording has been kept deliberately loose, as there will be different ways in different countries or at different political levels for implementing these.

At the end of each chapter all recommendations that arose in the chapter are listed to allow a short overview of the recommendations concerning the topic of the chapter.

The eighth chapter summarises the most important recommendations of all chapters sorted by the three general perspectives.

Executive Summary

CONCERTO is a European Commission initiative within the European Research Framework Programme (FP6 and FP7). It aims to demonstrate that the **optimisation of whole neighbourhoods** is more efficient and effective than optimising each building individually. The increase of energy efficiency and the use of renewable energy sources are both important contributions to reach a number of key EU targets. The EU initiative of DG Energy started in 2005 and has co-funded project **sites in 58 cities and communities in 23 countries.** CONCERTO projects were **precursors to the EU's Smart Cities Initiative,** which continue to explore effective ways to transform European cities into energy-efficient and sustainable neighbourhoods.

Sustainable energy neighbourhoods, such as those created under CONCERTO, are powerful showcases for demonstrating that **an energy transition is an opportunity** while making communities less dependent on energy imports and more resilient against energy price increases. Despite the financial crises hitting many of the projects and many having to adapt their original plans quite substantially, the projects succeeded in **creating real-life showcases of innovative concepts** and low energy buildings and neighbourhoods. All projects implemented innovative energy efficiency measures and now produce heat and power from renewable energy sources. Many have achieved passive house standard and even energy plus standard could be reached. The projects had to learn to deal with new technologies, that had not been available in some countries beforehand and had to **adapt measures and strategies to local conditions** – not just on a technical level, but also taking climate and cultural differences or local political aspects into account.

Most projects **inspired follow-on projects and many policy developments** at local, and sometimes even at national, scale, as particularly evident in France. These projects have thus laid an important foundation on which Smart Cities projects can now build.

The analysis of the 58 sites in 23 countries means that a number of **issues relating to calculated and actual energy performance** emerge. Many of these relate to the difficulty in comparing the energy performance Figures from different countries, due to underlying differences in practices regarding the calculation of it. A selection of these aspects were explored and compared with current thinking outside CONCERTO and recommendations were made to **move relevant building regulations forward,** in order to meet new challenges and towards better comparability. The need for more and better monitoring of actual performance, in particular at neighbourhood level, was also identified as a key issue.

Retrofitting **Europe's largely inefficient building stock** is a key challenge in reaching the EU's energy and climate change targets. Due to reduced demand for new-build in the wake of the global financial crisis, many CONCERTO projects shifted emphasis onto retrofitting. Though these projects had to tackle the typical barriers of lack of **skills and awareness, split incentives, rebound effects, the difficulties of historic buildings and simple lack of money,** these projects now provide an extensive body of experience and real-life examples of successful retrofitting projects, in 23 different countries with varying climates and socio-economic settings.

The projects demonstrate how the construction of low energy **public buildings,** energy efficiency retrofits and energy management can reduce emissions directly and lower energy costs for public bodies. These will demonstrate opportunities to act to private and commercial players and encourage them to choose efficient solutions. Low energy public buildings can

set incentives for local companies to invest in energy efficiency, low-carbon technologies and related skills.
Many energy technologies are still not sufficiently economically viable, due to their high up-front costs and low profits or low savings achieved. Others are only viable if looking at a long time period. For this reason, financing is a major issue in realising an energy transition. The CONCERTO projects demonstrate on the one hand that it is necessary to provide financial support for renewable energy and energy efficiency projects and on the other hand how to mobilise private contributions – often that of private households. Current business models that hold the potential to **overcome the barrier of up-front capital cost** have been explored. The importance of collaborating with local and municipal energy companies has been highlighted and options of a new role in offering **contracting solutions** have been explored.
In sustainable energy projects at neighbourhood scale, such as CONCERTO, a combination of different planning tools have to be employed. Experience shows that defining the frameworks, the tasks and responsibilities well for all parties involved is crucial for these projects. So are firmly and universally-agreed energy targets. Additionally, intensive links and interactions between different levels of planning, local and regional as well as energy specific planning, are conducive to project success. So is the participation in networks to share best practice experiences.
The role of social processes in the context of the introduction of technical or organisational measures, as they were realised in CONCERTO, have been analysed. **Raising awareness and acceptance** e.g. by consistent application of Energy Performance Certificates, have been identified as social success factors. So has the effective diffusion of knowledge via training measures, **assurance of quality**, creation and support of opportunities for involvement of concerned stakeholders as well as the use of networks for spreading innovative approaches and organising the relation between stakeholders. The necessity and advantages of involving affected individuals and/or groups when undertaking changes to their local environment have been highlighted in particular.

The findings summarised above have led to the recommendations for the EU, as well as for national and local governments to support them in their endeavour to reduce their CO_2-emissions reductions in the build environment.

Key Recommendations

Based on the experiences of the CONCERTO projects, the knowledge from other, similar projects, current scientific debate and literature, a set of core recommendations have been distilled. Some of these have been combined and rephrased, leading to the 18 key recommendations below, which have been divided into those for the EU, for national governments and local governments. The recommendations have been assigned to the political level they were felt to relate to best, even though some recommendations apply to more than one level. No distinction is made between national and subnational/regional level, because responsibilities between these levels vary between different Member States. In so far the clustering has to be seen as relatively loose.
For more specific information underlying the recommendations, the numbers of the relevant chapters have been given in brackets after the recommendation.

Recommendations for L local level, N national level, EU EU level.

Key Recommendations to the EU

EU Considering the paramount importance of **monitoring energy performance,** the difficulties and high costs of it have to be addressed. For example, by the EU considering to fund it fully as part of their projects and by supporting research and development of low-cost technical monitoring solutions through grants and other incentives. (2)

EU N Research and development regarding **nearly zero-energy buildings** and energy-plus buildings should now shift focus onto nearly zero-energy retrofitting and onto the development of new technical solutions for situations with low PV potential (e.g. larger blocks of flats). (2)

EU Due to the high **multiplier effect** as well as associated local economic benefits of measures for **public buildings,** all public building should be retrofitted to the highest possible technical standard. Relevant requirements at EU-level should be strengthened to exceed those of the Energy Efficiency Directive. (3, 4)

EU An **EU Deep Retrofitting Fund** should be set up to complement national financing schemes. It could be administered by the European Investment Bank. (5)

EU Any EU funding for projects, including that under Structural and Regional Development Funds, should define and **enforce minimum requirement for cost-optimal energy efficiency** measures and renewables. (5)

EU N L CONCERTO proved yet again how **powerful real-life examples** are in creating acceptance and by proving feasibility and value and reducing fears and negative myths amongst the local communities. It is of utmost importance to continue funding for such pilot communities and exploiting their potential as a catalyst for change. [7]

Key Recommendations to National Governments

N The **split-incentives,** also known as landlord-tenant dilemma, need to be addressed, for example:

- by designing and supporting appropriate contracting solutions for energy efficiency measures, that remove the need for up-front capital cost. (2, 3)
- addressing letting legislation, e.g. allowing the increase of rents following energy efficiency measures, to a level that is in line with expected energy cost savings. (3)

EU L N Energy criteria should be included into **specifications, tender documents and contracts,** as well as service and maintenance agreements for all public buildings. (4)

EU L N Public authorities should display **Energy Performance Certificates** in all their buildings, regardless of whether they are open to the public or frequented solely by employees and regardless of size. (4, 7)

N Stable, well-calibrated **feed-in tariffs,** guaranteeing revenues for a long period (20-30 years), have to be provided as these are crucial in bringing about an increased share of renewable energy and important for the viability of business models for renewables. (4, 5)

N L **Dedicated quality control regimes** for energy efficiency features in buildings have to be developed and formalised, addressing in particular time and human resources requirements as well as training and qualifications. (6, 7)

Key Recommendations to Local Governments

L N Consensus building for the retrofitting of multi-ownership buildings needs to be actively supported at local level – either by:
a) Building contractors including a decision support package in their service offering.
b) Municipalities playing a more active facilitating role.
c) Caretakers and other building management staff being given support and training on the delivery of consensus on retrofitting. (3)

L Municipal energy companies should explore micro-contracting solutions for energy efficiency measures and renewables as new service areas. These would in particular bring contracting solutions into the realm of private households and could extend to include comprehensive retrofitting measures, but also to renewables. (5)

L Technical measures should always be combined with awareness and acceptance measures to avoid suboptimal realisation of energy efficiency potentials and rebound effects. [7]

L Cities should set up a sustainable energy action plan that includes at least the following aspects: energy sustainability indicators, energy efficiency, future energy consumption, energy efficiency potentials, potentials to produce energy from local renewables, storage capacities and a set of firm targets, including a time horizon to reach the target by. Local stakeholders should be involved in the development of the plan. (6)

L Municipalities should employ energy officers for coordination of energy demand, energy efficiency, local energy production, infrastructure and related project funding. They should have an overarching remit for the whole geographic area of the municipality and work closely with planning departments. (5, 6)

L Existing networks should be tapped into or new local platforms should be set up in order to bring stakeholders together and make them communicate with each other, to identify synergies and avoid misunderstandings and conflicts within projects. (6, 7)

L Municipalities are encouraged to join existing international and other municipality networks such as the Covenant of Mayors, Smart Cities Stakeholder platform, European Innovation Partnership, ICLEI, and Climate Alliance should be tapped into in order to make municipalities communicate with each other and exchange best practice. (6, 7)

Following on from CONCERTO, the Smart Cities Initiative will continue the endeavour to optimise the sustainable use of energy by broadening the scope of activities even further to mobility and the implementation of smart technologies in the context of cities.

Contents

1. Introduction

1.1. EU Co-Funded Communities: The CONCERTO Initiative

CONCERTO is a European Commission initiative within the European Research Framework Programme (FP6 and FP7). It aims to demonstrate that the optimisation of whole neighbourhoods is more cost-effective than optimising each building individually. The increase of energy efficiency and the use of renewable energy sources are both important contributions to reach a number of key EU targets. The EU initiative of DG Energy started in 2005 and has co-funded project sites in 58 cities and communities in 23 countries.

These sites are listed in the front flap of this brochure, along with the key characteristics for each site. The total amount of EU funding for the CONCERTO initiative is € 175.486.501. CONCERTO demonstrates implemented examples of:

- Sustainable energy demand: energy efficiency measures in the built environment, both for new build and existing buildings
- Sustainable energy supply: the use of renewable energies sources for neighbourhoods and cities

CONCERTO projects were precursors to the EU's Smart Cities Initiative, which continue to explore cost-efficient ways to transform European cities into energy-efficient and sustainable neighbourhoods. The Smart Cities funding stream expands on the CONCERTO approach and extends it to include transport, energy storage, grid and ICT issues. It focuses especially on the intelligent integration of these areas and on new, emerging smart technologies on a city scale. In this way, the support of pilot projects on a district and city scale is being continued, in order to accelerate the diffusion of smart technologies.

1.2. Identifying Transferable Knowledge from CONCERTO: The Monitoring Project

The monitoring project CONCERTO Premium provides the European Commission with the scientific, technical and policy analysis of the 58 CONCERTO projects.

The main objective of CONCERTO Premium is to provide a robust data and information base that serves as the foundation for setting future regulatory frameworks and as a support for investors` decision-making.

CONCERTO Premium created a platform for the whole of the CONCERTO community, which is proud of the projects' achievements and which strives to communicate these achievements to stakeholders in order to stimulate replication. It highlights the role models for energy efficiency in buildings and renewable energy technologies. It also demonstrates that having very low energy buildings, as part of a community approach, is possible. And thus, that CONCERTO supports the implementation of smart cities within Europe.

Apart from the policy recommendations presented here, a technical monitoring data base (TMD) and a comprehensive assessment of the data, supplied by the 58 projects, are the main outputs of CONCERTO Premium. The database, as well as project results and links to single projects, are available to the public at www.concerto.eu.

The report at hand distils selected findings from CONCERTO which can serve as contributions to the political debate.

Further publications of CONCERTO Premium are the brochure "Energy Solutions for Smart Cities and Communities – Lessons learnt from the 58 pilots of the CONCERTO initiative" containing best practice examples from CONCERTO, as well as "CONCERTO Premium Final Assessment Report" covering the assessment mentioned above.

1.3. The Strategic Relevance of Smart Energy Communities

There is widespread consensus that consequences of climate change such as sea level rises, melting of glaciers and more frequent extreme weather events, including heavy rainfalls and drought periods, pose risks to business and livelihoods not only in Europe but worldwide. In the attempt to curtail global temperature increases a number of emission reduction targets have been set by the EU, which at the same time have the potential to improve energy security. Energy efficiency in particular is also seen as an important aspect for safeguarding competitiveness of EU-industry in the longer term. With that in mind, the EU has committed itself to cutting emissions by 2020 to 20 % below 1990 levels, to increase the share of renewable energy in final energy consumption to 20 %, and to achieve a 20 % increase in energy efficiency. For 2050, EU leaders have endorsed the objective of reducing Europe's greenhouse gas emissions by 80-95 % compared to 1990 levels. The forthcoming 2030 targets are intended to support these.

Furthermore, the European Commission has published a roadmap for shaping the low-carbon European economy required for these goals, and thus defining a pathway for an EU-wide transition to a sustainable energy system. This emphasis on sustainability and climate change mitigation has shifted in 2013, towards greater emphasis of cheap energy and competitiveness. However, in the long term, we can only achieve the targets above with energy efficiency - the more energy-efficient we are, the less it matters what the cost of energy is.

The EU building sector is responsible for around 40 % of the CO_2-emissions. The targets above can only be reached if significant progress in reducing CO_2 emissions in this sector is achieved. This is the background to the launch of the CONCERTO Initiative by the EU in 2003. Sustainable energy neighbourhoods, such as those created under CONCERTO, are powerful showcases for demonstrating that an energy transition isn't a burden but an opportunity. While making communities less dependent on energy imports and more resilient against energy price increases, such projects are also about quality of life and lower bills as well as creating new, local business opportunities.

In order to roll out these achievements, long-term thinking and decision making is paramount. CONCERTO projects are large-scale projects, lasting for at least 5 years, many longer, with the initial planning phase often preceding the project application by several years. A total span of a decade is not unusual. Yet due to their duration and size, large numbers of stakeholders are involved. They learn from the project and take their learning forward.

Towns and neighbourhoods are small-scale models for countries and for Europe. They are immediate to people's everyday lives. Real-life, actual projects, that prove to the local community that sustainable energy concepts work in reality, are very effective catalysts for furthering the energy transition, representing a powerful reason to the EU to instigate and fund such projects. The CONCERTO initiative proves that if given the right planning, cities and communities can be transformed into sustainable energy pioneers. Most projects inspired follow-on projects and many policy developments at local, and sometimes even at national, scale.

These projects laid an important foundation on which Smart Cities projects can now build.

The Neighbourhood Scale: A Key Characteristic of CONCERTO

The Energy Performance in Buildings Directive clearly focuses on the energy performance of individual buildings. However, there are good reasons to address groups of buildings and to calculate a common energy balance for them. For assessing the opportunity of considering groups of buildings, the energy demand and the energy supply need to be analysed separately. As for the energy demand side, disadvantageous conditions, affecting one or a number of buildings within a neighbourhood (e.g. shading), preventing them from achieving a low energy demand with an acceptable level of effort, can be compensated for. As for the energy supply side, nearby/on-site central systems can serve as an advantageous alternative to individual systems per building. Such small-scale central supply can yield benefits e.g. in terms of capital cost savings, higher efficiency and better seasonal storage.

1.4. Introductory Overview of Key Figures from CONCERTO

The following chapters will analyse important aspects of the projects that are politically relevant. In order to set the context for this analysis, several overviews across all currently available performance data and key Figures will be provided (as per September 2013 - many projects are still ongoing).

Quality and Availability of Data

The data in the Figures presented throughout the following chapters is based on the CONCERTO Premium database using the data status from September 2013, if not stated differently. The data was provided directly by the CONCERTO projects. Differences arising from different national standards, calculation methods and other contextual factors are considered and standardised as far as possible. When comparing CONCERTO sites, additional information regarding differences in contextual factors should always be considered. The state of data within the database is continuously evolving, as and when projects can provide more data, with some projects only due to finish in 2015. Up-to-date figures can be accessed online under: http://concerto.eu/concerto/environmental-technologies/technologies-intel-enquiries.html.

The selection of examples for the various topics is based on the data availability, the aim to illustrate the range and diversity of CONCERTO projects and/or also to display outstanding success stories. The frequency in which single examples are used does explicitly not include any statement on the quality or ranking of projects or sites. More comprehensive figures and assessments can be found in the report "CONCERTO Premium Final Assessment Report". This report should also be consulted for details on the methodology used. As supplied by projects, and as indicated in the titles of figures, data often stems from energy performance calculations according to the relevant national methodologies, though measured data is also used where available and where suitable to the context.

During the course of CONCERTO, a large number of energy supply units were installed, resulting in 102 300 t CO_2 emission reduction per year compared to "business as usual" (according to data available in August 2013). A large number of technical solutions was implemented. The following graphs show the proportion of installed energy supply capacities in MW[1] for RES heating power (198 MW) and electricity (103 MW). In addition to this, there is also another 35 MW installed RES devices for cooling power.

Figure 1.1: **Total Installed RES Heating Power in CONCERTO of 248 MW**

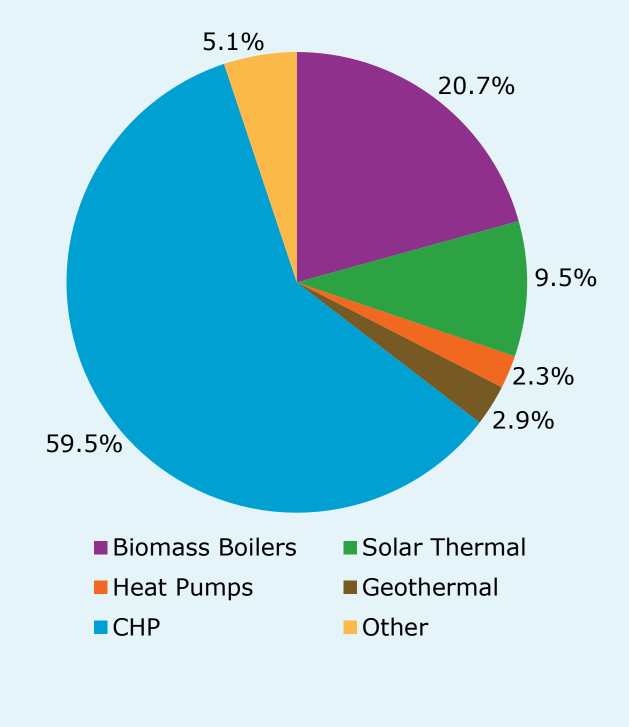
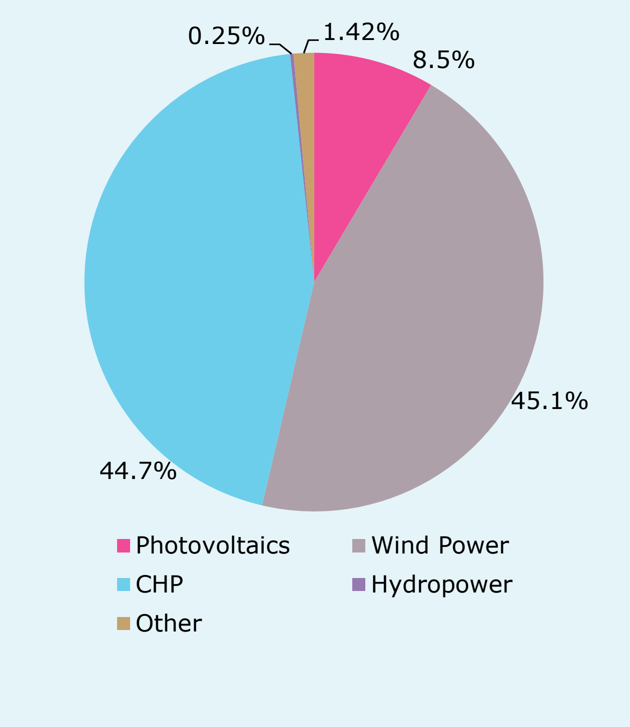


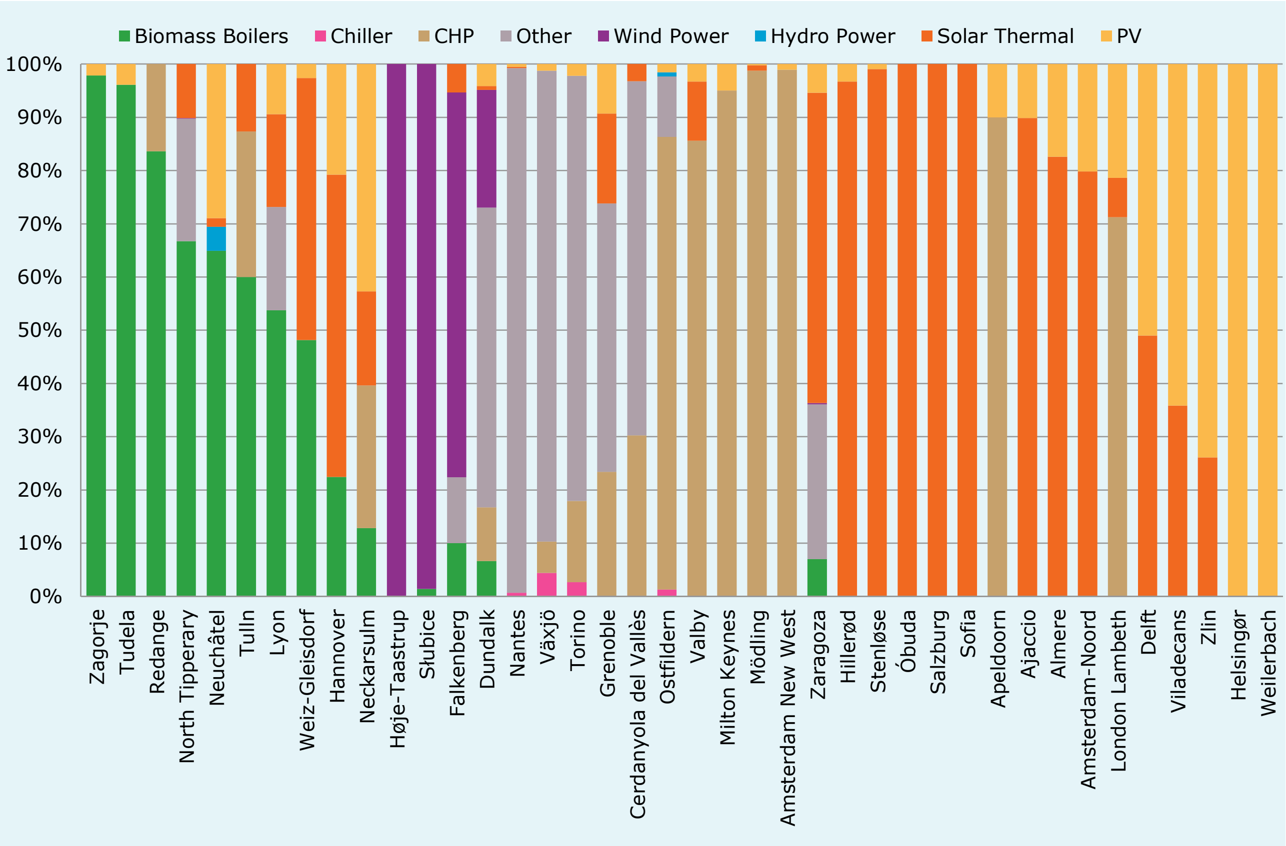
Figure 1.2: **Total Installed RES Electricity Power in CONCERTO of 118 MW**



[1] Capacities where data was not available are not included

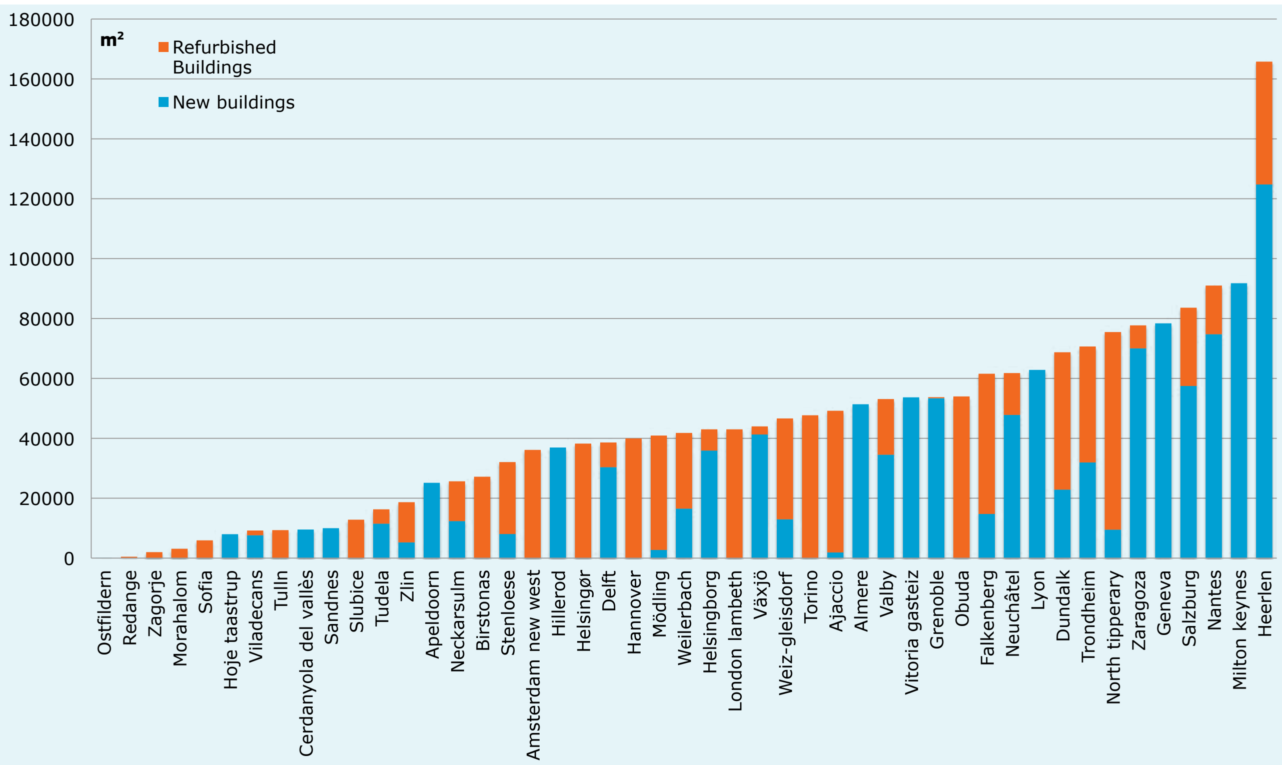
Using a mix of several renewable energy technologies to achieve the best possible exploitation of local potentials and the best CO_2 savings was a key feature within CONCERTO. The following graph shows the technology mix (based on total installed capacity) used in CONCERTO sites, indicating that only very few sites relied on a single technology (solar, both thermal or PV), and that most had a solar component.

Figure 1.3: **RES Technology Mix in Different CONCERTO Sites**



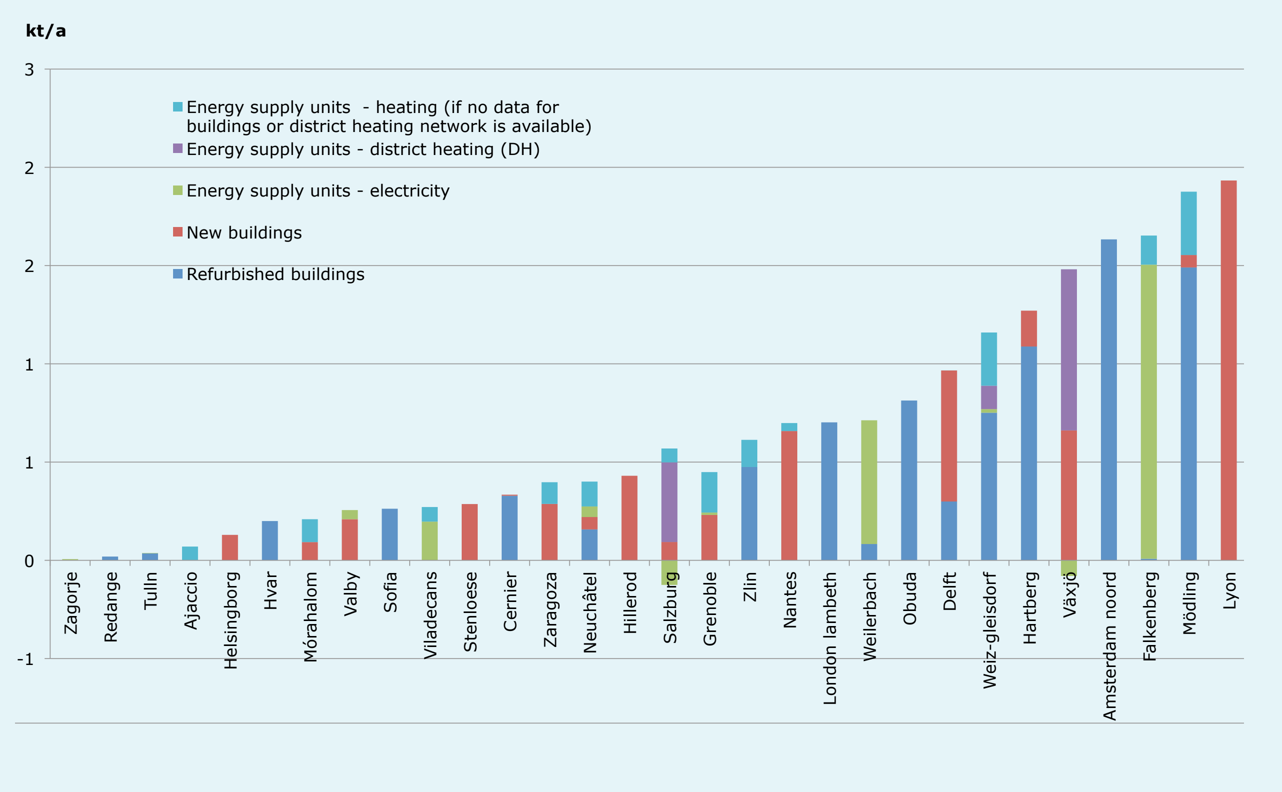
More than 3 000 high performance new buildings were built (1.75 million m²) in total and around 1 400 buildings were refurbished (2 million m²). How these are spread across participating sites is shown in Figure 1.4.

Figure 1.4: **Absolute Floor Area Receiving CONCERTO Funding by Site**



The next graph shows the proportion of CO_2 emission reduction achieved in absolute terms in a selection of CONCERTO projects. The achieved CO_2 emission reduction is subdivided into new buildings, refurbished buildings and renewable energy installations in tons per year, per site.

Figure 1.5: **CO_2-Reductions Achieved by the CONCERTO-Sites (sites with <3 kt/a)**



In a nutshell:

CONCERTO at a glance:

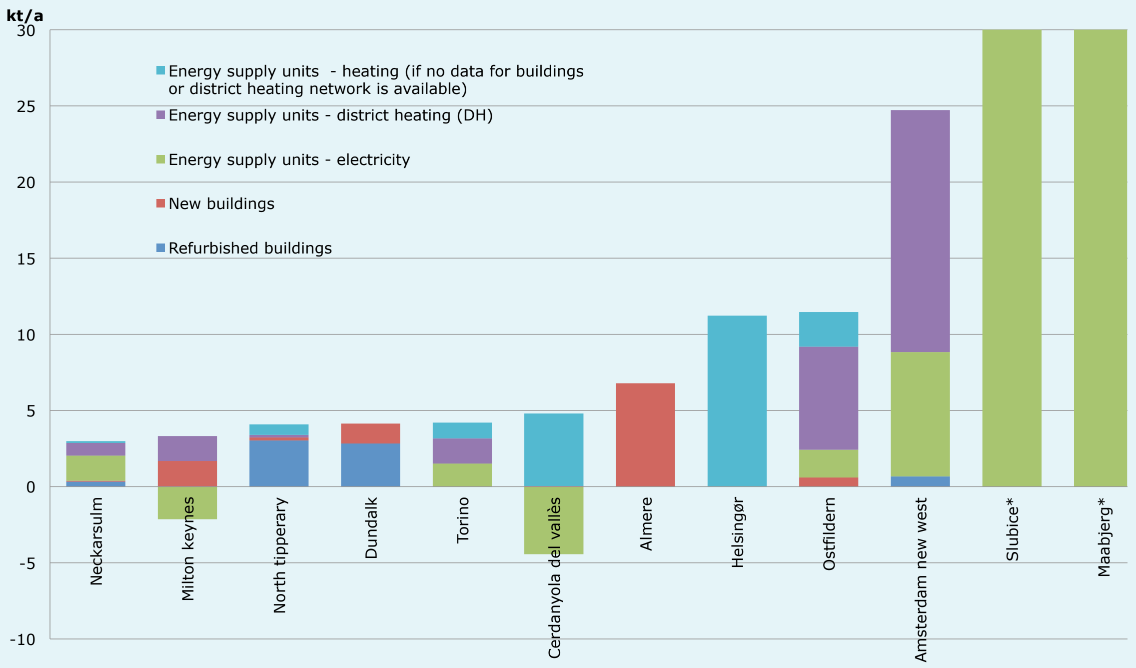
- 376 kt of CO_2 emission were reduced per year*:
  - 17 kt CO_2 from refurbished buildings
  - 17 kt CO_2 from new buildings
  - 147 kt CO_2 from energy supply units – electricity
  - 173 kt CO_2 from energy supply units – district heating
  - 22 kt CO_2 from energy supply units – heating

- 1 326 GWh Reduction in primary energy demand (non-renewable) per year
  - 5 % of these in refurbished buildings
  - 6 % in new buildings
  - 37 % from energy supply units – electricity
  - 46 % from energy supply units – district heating
  - 6 % in energy supply units – heating

- More than 5 million people live in CONCERTO cities and benefit from the measures

*Data status of 10th September 2013

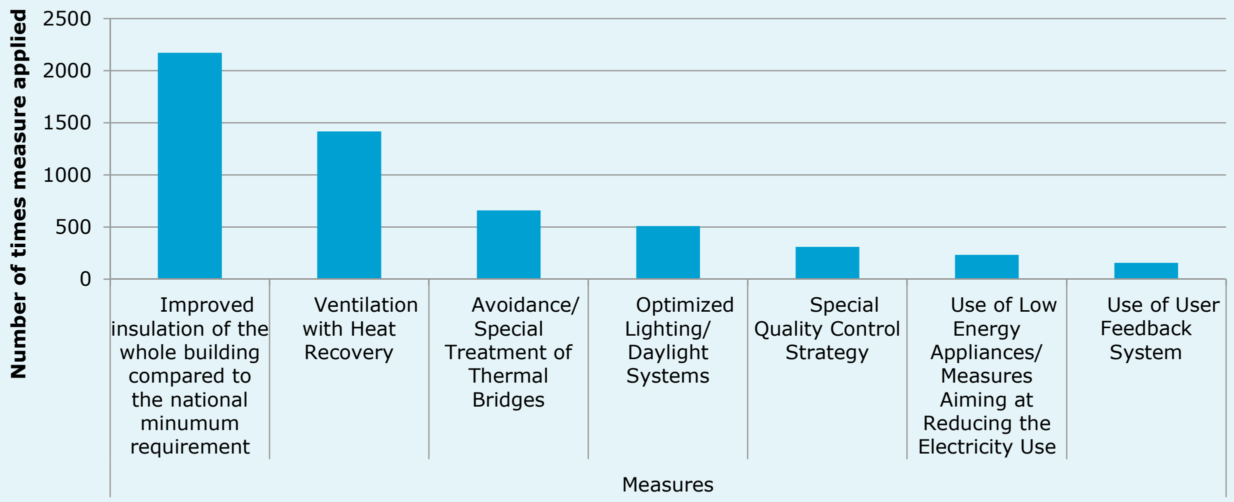
Figure 1.6: **CO_2-Reductions Achieved by the CONCERTO-Sites (sites with > 3kt/a)**



* In Slubice a total CO_2 reduction of 73 kt per year has been achieved (mainly due to a wind park) and in Maabjerg 207 kt per year (mainly due to a large CHP plant)

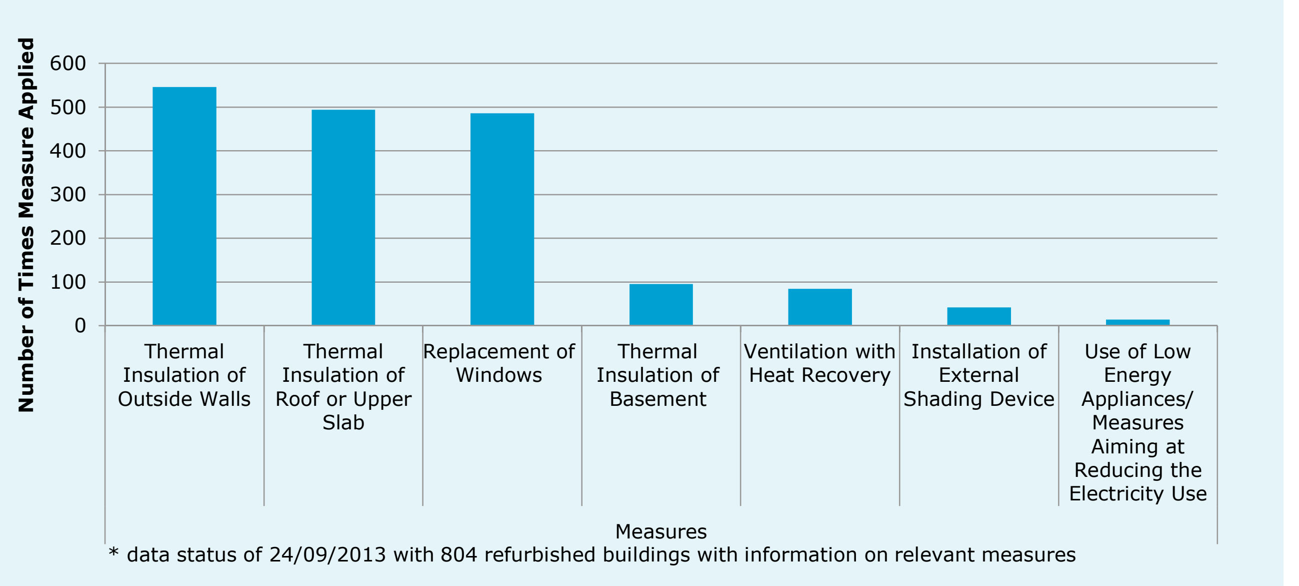
The following figures show which energy efficiency measure was used how often in CONCERTO new-build and retrofitting projects.

Fig. 1.7**: Number of Times that Certain Demand Side Measures Have Been Applied within New CONCERTO-Buildings***



* data status of 24/09/2013 with 2231 new buildings with information on relevant measures available

Figure 1.8: **Number of Times that Certain Demand Side Measures have been Applied within Refurbished CONCERTO-Buildings***



1.5. Aim, Approach and Structure of this Study

The aim of this reference study is to provide contributions and recommendations for the development of proposals for future European Union policy regarding the energy efficiency in buildings, urban development and smart energy communities/ cities in general. It is designed as a reference manual on key findings from CONCERTO and supplemented by recommendations based on these. Target groups for the study are the European Commission, as well as national and local decision makers.

In the course of the CONCERTO initiative, a number of important topics for the EC, relevant stakeholders and future projects emerged from the manifold activities within and around CONCERTO.

The 58 sites developed and realised numerous creative ways for dealing with challenges. To gather the policy-relevant experiences, the CONCERTO Premium policy team collected information from project coordinators and other contact persons via face-to-face meetings, phone interviews and written questionnaires, as well as from available project reports, publications and site visits. Six main topics were identified. Having considered the assessment outcomes, drawn from the tremendous amount of technical monitoring data which has been entered into the Technical Monitoring Database and having juxtaposed these with the current debate within literature and at conferences, a set of key topics emerged. The choice of topics is neither exhaustive nor does it imply a qualitative statement on the general importance of single issues. The core topics, integration and diffusion of RES technologies and energy efficiency measures are not explicitly given separate chapters, as these topics are the basis of this study and always present.

These chosen topics define the chapters of this study, compile the information that CONCERTO can add to each of them, and thus form the basis for the resulting policy recommendations.

The initial chapter (Chapter two) takes a closer look at **sustainable energy solutions in the built environment** and relevant regulations at the different levels.

Chapter three is dedicated to the **existing building stock** being a dominant challenge to deal with in the context of the CONCERTO initiative. Compared to new buildings, the preconditions and possibilities, but also limitations, can differ tremendously.

The fourth chapter deals more specifically with the potential **role of public buildings** being a predominant possibility for pioneer and forerunner projects. Despite the more specific focus, the topic was chosen for a separate chapter because of the potential to influence local diffusion processes and the role model function of public estate.

The fifth chapter deals with a number of **economic issues** on financing and business models for CONCERTO-like projects.

The sixth chapter on **planning instruments** and approaches focuses on instructive CONCERTO examples to draw conclusions on a sustainable urban vision for future projects.

Chapter seven is dedicated to **social issues** and addresses a number of relevant soft factors in the context of the realisation of energy efficiency measures and/or the implementation of RES.

The concluding chapter eight summarises and condenses the policy-relevant aspects of the single chapters by drawing overall conclusions on the CONCERTO Premium experiences.

2. Energy Performance, Calculations & Regulations

2.1. Introduction

CONCERTO projects are first and foremost built-environment projects, meaning that these projects had to interact with, and were dependent on, building regulations in force in their respective countries at the time. Insights gained from the analysis of these projects can help improve relevant policies and regulation regarding various aspects of energy performance.

2.2. EU Policy Context

Building regulations, also sometimes referred to as building codes, ensure that any new or substantially altered building meets certain technical requirements. Traditionally, these have concentrated on soundness of structure as well as health and safety related aspects. However, since the coming into force of the first Energy Performance in Buildings Directive (EPBD 1, 2002/91/EC), all building regulations now have to contain requirements for energy performance for new buildings and major refurbishments. Requirements have since been strengthened in its revision of 2010 (EPBD 2, 2010/31/EU). Its Annex 1 sets out which building characteristics and components are to be included in the energy performance calculations. A headline target is to achieve "Near Zero Energy" standard for new buildings across Europe by 2020 (2018 for publicly owned buildings).

With the need to consider renewables at planning and design stage, (article 6.1) the energy supply side has now also entered the realm of building regulations. EN 15603 defines the calculation methodology further with the aim of bringing methodologies across Europe closer together, yet is not compulsory to use. Efforts to revise this standard are ongoing, with a new version expected for 2014. Current standardisation efforts include the following:

Table 2.1 **Development of CEN-Standards**

Project reference	Standard under Development	available
prEN 15603	Energy performance of buildings - Overarching standard EPBD	2015-02
FprCEN/TR 15615 rev	Explanation of the general relationship between various European standards and the Energy Performance of Buildings Directive (EPBD) - Umbrella Document	2014-06
FprCEN/TS 16628	Energy Performance of Buildings - Basic Principles for the set of EPBD standards	2014-06
FprCEN/TS 16629	Energy Performance of Buildings - Detailed Technical Rules for the set of EPB-standards	2014-06

2.3. Contributions to Building Regulations under CONCERTO

As the first round of CONCERTO projects already started in 2005, with proposals dating back to 2003, they had to deal with building regulations that in some cases were only starting to take on board requirements for energy performance and renewable energy at that time. However, there are some examples how CONCERTO projects, or individuals involved in them, helped to update these regulations. The projects have allowed the identification of weaknesses in national regulations and helped to evolve these.

For example, project activities in Zaragoza (ES) identified that it is important to revise some parts of the Construction Energy Code, notably on energy-related optimisation of building design and ventilation systems. In North Tipperary (IR) and in Salzburg (AT), CONCERTO activities helped to identify inaccuracies in energy performance calculation methodologies and helped to improve these.

Inspired by CONCERTO, the Geneva Canton adopted a new energy law in 2010, published with a new definition of a territorial energy concept. This law introduced several elements from the CONCERTO experience. It responded to the need to organize the interaction between institutional, professional and economic stakeholders in relation to the given environment and to improve awareness towards Geneva's goal of the '2000 watt society without nuclear'. Its aims are

- To lower energy requirements by introducing higher performance criteria in buildings and to increase the use of RES technologies
- To make an energy audit mandatory before refurbishment activities and before the installation of solar thermal technologies during major roof refurbishment work
- To develop more effective infrastructure and equipment for energy production and distribution.
- To evaluate the local availability and to use the local potential of RES

The French CONCERTO projects in Lyon, Grenoble, Nantes and Ajaccio collaborated closely and together contributed to the energy requirements for the new French energy performance regulations 'RT2012 (Batiments Basse Consommation). This was possible as members of staff in Lyon and Grenoble were also members of the national working group "Grenelle". In parallel, the RENAISSANCE project supported the region of Grand Lyon to develop its own set of criteria for the construction of sustainable buildings (Référentiels Habitat et Bureaux Durables) and provided inputs for similar specifications at regional level.

As a result of monitoring in low-energy buildings in Hillerød (DK), the use of air-to-air heat pumps, as the only heating source in buildings used for all year occupancy, has been found unsuitable. The reason is that the heat pumps cannot supply sufficient heat when outside temperatures are very low - and at the same time the COP is extremely low. These findings added to similar results from other studies. This growing evidence amounted to the newest Danish building regulations (BR10) stating that air heating cannot be used as the only heat source in low-energy buildings (BR2020).

2.3.1. Efficiency First – U-Values in Different Climatic Zones

Figures 2.1 and 2.2 below show U-values for roofs, walls and ground floors from a number of sites, showing wide variations between climatic zones. They generally improve with the increase in heating degree days (10 year average), as shown on the x-axis. The graph on the left shows values for each building element used in CONCERTO new builds juxtaposed with national standard values (as provided by the projects at the time of planning). The right hand graph shows U-values for retrofitting projects (again, as provided by projects). In both cases, CONCERTO values are consistently below the national standard, reflecting the principle that "energy efficiency must come first, then renewables".

Figure 2.1: **U-Values in CONCERTO – New Builds Compared against National Standard**

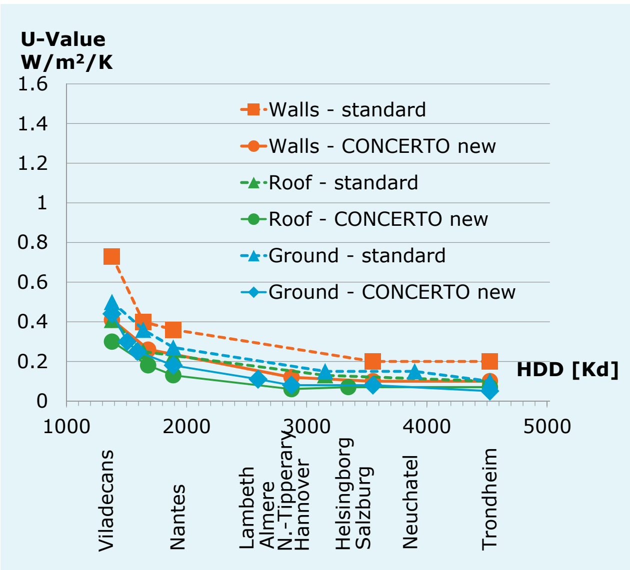


Figure 2.2: **U-Values in CONCERTO – Retrofit U-Values in CONCERTO – Before, After and National Standard**

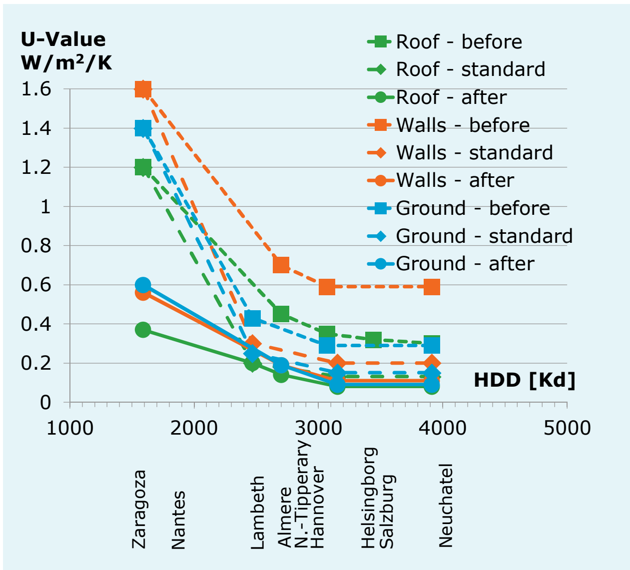


Image 2.1 **External Wall Insulation in Almere (NL)**

2.4. Defining Good Practice in Building Regulations

One of the challenges of assessing construction projects across national borders is that building regulations are different between countries, both in content and in the way they are defined and reinforced – i.e. at local, regional or national level. Comparing their contents and inherent performance levels internationally is complex, for reasons further explained in Sections 2.5 ff. The recent study of the Global Buildings Performance Network (GBPN) of energy in international building regulations, using their "Policy Comparative Tool,"[1] is therefore unique and valuable. As part of it, international experts found that the most important criteria for effective energy-related building regulations are: presence of a performance-based approach, inclusion of all types of energy consumption, high energy performance and use of passive/active renewable energy. They also include: zero energy targets, regular and frequent revision cycles, levels of encouragement to go beyond minimum standard, good enforcement, policy packages and certification that support regulations, efficiency requirements on the building shell, requirements for commissioning of technical systems and requirements to include RES. The study acknowledged that many of the more successful energy efficiency regulations of those studied came from within Europe. This was due to a long tradition of developing these and supporting regulations with certification, as required by the EPBD. However, the study did not score some EU countries as highly as expected, in particular Germany, the United Kingdom (in this case: England and Wales, not Scotland and Northern Ireland) and Ireland. One reason for this was the use of a model or equivalent building calculation as overall performance calculation. The following further findings are also worth highlighting:

- Some regulations did not include requirements for domestic hot water systems, appliances, pumps and fans.
- Due to mandatory renewable energy requirements for most new buildings, France and Ireland obtained full marks on the criteria of including renewable energy, followed by Germany and Spain, with extra credits to France for its bio-climatic design (adaptation to local climate).
- None of the regulations were found to have good standards of independent and robust compliance monitoring, but Sweden scored highest on enforcement due to post occupancy energy verification.
- Proper commissioning of technical building services systems was also found as important in Europe, with Austria, Denmark and Sweden scoring best.

GBPN make it clear that efforts need to be stepped up significantly. In order to achieve the required significant energy performance improvements, energy efficiency policy-making should be dynamic, using a continuous process of policy design, implementation and re-evaluation. A clear, longer term road map for mandatory, ambitious building regulations and supporting policy packages are crucial for ensuring the support of the market and for driving the research and development of new and cheaper energy efficiency solutions.

In a nutshell:
Good building regulations are dynamic, but only with a clear, long-term road map and when backed up with supporting measures and compliance monitoring.

[1] www.gbpn.org/databases-tools/purpose-policy-comparative-tool

2.5. Moving Building Regulations Forward

In order to compile and assess the results of the 58 CONCERTO sites, their context within the respective national building regulations had to be considered and coordinators were asked a set of questions regarding regulations in their country or region. Together with the analysis of EU requirements, this pointed towards certain areas that could be developed further and which are more specific than those highlighted in Section 2.4, namely: international comparability of standards, Nearly-Zero-Energy-Buildings, plug-in appliances/ non-regulated electricity use, rising cooling demand and monitoring & data availability. Further improvement potential may lie in including embodied energy.

2.5.1. Tackling International Comparability of Energy Standards

The EPBD 2 acknowledges the need for common and comparable standards – it states specifically:

- Article 1.2: "This directive lays down requirements as regards: (a) the common general framework for a methodology for calculating the integrated energy performance of buildings and building units;.... (Art.3) Member States shall apply a methodology for calculating the energy performance of buildings in accordance with the common general framework set out in Annex I"
- Article 11.9: „The Commission shall, by 2011, in consultation with the relevant sectors, adopt a voluntary common European Union certification scheme for the energy performance of nonresidential buildings.
- Annex I sets primary energy as the common metric to be used.

Comparing energy performance values across countries has always been, and is still, problematic. However, comparing these requirements is highly desirable for a number of stakeholders, for example landlords and investors with international property portfolios, suppliers to the building trade, the EU and individual member states, who want to compare how well they are doing in comparison to their neighbours and last but not least, members of the scientific community. In order for Member States to learn from each other and ultimately reduce emissions to the best possible level, better comparability would be highly desirable.

As illustrated by a statement from the partnering sites in Ostfildern (DE), Torino (IT) and Cerdanyola del Vallès (ES), comparisons across countries were an issue within CONCERTO projects, which all had multinational partners:
"[Our] experience shows, that it is nearly impossible to compare buildings in Spain with buildings in Germany or Italy because the methodologies for the classification of buildings are different in each country:
in Italy the limits for residential buildings are calculated from an index that depends on the heating and DHW [domestic hot water] performance. The Spanish method considers an index that depends on the relation between the real building and the reference building which fulfils the Spanish regulations. The German results are based on the metered consumption for three years"

It has to be recognised that building regulations are an example of the EU's subsidiarity principle: The Directive provides a framework, but all Member States have control over the details. Even if energy performance calculation methods were to be fully harmonised by CEN, national differences would still remain, and some with good reason. As energy performance values depend on variables such as climatic conditions, local building practices, metrics used, system boundaries, primary energy factors etc., comparisons are complex. This issue also represents a key challenge for the overarching analysis of the 58 CONCERTO sites. Obvious differences in performance, due to different geographic location, climatic conditions and data from different years, can be dealt with by normalising values according to the number of degree days for the year and location. However, such a conversion or normalisation process has to be weighed up against preserving the authenticity of the data, as with each conversion, new assumptions and uncertainties creep in.

In a nutshell:
What is more useful? Directly measured (or calculated) data which cannot be compared, or comparisons based on converted factors that are no longer the real values?

Key Factors in Comparisons

Energy performance values are generally stated as figures with the unit "kWh/m²/a". Uncertainties regarding whether this is useful energy, final energy or primary energy impede useful comparisons. Furthermore, the floor areas are calculated differently in different countries – some use gross floor area, some use net floor area or heated net floor area with different rules as to how each is defined, for example those relating to balconies and sloping ceilings. The EU research project ASIEPI found that floor area calculations for the same building can easily vary by 15 % between countries[2], which obviously influences the energy performance value significantly. An unexpected finding within the same project was that still in 2010, far from all EU countries considered all energy uses required by the EPBD in their energy performance calculation method. The energy use for fans, domestic hot water and cooling were among the energy uses which were sometimes not taken into account. This largely complicates comparison between different European countries. What complicates it further is that not all energy saving measures are equally relevant in all climates in Europe.

Harmonising Floor Areas

Floor area measuring conventions are closely tied up with national ways of thinking about property and related economic aspects, hence not easy to change. The need for harmonisation has, however, been recognised, especially amongst those managing multinational property portfolios. Attempts at harmonising them are emerging. IPD (a property performance analysis provider) has set up its own „IPD Space Code". Furthermore, a European Measuring Code has been developed and is applicable to European Commission buildings in Brussels. This code has now been adopted by organisations such as The Comité de Liaison des Géomètres Européens (CLGE).

EU The EC should push for a harmonisation of floor area calculations, e.g. initially by promoting wider use of the European Measuring Code. Initially, these measurements could be declared in addition to the traditional value. Ultimately, standards and regulations could follow (similar to those on metric measurements).

EU N Gross floor areas and heated or conditioned areas should always be declared as part of energy performance calculations.

In a nutshell:
A kWh is not always a kWh and a m² is not always a m².

2.5.2. Is Primary Energy the Best Metric?

An important step towards comparability was made by the EPBD in demanding that energy performance be calculated as primary energy. This appears sensible, as it gives a truer representation of the environmental impact of building energy use than final energy use and has the advantage that many Member States use this metric already (see Table 2.2 – information provided by CONCERTO site coordinators).

[2] Spiekmann M, van Dijk D (2008) Comparing Energy Performance Requirements over Europe, ASIEPI

Table 2.2: **Metric used in Building Regulations on Energy Performance**

Country	Final Energy	Primary Energy	CO_2
Belgium		x	
Czech Republic	x		
Denmark	x	x	
Finland	x	x	
France		x	
Germany		x	
Italy		x	x
Ireland		x	x
Lithuania	x		
Netherlands	x	x	
Slovakia	x		x
Spain		x	
Sweden	x		
United Kingdom			x

There are two different factors for primary energy. The "total primary energy factor" includes the additional energy generated for each kWh of delivered energy, but is lost due to inefficiencies in generation and transmission. Non-renewable primary energy only differs for renewable fuels, as the generated energy is set at zero primary energy, but a factor is added in accounting for fossil fuel used in transporting the fuel.
The Table below shows values suggested in EN 15603 Annex E for use in buildings energy performance calculations.

Table 2.3: **Conversion Factors from EN 15603 Annex E**

	Primary Energy Factors		CO_2 production coefficient
	Non-renewable PE	Total PE	Kg/ MWh
Fuel Oil	1.35	1.35	330
Gas	1.36	1.36	277
Anthracite	1.19	1.19	394
Lignite	1.40	1.40	433
Coke	1.53	1.53	467
Wood shavings	0.06	1.06	4
Log	0.09	1.09	14
Beech log	0.07	1.07	13
Fir log	0.10	1.10	20
Electricity from hydraulic power plant	0.50	1.50	7
Electricity from nuclear power plant	2.80	2.80	16
Electricity from coal power plant	4.05	4.05	1 340
Electricity Mix UCPTE (= Union for the Coordination of the Production and Transport of Electric Power)	3.14	3.31	617

The metric has the advantage of showing the benefits of district heating systems as shown in Figure (2.3): which shows primary energy factors of chosen CONCERTO district heating networks compared to an oil boiler as reference standard.

Figure 2.3: **Primary Energy (Non-Renewable) of DH Networks** (only new CONCERTO energy supply units (ESU) considered; existing ESUs before CONCERTO are excluded)

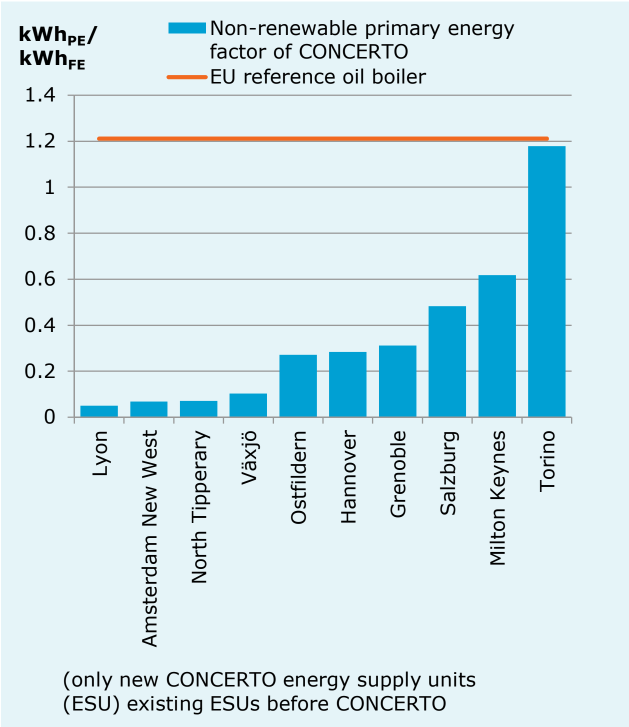
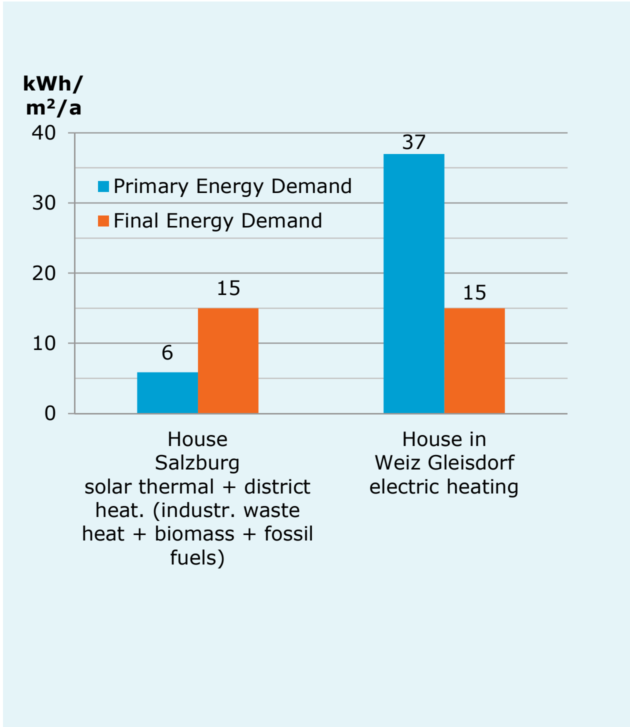


Figure 2.4: **Comparison Primary Energy Demand to Final Energy Demand**



Several studies have stated that concentrating on primary energy as sole metric has a number of shortcomings:

- While non-renewable primary energy factors are more or less proportional to CO_2 emissions, they do not truly reflect the effect of a building's operation on the climate, nor do they reflect acidification, ozone depletion, particulate matter, nuclear waste etc.
- Proportions between primary energy and CO_2 emissions are distorted when nuclear electricity is involved, or renewable electricity for that matter.
- The use of primary energy as metric encourages fuel switching from fuels with a high PE factor by those with a low PE-factor (e.g. biomass), instead of encouraging efficiency. This is illustrated in Figure 2.4, showing two buildings with the same final energy demand, but very different primary energy demand. Though in this case, both buildings have the same very low heating energy use (around passive house standard), it suggests the potential for disguising suboptimal energy efficiency, even if the final energy demand was higher. This must be avoided, as biomass resources are ultimately limited (though this is less of an issue in Scandinavian countries).
- A single primary energy benchmark for nearly zero-energy buildings would obscure the performance of the components it consists of. The energy consumption of heating, cooling, hot water and lighting should be declared as well. Final energy values or useful energy values would be a truer reflection of actual energy flows in the building and hence its inherent qualities and properties.
- As a variation of this point, for nearly zero-energy buildings, the balance between energy consumed and energy generated would be obscured.
- Primary energy is less easy to grasp for end-users than end energy. The latter correlates to value on bills and hence has economic significance.
- As different countries use different primary energy factors, especially for electricity, comparisons across borders are difficult – see Table 2.4.

Table 2.4: **Examples for Different Primary Energy Factors for Electricity in the EU**

France	2.58
Germany	2.6
Italy	2.37
Poland	3.0
Spain	2.6
Sweden	1.5
UK	2.92

N Tough efficiency standards need to be set in addition to primary energy benchmarks – especially regarding: energy losses from infiltration and ventilation, distribution losses, fan and pump power losses and transmission heat losses.

EU N L When calculating energy performance, final energy and useful energy (sometimes referred to as energy need) should be declared in addition to primary energy. With all three energy forms given, conversion efficiencies, assumptions, actual energy flows and the inherent properties of a building become easier to understand.

In a nutshell:
Primary energy as the only metric for energy performance is too limited.

2.5.3. Nearly-Zero-Energy-Buildings (NZEBs)

The official definition of the EPBD (2010/31/EU) Article 2.2 is: " 'nearly zero-energy building' means a building that has a very high energy performance, as determined in accordance with Annex I. The nearly zero or very low amount of energy required should be covered to a very significant extent by energy from renewable sources, including energy from renewable sources produced on-site or nearby;"

The EPBD calls for all new buildings to be „Nearly Zero Energy Buildings" (NZEBs) from 2020 and for public new buildings from 2018. Furthermore it calls for the promotion of exemplary, cost-effective nearly zero energy retrofits. National plans for increasing the number of nearly zero- energy buildings had to be produced by each Member State by 31.12.2012. As late as June 2013 the European Commission still stated that with regard to nearly zero-energy buildings too little progress by Member States has been made, that many Member States' plans on NZEB had not been received and that more guidance seems to be necessary.

Policy support for stimulating the building industry to continue to improve performance makes economic sense. Low energy buildings often have additional benefits neglected: more uniform temperature distribution, lesser draughts, higher availability of daylighting (if energy for lighting has been taken into account), all contributing to better, more valuable buildings ...

In a nutshell:
Primary low energy buildings can also offer higher thermal and visual comfort and better use of valuable floor space.

On behalf of the EC, a consortium led by Ecofys produced the report "Towards Nearly Zero-Energy Buildings - Definition of Common Principles under the EPB". It investigated existing standards and proposes definitions and criteria to aid the European Commission in assessing national plans that have to be produced regarding the implementation of these requirements. The challenge here is to move from using cost-optimality (i.e. life-cycle based) calculations to define performance standards to a very low energy standard. The report found the following status quo:

- 75 approaches from 17 countries were found but, at the end of 2012, only one had been included in national legislation in Denmark.
- There are many differences in energy or emission balance calculation.
- There is a database containing 330 existing nearly zero-energy buildings, covering many building types and climates (see The IEA project "Towards Net Zero Energy Solar Buildings").

Relevant findings of the study are:

- A very low level of energy heating and cooling load is a vital pre-condition for nearly zero primary energy buildings.
- Renewable energy sources will need to play an important role within nearly zero-energy concepts, although the EPBD stresses the principle of energy efficiency first.
- Energy demand of < 30 kWh/m²/a for heating and cooling may probably suffice and the energy class < 15 kWh/m²/a will almost certainly suffice to be called "nearly zero-energy building" by 2021.
- If the share of electricity-supplied buildings rises, the interaction of (nearly zero-energy) buildings with the grid will increase, which cannot act as unlimited storage capacity. A simple energy balance, calculated over a year, would not take the effect on the grid into account. The timing of electricity use and generation needs to be considered.
- If considering a period of 30 years and using 2010 prices together with relatively conservative assumptions for performance and availability of energy efficiency technologies, buildings constructed with very low energy requirements have costs that are lower or comparable to buildings with high energy requirements. Calculations with 2020 prices increase the economic attractiveness of low energy buildings, meaning that the cost optimum moves towards (albeit not meeting) zero. This effect would be more pronounced if using less conservative assumptions.

Recommendations contained in the report are:

N For Nearly-Zero-Energy-Buildings, the share of renewable energy should be stated explicitly.

N Primary energy factors have to be driven down – otherwise even a move towards 'zero' will neither bring most of the new buildings in Europe really close to zero primary energy nor to zero CO_2 emissions.

Still, in summary the report states that "Current technologies related to energy savings, energy efficiency and renewable energies are sufficient to reach, in combination, a suitable target for nearly zero-energy buildings. A real technology gap to be bridged until 2021 is not perceived [3]. All necessary changes for achieving nearly zero-energy buildings as the standard by 2021 are considered to be manageable, especially if Member States make exploit synergies.

Nevertheless, this needs to be read with the proviso that seasonal variations of intermittent renewable energy sources have to be resolved with seasonal storage concepts or intelligent mixes of renewables.

In a nutshell:
There is no major technology gap for Nearly-Zero-Energy-Buildings.

[3] (Hermelink u. a., 2013, p. 14)

2.5.4. En-Route to NZEBs – The Passive House Standard

The passive-house concept, developed originally by the Passive House Institute in Darmstadt (DE), is a concept that many would say uses nearly zero-energy. Though to meet all the requirements stated by the EPBD, passive house standard would need to be combined with renewable energy source.

Key requirements for a passive house are:

- Annual heating demand as calculated with the Passive House Planning Package of not more than 15 kWh/m^2 per year in heating and 15 kWh/m^2 per year cooling energy or alternatively a peak heat load of 10 W/m^2
- Total primary energy for heating, hot water and all electricity to no more than 120 $kWh/m^2/a$
- Air leakage of no more air than 0.6 times the house volume per hour ($n50 \leq 0.6$ / hour) at 50 Pa

This standard has in recent years become widely understood and is being used internationally. In fact it is perhaps the only energy performance definition that is common and comparable across countries.

While NZEBs are a part of the second EPBD – CONCERTO was largely about broad implementation of the first EPBD and hence not geared towards NZEB standard. Still, CONCERTO provides a considerable number of passive houses, adding to the evidence that it can be done, and not just as one-offs, but across whole neighbourhoods. The projects thus provided learning ground for the various stakeholders who realised them, which now provide a skill base that now can help roll out this standard.

In CONCERTO, the following sites contained passive houses: passive houses in the eco-village in Cloughjordan (IE), Passivhaus ELIN in Hartberg (AT), zero-energy buildings in Kortrijk (BE), 40 passive dwellings in Høje-Taastrup (DK), passive houses (104) in Almere (NL); eight floor timber house Portvakten South, Växjö (SE), Trondheim (NO) passive house social housing (elderly care); Björka passive house complex in Helsingborg (SE); ultra-low energy houses in Stenløse (DK), several houses in Weilerbach (DE), several houses in Redange (LU), buildings of Stadtwerk Lehen in Salzburg (AT), Parklife rental flats and Parklife old people's home in Salzburg (AT), a family home and the "Bezirkspensionistenheim" / old people's home in Weiz-Gleisdorf (AT)

Image 2.2: **Apartments in the First Phase of Venning in Kortrijk (BE)**

Image 2.3: **Parklife Flats and Old People's Home in Salzburg (AT)**

Image 2.4: **Ultra-low Energy Houses in Stenløse (DK)**

Figure 2.5 shows final energy demand for heating and domestic hot water (calculated values) of new buildings, thus showing that heating demand in particular is comparable to passive house standard for a number of buildings.

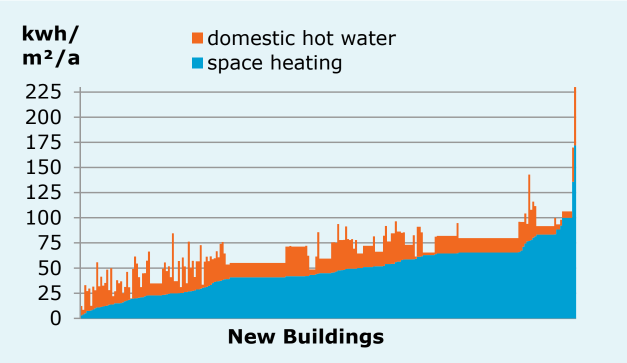
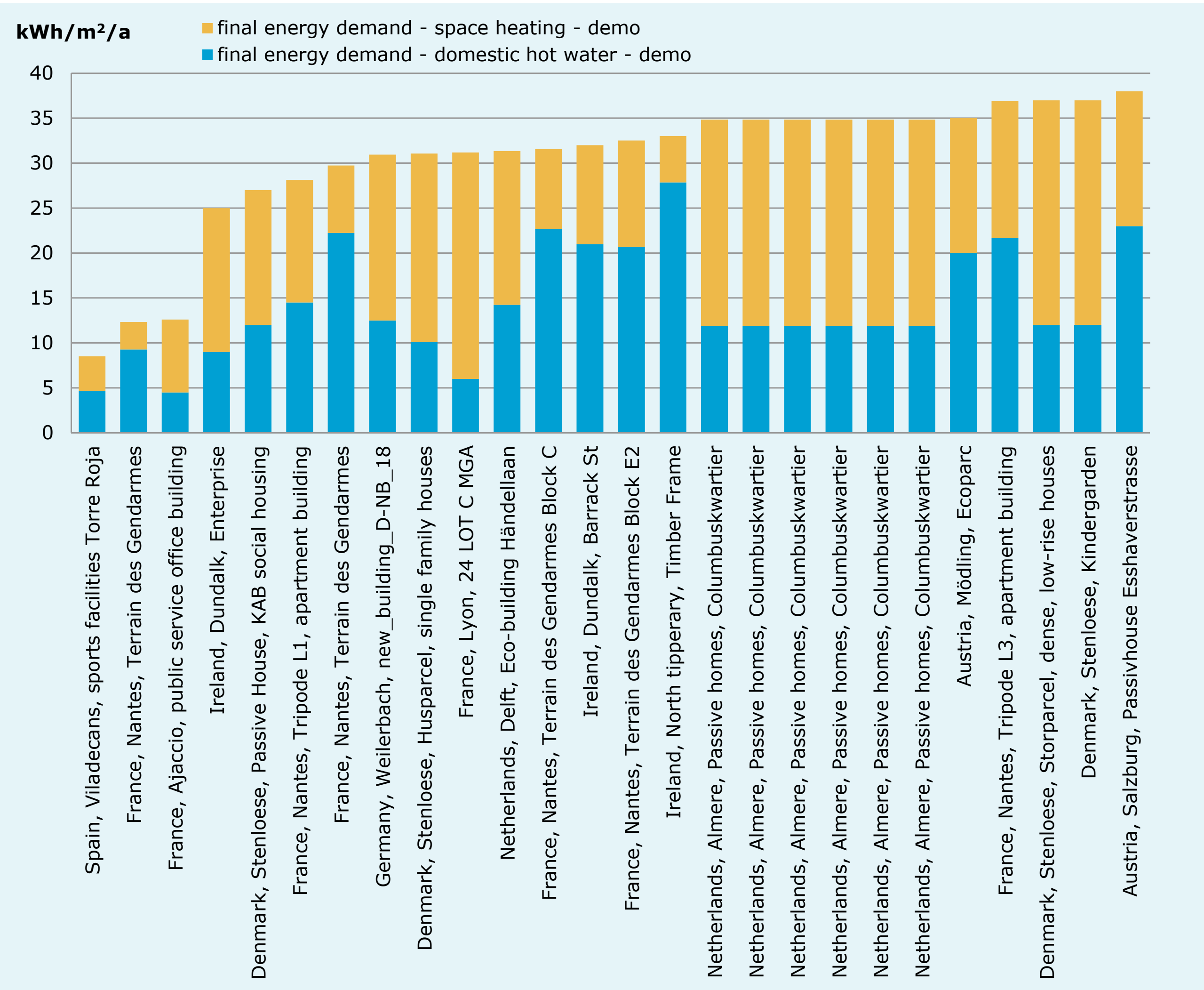


Figure 2.5: **Final Energy Demand (Calculated) for New Buildings**

Consumption of a selection of the best buildings are shown in Figure 2.5. Most of those shown are representative for a group of neighbouring buildings with similarly low energy demand.

In a nutshell:
Low-energy buildings are now possible in many Member States.

Figure 2.6: **Final Energy Demand (Calculated) for Domestic Hot Water and Space Heating**



2.5.5. Current State of the Art: Energy Surplus or Energy-Plus Buildings

However, “nearly zero” does not necessarily mean “just short of zero” – it could also mean “less than zero”, which would mean that a building generates a little bit more energy than its occupants actually need. In fact, cutting edge buildings exist already as so-called energy-surplus/ energy-plus buildings. CONCERTO provides the following examples: Positive Office Building in Grenoble (FR) – see also Section 4.4.1; 2 energy-plus houses, one of which is built from straw bale in Weilerbach (DE) – see also Section 2.5.8.

Image 2.5: **Energy-Plus Office in Grenoble (F)**

Image 2.6: **Energy-Plus House in Stenlose (DK)**

A remarkable development is that in Germany, many manufacturers of prefabricated housing offer kits for turning their homes into energy-plus homes, making this concept available and affordable to a mass market. As part of the German initiative “EffizienzhausPlus”, Hans Erhorn of Fraunhofer IBP has looked at 31 energy-plus buildings of 12 prefab housing companies and identified the following typical “ingredients”: high levels of insulation, underfloor heating and DHW often supplied by ground source heat pumps, photovoltaic for on-site generation, coupled with battery storage (approximately < 0,50 m² PV modules per m² habitable space), demand controlled mechanical ventilation with heat recovery (efficiency >90 %), LED lighting and A++-rated appliances. The definition applied here is that these buildings must generate more than 2500 kWh of electricity per year per dwelling as well as covering the entire heating demand. It can be the case that an energy-plus building produces a large surplus of energy in the summer, but has a shortfall of similar proportions in winter. Tighter rules as to how large this discrepancy is allowed to be are necessary as previously stated (see Section 2.5.3). Ultimately, the rise of energy-plus buildings increases the shifting of households from energy consumer to so-called “prosumer” (i.e. producer and consumer in one). This means an increase of decentralised production and storage.

In a nutshell:
It is not a utopia: we have entered the era of the energy-plus building already, but challenges remain.

EU N Building regulations should address limits for summer/ winter energy imbalances in Nearly-Zero-Energy-Buildings.

EU N Research and development needs shift focus onto nearly zero-energy retrofitting and the development of relevant technical solutions.

EU N Research & development needs to address energy-plus solutions for situations with lesser photovoltaics potential (e.g. larger blocks of flats) by developing new technical solution e.g. more effective building mounted turbines and other technologies.

2.5.6. Dealing with the Rising Cooling Demand

Annex 1 of the EPBD states that cooling energy is to be included in energy performance calculations. Cooling demand is expected to rise, partly due to higher comfort requirements and partly due to higher temperatures resulting from urban heat island effects and in the longer term from global warming. Often cooling is delivered by electricity-powered chillers, exacerbating electricity demand. In many cases, in moderated climates, cooling is not allowed for up-front, nor included into calculations. For example, for housing in central Europe, cooling would neither be anticipated nor would calculations be required. Nevertheless, for upmarket housing it would be expected or retrofitted later, representing a substantial unregulated electrical demand. Occasionally, this may be due to overheating potentials not being “designed out”, due to aesthetic consideration (large, glazed areas without shading devices). There is also anecdotal evidence of shading devices being left out, due to cost at the last minute. On the one hand greater awareness of overheating risks is needed - for example by including cooling energy benchmarks in tenders. On the other hand, low-carbon cooling technologies have to become more wide spread, instead of relying on conventional electrical chiller units, which consume large amounts of electricity.

Conversations with CONCERTO project coordinators in many countries showed that cooling energy is included in energy performance calculation, but limits do not necessarily exist. For example in Spain, summer overheating behaviour has been considered for new public non-residential buildings. The official calculation programme calculates the overall energy demand including cooling, but no performance requirements as such are set. Upper and lower limits for temperature requirements in working environments (outside of building regulations) have been reported for Austria, Denmark, Germany and Norway, though this list is likely to be non-exhaustive. Such limits are often used to define client briefs. For example in Denmark: temperatures must not exceed 26 °C for more than 100 hours per year and 27 °C for more than 25 hours per year. Furthermore the following information on over-heating related regulations applies for the countries mentioned.

- In Austria, standards and overheating limits in summer have to be met according to the ÖNORM B 8110-3 on “Thermal protection in building construction – Heat storage and solar impact”, issued in 1999. This standard says that overheating in summer has to be avoided if the room temperature doesn’t exceed the defined temperature limits: + 27 °C during the day and + 25 °C during the night.
- In Denmark, in the calculation tool used for calculating the energy performance of buildings, overheating is included as a “penalty”. It is expected that a more detailed tool for assessment of the actual temperatures will soon be introduced.
- In Germany, the legal basis is the Energy Saving Ordinance (called Energieeinsparverordnung, EnEV 2009), which is based on a DIN-Standard D4108-2. It requires the calculation of solar gains, a value that is calculated depending on the size of window area, the solar transmittance of glazing, orientation and shading devices.
- The Norwegian regulation for energy demand in buildings is relatively strict. The programme mostly used is called SIMIEN. It automatically simulates the summer situation, and informs you when there’s a problem, but proof does not have to be supplied in general. For multi-family buildings there is a minimum requirement for solar shading.

If firmer performance requirements were in place throughout Europe, it would become more obviously advantageous to design in shading and other passive measures, as well as using “free cooling” (night time cooling, activating thermal mass, tri-generation, district cooling networks etc.). On the whole, the necessary technologies exist and are tried and tested. CONCERTO examples of such solutions are presented in the BOXES. It is particularly important to consider these solutions at design stage, as they are on the whole harder to retrofit, than a plug-in chiller unit. The research project ASIEPI points out, how important it is to integrate sustainable cooling technologies into calculation methods and standards.

Slab Cooling in The ELEKTROR Building, Ostfildern (DE)

The Elektror company office building with an office area of 3 280 m² is heated and cooled using heat from the biomass ORC cogeneration plant. The heating energy for the winter season is supplied to the ceiling slabs and with convectors at the air outlets. In summer, cooling is only provided to the concrete core ceiling. The installed water/lithium bromide absorption chiller from Yazaki with nominal 105 kW cooling capacity is directly connected to the district heating network and provides about two-thirds of the total cooling energy demand of the building (design value of 180 MWh/a).

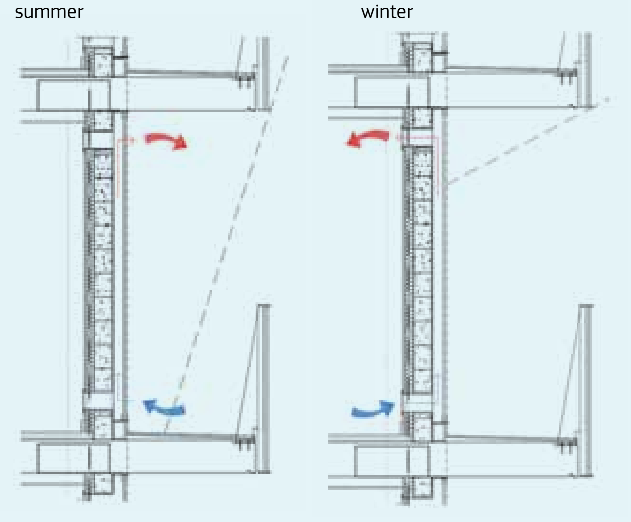


Image 2.7: **Passive Cooling in Residential Housing in Cerdanyola del Vallès (ES)**

Galleries allow the interior of the dwellings to be heated in winter by means of the greenhouse effect, while supporting natural ventilation in summer. These have been designed in the south of the buildings The building envelope has a high level of insulation and the windows have mobile solar protection systems. The dwellings have been designed with an intermediate space that contains devices to regulate natural ventilation in summer. All the dwellings have trombe wall modules in the southern façade for preheating in winter and ventilation in summer.

Lake Cooling in Geneva (CH)

The backbone of the Geneva (CH) CONCERTO project is a low-temperature thermal exchange network that uses water from Lake Geneva (CH) as a heat source/sink which remains at a nearly constant temperature of 8ºC near the lake bed. Consequently, the connected buildings in the Genève-Lac-Nations district (offices of the United Nations, the International Labour Organisation and International Committee for the Red Cross) reduce their electrical consumption for cooling by about 50 % compared to national standards. The main components of the network are:

- A water pumping station, (including a system on the return line which recaptures hydraulic energy to drive the pumps, resulting in reduced energy requirements for pumping)
- The water distribution network that extends five kilometers inland from the lake
- Substations for each supplied building including heat pumps (for heating) and/or heat exchangers (for direct cooling)
- Thermal heating capacity of about 3 MW, thermal cooling capacity of the network of 16.2 MW

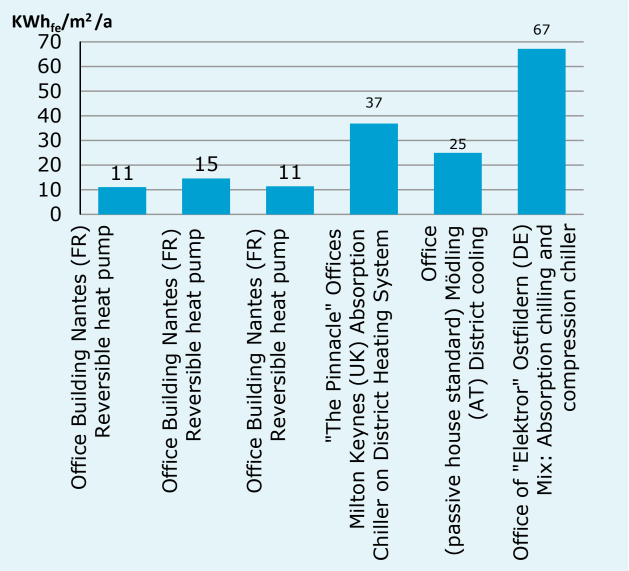


Figure 2.7 **Cooling Demand in Selected CONCERTO Buildings**

CONCERTO projects have installed 6 building integrated chillers, 9 reversible heat pumps, 4 district cooling networks (Geneva (CH), Heerlen (NL), Växjö (SE), Cerdanyola del Vallès (SE) and thus have contributed to creating a critical mass of examples for future-proof, comfortable buildings. Examples of cooling demand (final energy) of buildings supplied by these systems are shown in Figure 2.7. However, the 'Intelligent Energy' funded project ASIEPI found that while alternative cooling techniques do have great potential for reducing the cooling load and cooling energy consumption in buildings, their implementation in energy performance regulations is not very robust and can actually constitute a barrier to their use.

N Building regulations and relevant calculation systems should prioritise passive cooling design and alternative cooling techniques over conventional cooling systems.

2.5.7. A Step-Change in Building Regulations – Including Plug-in Appliances

Despite energy efficiency targets and reduction measures, there are various forces pushing towards an upward trend in energy use. These stem largely from increasing electrification, ever more powerful ICT systems and the desire of people to have these. As thermal insulation standards rise, it is domestic hot water and household electricity that make up the bulk of energy consumption in buildings.

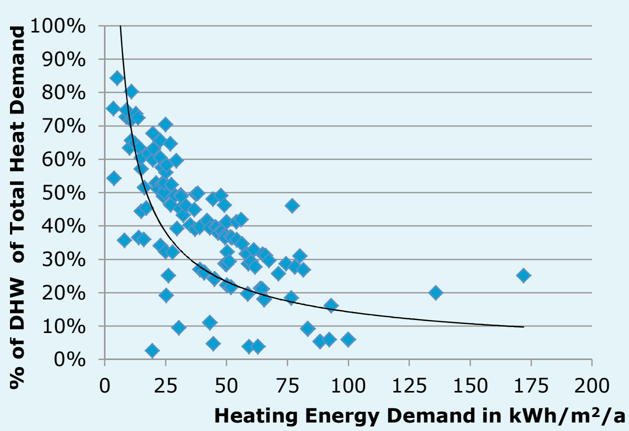


Figure 2.8 **Share of Domestic Hot Water Heating within Total Heat Demand**

Figure 2.8 shows the share of domestic hot water becoming relatively more important (the lower the absolute heating demand on the x-axis, the higher the share on the y-axis). Hence in a next step, an efficient hot water system is important. While hot water use largely depends on user-behaviour, consumption can be reduced with water-saving appliances.

Domestic hot water is included in those energy uses covered by energy performance calculations under the EPBD, so is electricity for pumps and fans, as well as lighting in principle. On the one hand, lighting has not been included for all types of buildings in all countries and plug-in appliances are generally excluded. These, however, show a steady increase in power consumption, as more and more appliances are being used in everyday life (computers, smart phones, video games, household gadgets, bigger cookers and fridges ...) and in a thermally efficient building may eventually exceed all other energy uses in terms of consumption and resulting emissions. This effect will be amplified with the increasing popularity of electric cars. The rise of so-called "Smart Homes" can increase electricity demand further by providing electricity-driven controls for everything from fingerprint recognition door locks via timed shutters to entertainment systems in every room. On the other hand, the concept holds the potential to save energy by starting or shutting down such systems on demand. Smart systems can also sense and react to peak loads by postponing energy intensive activities such as laundering or turning fridges off temporarily.

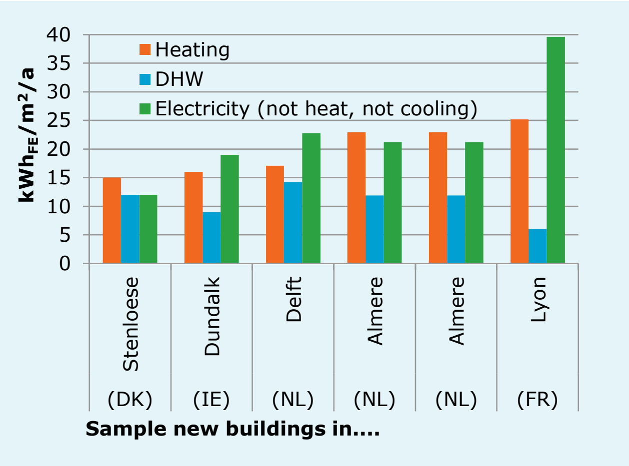


Figure 2.9: **Final Energy Demand (Calculated) of Sample New Buildings in CONCERTO**

Not many CONCERTO buildings have data on electricity available – but amongst those that do, some show a relatively large share of electricity (see Figure 2.9). The idea has always been that the consumption of plug-in devices depends too much on the occupier and too little on the building for them to be included in, and regulated by building regulations. Benchmarking or limiting such uses is therefore seen as problematic and controversial.

This rationale can be queried in as far as such uses still happen within the building and have to be allowed for by the building in terms of provision of sockets, energy supply capacity to the home etc.. In some countries, methods for calculating and including plug-in energy use can be found already, though these are not mandatory.

If buildings – especially new ones – are moving closer to energy self-sufficiency, using batteries etc, it makes sense to calculate such uses. The aforementioned report "Towards nearly zero-energy buildings" sees, in the medium term, an inclusion of targets for lighting and appliances. These are uses that can be reduced relatively easily, with efficient appliances and new LED-lighting technology.

As mentioned in Section 2.5.3, the balance of energy production and energy use throughout the course of the days and the year needs to be considered. In this context, in-house storage solutions will gain in importance. These are already available as part of advanced solar packages. Ultimately, storage capacity may have to enter regulation too.

Table 2.5: **Calculating Plug-In Consumption**

Available methods for calculating energy use for plug-in appliances in dwellings	
internationally	Passive house (voluntary standard) and methodology of the Passive House planning tool
Germany	For a "Plusenergiehaus"/ energy-plus dwelling at least 20 kWh/m²/a or 2500 kWh/a need to be provided for plug-in appliances
UK	Within the calculation tool SAP, used for building regulations approval, there is an algorithm for the amount of electricity for plug-in appliances. This needs to be included only if aiming for the highest possible rating of the Code for Sustainable Homes rating system.
Norway	In current building regulation, the energy consumption from electrical uses is not covered. However the Norwegian Standard 3031, indicates a standard consumption for each building category, which is a basis for dynamic building simulations. Installation of demand controlled lighting is rewarded with 20% reduction of standard energy consumption for lighting, when comparing the buildings overall energy efficiency.

N Proposals for systematic inclusion of plug-in energy consumption into building regulations and relevant calculation systems and standards should be developed.

N Inclusion of requirements regarding electric storage into building regulations should be considered in the longer term.

In a nutshell:
Buildings do not need any energy – the occupiers do and they need plug-in appliances as much as heating.

2.5.8. Should Embodied Energy be Regulated?

CONCERTO was about reducing energy consumption in the use phase of buildings and this is indeed the key challenge, if tackling the 40% of emissions from building stock. However, the more this energy consumption nears zero, the more the energy used and emissions produced in manufacturing and transporting building materials, as well as for assembling the building, exceed those of the use phase. This could either be tackled at point of origin within the manufacturing industry and transport sector, but this is difficult, as the energy intensive industries concerned often receive exceptions from various emission reduction schemes. Including it at the point of the final product, i.e. the building, attempts to tackle the issue from the demand side. Scientific focus appears to shift increasingly toward embodied energy. Sustainability assessment systems tend to include embodied energy and therefore provide a blueprint for possible inclusion into regulations. Some CONCERTO projects have set a positive example of thinking beyond energy in use, again providing a showcase for a more ambitious approach. BPIE state that "due to insufficient consistency of results from different LCA tools, it may be too early to require LCA information as part of a threshold value. Nevertheless, in principle, it would make sense to include LCA information in the evaluation of a building's energy performance" [4].

N Rather than setting mandatory limits on embodied energy, for now an estimate of the energy needed for production and disposal could be asked for. This would be mentioned for information only, in addition to the indicators reflecting the energy performance of the building, thus helping to establishing LCA-calculations better.

Including the information regarding energy consumption during the phases of construction and disposal of a building will underline the importance of each life cycle phase's energy consumption.

[4] Atanasiu, B. (2011), Principles for Nearly Zero-Energy Buildings - Paving the Way for Effective Implementation of Policy Requirements, Executive Summary, p.9

Image 2.8: **Multistorey Timber Frame Buildings in Växjö (SE)**

The private party – Midroc Property Development – has constructed 134 dwellings in four wooden multi-storey buildings at the site of Limnologen in Växjö (SE). They are Sweden's largest newly constructed wooden buildings. Wooden buildings have low carbon emissions during production and sequester carbon during their lifetime. Producing wood is energy efficient and does not use finite resources. The building only consumes 65 kWh per square meter per year. Wooden buildings, in particular the ones that use a high level of pre-fabrication, are flexible and it is possible to recycle building elements. At the end of the lifecycle, the material does not need to be disposed of, but can be combusted and converted to heat and electricity. There are other desirable attributes in addition to the environmental benefits, such as it being highly fireproof and creating a good working environment.

Image 2.9: **Low-Impact Construction in the Eco-Village of Cloughjordan (IE)**

Every house built here must adhere to the village's eco-charter: the charter says that buildings should be highly insulated, make use of passive solar gain and renewable energy, minimise potable water consumption, reduce construction waste, and on top of this use low embodied energy materials. A particularly good example of this is a timber-framed lime hemp house. In order to satisfy building control, a standard timber-frame was erected, rather than using a self-supporting lime-hemp mixture. A mixture of lime and hemp was then filled in around the timberframe over the full thickness of the exterior walls, giving 300 mm of insulation between studs and providing a good combination of insulation and thermal mass. The materials can be produced locally and the fast growing hemp plant stores carbon during its growth, while also releasing oxygen into the atmosphere. The captured carbon is thus retained within the fabric of a building. Courses on relevant construction techniques are being run regularly at the hostel within the village.

Image 2.10: **Straw Bale Building in Weilerbach (DE)**

In Eulenbis (Weilerbach, DE) a straw bale house with extremely low embodied energy has been built. It has been calculated that only 90 litres of diesel have been used to produce the building material, more specifically to power the combine harvester for harvesting the straw. Hence, the embodied CO_2 balance is exemplary. The house has been used to hold information events regarding energy efficient building, as part of the CONCERTO project.

2.6. Monitoring, Data Availability, Data Communication

Monitoring of energy flows within buildings, energy supply units and neighbourhoods is pivotal in order to understand energy better – or as the old energy manager adage says "you cannot manage it if you cannot measure it". Long-term monitoring is indispensable for achieving, measuring and communicating long-term success within the building, but also to the outside world. Monitoring is also important in order to provide a reliable database of international energy performance data on which political debates can build upon.

All CONCERTO projects had to undertake some monitoring activities. Generally, two years of monitoring were required in order to give the buildings and energy supply units the chance to overcome the teething problems of the first year. Often just a handful of exemplary buildings was monitored.
Monitoring of whole neighbourhoods is common in projects that implemented district heating schemes, giving an impression of energy flows and demand levelling opportunities in a larger system. However, there is still need for a better understanding of all the various energy flows at neighbourhood scale.

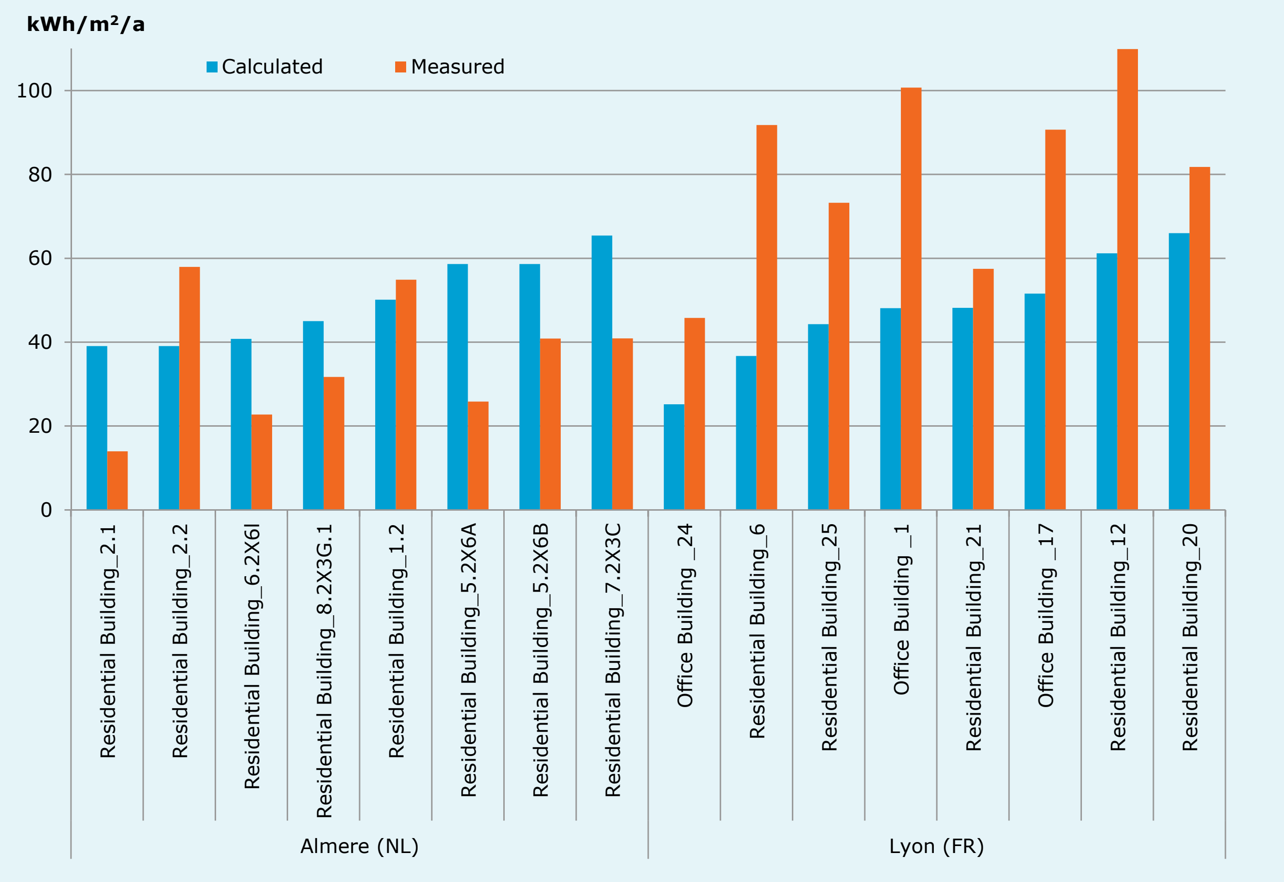
Metering for Tenant Awareness in Helsingborg (SE)
A new metering system has been developed and implemented in selected new buildings of Helsingborgshem. The system has increased the awareness of the tenants regarding their energy consumption and has led to energy savings. The energy consumption is clearly visualised on the monitoring screen. Besides energy consumption, the metering system also handles comfort metering, burglar alarms, fire alarms etc. which improve the tenant's attention to the monitoring screen. The system has proved that with a higher awareness from the consumer, energy savings can be realised.

Input-Output Controller at Lister Bad in Hannover (DE)

Hannover: At Lister Bad a so-called input-output controller has been implemented which at the time was the first application of this control device in an outdoor swimming pool. It checks the solar system output automatically and compares it with an expected output according to weather conditions and the operation temperatures in these systems. Therefore, several sensors for measuring the solar radiation and the ambient water temperature have been installed. The system automatically caused the solar system pump to switch off twice because the maximum desired temperature of the pools had been reached.

The graph below shows a juxtaposition of metered and calculated energy performance of selected newbuild CONCERTO buildings with particularly large discrepancies. It is important to note that discrepancies can go either way and hence are totally unpredictable. Often they can have good reasons, such as that the calculation excluded some energy uses (e.g. plug-in appliances) or that there are shortcomings in construction quality or non-standard occupancy patterns and user behaviour - in short, issues relating to people and their skills. Chapter 7 addresses these in detail. Nevertheless, only diligent monitoring and consequent targeting of untypical values can uncover and address these. It can also help identify, whether building users understand the technologies employed or whether training measures are necessary. Good technical monitoring would communicate energy performance Figures to users via well visible displays. Monitoring becomes ever more important in a smart grid scenario, as it depends on all stakeholders playing their role in balancing loads. Smart meters will play a role in this, yet are currently hampered by concerns regarding privacy (See also chapter 7).

Figure 2.10: **Comparison of Calculated and Measured Final Energy Demand for Heating (new buildings)**



Performance

The following recommendations have been compiled during the analysis of the 58 sites, based on interactions with project and site coordinators:

- **EU** Considering the difficulties surrounding monitoring and the paramount importance of it, the EC should consider funding it fully. Furthermore research and development work into low-cost technical monitoring solutions should be promoted through grants and other incentives.
- **EU N L** When monitoring demonstration buildings, the following uses should be sub-metered separately if at all possible: hot water separate from space heating, secondary heating separate from other electrical uses, lighting and fans & pumps separate from other electrical uses, cooling if applicable.
- **EU N L** Monitoring the items above is only one side of the story – one should also monitor whether the benefits expected from the energy use were actually achieved. For this, pilot buildings should also monitor temperature by using data loggers. However, the energy consumption may be as expected, the temperatures as designed, but the resident may feel too warm or too cold – ultimately, occupants surveys should be undertaken to complete the picture.
- **EU N L** Occupiers should be provided with clearly visible displays showing real-time monitoring data.
- **EU N L** Monitoring of energy flows at neighbourhood scale should be promoted.
- **N** Solutions must be found to overcome privacy issues hampering the collection of monitoring data.

Monitoring in North Tipperary (IE)

Until recently, Ireland did not have a suitable set of energy performance data benchmarks for existing dwellings. The CONCERTO project in North Tipperary therefore entered into collaboration with the national energy agency SEAI to establish such figures as part of their retrofitting project. Additional money for detailed monitoring could therefore be obtained, to cover the high human resource costs. Every house has the especially developed monitoring system. It encompasses multiple meters for electricity, gas and renewable energy. Data is logged in the house and transmitted via broadband to the data-base, which automatically captures the consumption. However, secondary heating is a big issue in rural Ireland (fireplaces using wood or coal) – it can only be monitored via visits and participants logging each basket of wood they burn. The secondary heating share was found to be in the region of 30-35 %, while the Irish calculation methodology used a value of 10 %. This monitoring work has been extended into a longitudinal study, as Ireland does not currently have good long term data.

In a nutshell:
We need to know, where all the energy goes.

Performance

2.7. Summary & Recommendations

In summary, the analysis of the 58 sites in 23 countries means that a number of issues relating to calculated and actual energy performance emerge. Many of these relate to the difficulty in comparing the energy performance figures from different countries, due to underlying differences in practices regarding the calculation of it. A selection of these aspects were explored and compared with current thinking outside CONCERTO and recommendations were made to move relevant building regulations forward, in order to meet new challenges and towards better comparability.

EU	The EC should push for a harmonisation of floor area calculations, e.g. at first by promoting wider use of the European Measuring Code. Initially these measurements could be declared in addition to the traditional value. Ultimately, standards and regulations could follow (similarly to those on metric measurements).
EU N	Gross floor areas and heated or conditioned areas should always be declared as part of energy performance calculations.
EU N	Tough efficiency standards should be set in building regulations, in addition to primary energy benchmarks. These should address energy losses from infiltration and ventilation, distribution losses, fan and pump power losses and transmission heat losses.
EU N L	When calculating energy performance, final energy and useful energy (sometimes referred to as energy need) should be declared in addition to primary energy. With all three energy forms given, conversion efficiencies, assumptions, actual energy flows and the inherent properties of a building become easier to understand.
EU N	Building regulations should address limits for summer/ winter energy imbalances in Nearly-Zero-Energy-Buildings.
EU N	Research and development needs shift focus onto nearly zero-energy retrofitting and the development of relevant technical solutions.
EU N	Research & development needs to address energy-plus solutions for situations with lesser photovoltaics potential (e.g. larger blocks of flats) by developing new technical solutions e.g. more effective building-mounted turbines.
N	Building regulations and relevant calculation systems should prioritise passive cooling design and alternative cooling techniques over conventional cooling systems.
N	Proposals for the systematic inclusion of plug-in energy consumption into building regulations and relevant calculation systems and standards should be developed.
N	Inclusion of requirements regarding electric storage into building regulations should be considered in the longer term.
N	Rather than setting mandatory limits on embodied energy, for now an estimate of the energy needed for production and disposal could be asked for. This would be mentioned for information only, in addition to the indicators reflecting the energy performance of the building, thus helping to establishing embodied energy calculations better.
EU	Considering the difficulties surrounding monitoring and the paramount importance of it, the EU should consider funding it fully. Furthermore research and development work into low-cost technical monitoring solutions should be promoted through grants and other incentives.
EU N L	When monitoring demonstration buildings, the following uses should be sub-metered separately if at all possible: hot water separate from space heating, secondary heating separate from other electrical uses, lighting and fans & pumps separate from other electrical uses, cooling if applicable.
EU N L	Monitoring should also capture whether the benefits expected from the energy use were actually achieved. For this, pilot buildings should also monitor temperature by using data loggers. Ultimately, post occupancy surveys should be undertaken to complete the picture.
EU N L	Occupiers should be provided with clearly visible displays showing real-time monitoring data.
EU N L	Monitoring of energy flows at neighbourhood scale should be promoted.
N	Solutions should be found to overcome privacy issues hampering the collection of monitoring data.

2.8. Sources for Further Information

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Typology Approach for Building Stock Energy Assessment (TABULA)
http://www.eaci-projects.eu/iee/page/Page.jsp?op=project_detail&prid=1865

ASIEPI – Assessment and Improvement of EPBD Impact (research project)
http://www.asiepi.eu

3. Retrofitting for Smarter Communities

3.1. Introduction

As the EC's review of the second National Energy Efficiency Action Plans shows that Member States are faced with a considerable challenge of scaling up energy efficiency, large savings opportunities are to be made in existing buildings, which consume 40 % of final energy. Barriers to energy efficiency retrofitting are, however, perceived to be high and relate to social issues, such as awareness, tenure issues (e.g. principal agent dilemma) and skills on the one hand and economic issues on the other. These are addressed in further detail in Chapters 5 and 7, while this chapter explores retrofitting in general and specific insights from CONCERTO.

3.2. EU Policy Context

The Energy Roadmap 2050 (COM (2011) 885 final) states that "higher energy efficiency in new and existing buildings is key". More detailed requirements are provided by the Energy Performance in Buildings Directive (2010/310/EU) and the Energy Efficiency Directive (2012/27/EU).

The Energy Performance in Buildings Directive (2010/310/EU) requires minimum energy performance requirements for major refurbishments, also below 1 000 m^2, and for building elements to be replaced. Member States are called upon to reduce existing legal and market barriers and encourage investments and also to provide subsidised technical advice and financing facilities, with which the EU can help. There is an emphasis on cost-optimality. The ultimate aim is an effective transformation of existing buildings into nearly zero-energy buildings, for which targets are to be set by Member States. Furthermore, recommendations for retrofitting are to be contained within Energy Performance Certificates.

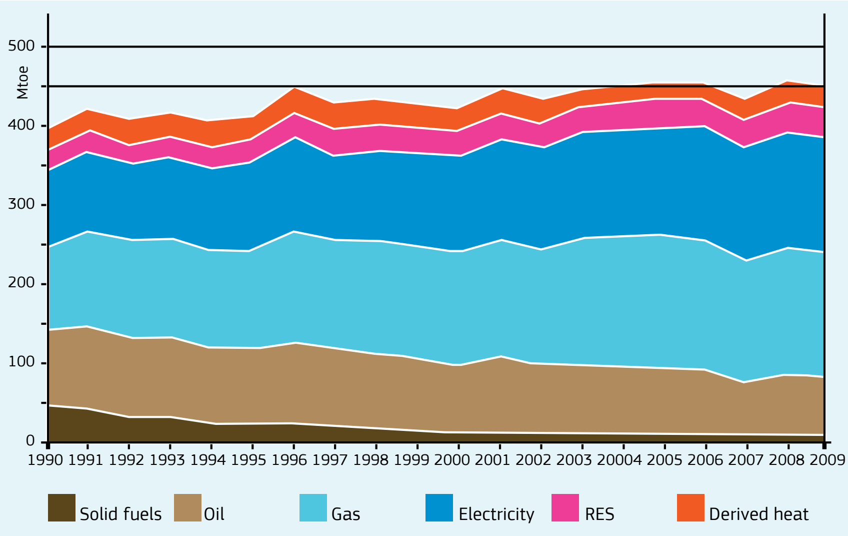
The Energy Efficiency Directive (2010/310/EU) sets an annual rate of 3 % of all buildings, but only those owned by national governments. It calls for the identification and removal of regulatory and nonregulatory barriers to the use of energy performance contracting, as well as those obstacles to the retrofitting of the existing building stock, based on a split of incentives. Member States are required to establish a long-term strategy beyond 2020 for mobilising investment in the retrofitting of residential and commercial buildings, which should address cost-effective "deep renovations".

There is no specific reference to measures at neighbourhood scale in any of the documents.

3.3. The Challenge of Europe's Existing Building Stock

It is well known that buildings currently represent almost 40 % of total final energy consumption and therefore the reduction of energy consumption of buildings can make a crucial contribution to the EU 20-20-20 targets. Throughout Europe, energy performance is now part of building regulation but it focuses mainly on new buildings, which have an annual growth of only 1 %. If not built to zero CO_2-standard, these will only add to the problem, as Figure 3.1 shows: the final energy demand in the building sector is actually slowly but steadily rising. Approximately 70 % of the building stock we will be using in 2050 has already been built, meaning that Europe's building stock is characterised by a large proportion of old, inefficient buildings. Hence, this is where by far the largest share of emissions arises and where emission reduction efforts must be concentrated on.

Figure 3.1: **Historical Final Energy Consumption in the Building Sector since 1990s for the EU27 Switzerland and Norway**[5]

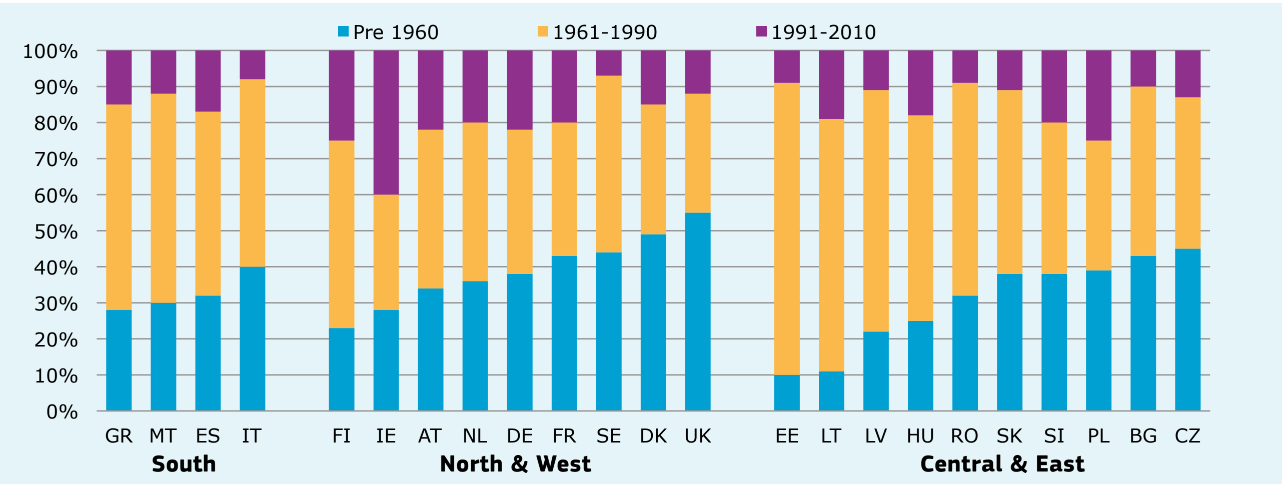


3.3.1. Europe's Inefficient Building Stock

In total, there are 24 billion m² of floor area in buildings in the EU 27. Three-quarters of the EU building stock belong to residential buildings and one quarter to non-residential buildings, which can be split into one-third (by floor area) apartment blocks and two-thirds single family houses, showing the significance of the latter.

Figure 3.2 shows that on the whole, there is a large share of pre-1990 housing stock in most countries. The older the buildings are, the lower the average insulation standard is likely to be.

Figure 3.2: **Age Profile of Residential Floor Space**[6]



In terms of very rough energy characteristics, it can be stated that regardless of whether a building is in central, southern or eastern Europe, final energy consumption in single-family homes built prior to the 1970s will be around or above 200 kWh/m²/a for heating and still ranges between 50-100 kWh/m²/a for recently built single-family homes.

For reference, this compares with kWh/m²/a for space heating in a passive house and needs to be "near zero" by 2020 for new buildings, in order to fulfil the requirements of the EPBD of 2010. All put together, this illustrates how great the challenge is that is posed by inefficient existing buildings, but also how substantial the potential for improvement is too.

[5] (Economidou, 2011, p. 43)

[6] (Economidou, 2011, p. 36)

3.4. Retrofitting in the Pilot Projects

As the financial crisis unfolded, demand for new buildings came to a halt in many countries and private investors often could not find funding. Therefore many CONCERTO projects had to shift emphasis onto existing buildings as seen in the projects in Hillerød (DK), Tudela (ES) and Viladecans (ES). This now offers the advantage of providing additional learning in this important field. Due to CONCERTO, there are now retrofitting demonstration projects in 23 countries having to respond to a wide range of climatic zones and social contexts, as illustrated in Table 3.1. Hence varied and comprehensive experience is available both from the analysis of the projects and from the input provided by their experienced site coordinators.

Even though the projects encountered the typical economic, social and structural barriers found in other studies, the overall message of CONCERTO is that it provides proof that retrofitting projects can be done, reducing energy consumption at a large, urban scale, while responding to a wide range of settings. These projects play an important role in creating a critical mass of demonstration projects at community scale. They provide an evidence base, covering both the barriers encountered but also successfully implemented technical and organisational solutions. Relevant technical results on the CONCERTO project sites can be accessed via the CONCERTO Technical Monitoring Database.

Table 3.1: **Selected Examples of Retrofitting Projects within CONCERTO**

Site	Details
Ajaccio (FR)	Buildings from the 1960s were made more energy efficient; double-glazing with thermo-coating has been installed in fifty buildings in the historic city centre. Altogether 250 buildings have been re-glazed in this way.
Amsterdam, New West (NL)	A total of 500 1960s dwellings in 4 buildings were refurbished by the project, providing a blue-print for 50 000 similar dwellings that could be renewed in the same way in future. Meanwhile, the energy supply to the area is benefiting from a new biogas plant that converts waste to energy. It could be proven that with the right stakeholders, involved emissions from 1950s/1960s buildings can be reduced by 70 %, at reasonable cost.
County of North Tipperary (IE)	Basic measures to around 400 rural dwellings across the county as well as the retrofitting of an agricultural college were realised.
Galanta (SK)	Three 8-storey residential buildings with 32 dwellings and a school will be retrofitted. A 2,1 kWp PV system is to be installed on each retrofitted multi-storey house and 4,6 kWp on the school.
Grand Boulevard, Grenoble (FR)	Refurbishment of dwellings and commercial space in a dense inner city area.
Hannover (DE)	Refurbishment of 35 multi-occupancy buildings with 350 dwellings plus some detached houses.
Kortrijk (BE)	The public sector social housing company Goedkope gave their out-dated stock, which was in poor condition, a major upgrade, with a focus on energy saving and environmental criteria, but also with the aim to achieve social and cultural improvements in the neighbourhood.
Lambeth, London (UK)	Refurbishment of inner city tower blocks serving as social housing.
Lourdes, Tudela (ES)	The retrofitting a number of low-rise blocks helped to halt the threat of ghettoisation in a culturally mixed area.
Montieri (IT)	The project aims to connect private and public buildings to a geothermal district heating network to serve 425 users within the historic village of Montieri. Part of these dwellings will receive energy efficiency improvements and solar hot water systems as well.
Słubice (PL)	Private owner occupiers have refurbished their mixed ownership block.
El Picarral, Zaragoza (ES)	Seventy dwellings in El Picarral, a working class neighbourhood, received comprehensive modernisation work, including new heating systems, insulation and lifts.

Image 3.1: **Słubice (PL) – before**

Image 3.2: **Słubice (PL) – after**

3.4.1 How Much Energy can be Saved?

Looking across CONCERTO sites, Figure 3.3 shows that more than half of the buildings captured in the CONCERTO database saved 50 % or more, sometimes saving over 80 %.

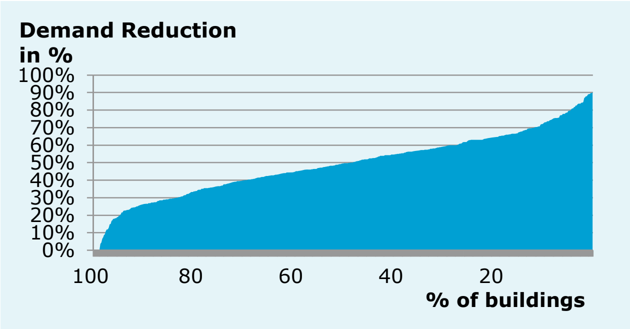


Figure 3.3: **Percentages of Savings Achieved in Retrofitted Buildings (Final Energy for Heating and DHW)**

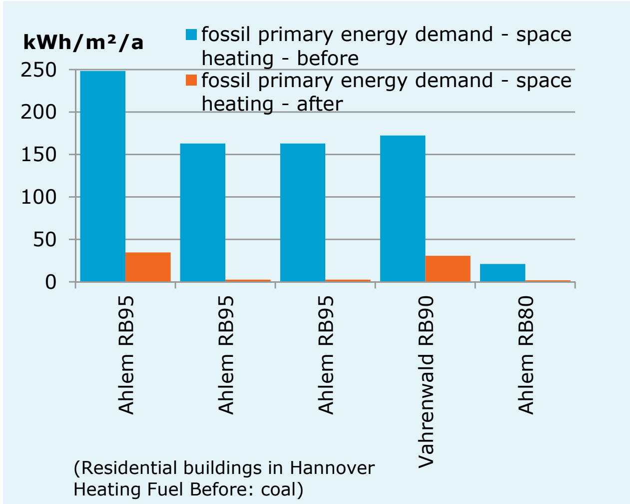


Figure 3.5: **Fuel Switching to Biomass: Examples of Primary Energy Demand of Space Heating Before and After**

Figure 3.4 shows calculated final energy demand for heating and domestic hot water in a selection of high-performing refurbished buildings, compared against their previous performance and compared against benchmarks for average national consumption, showing substantial savings.

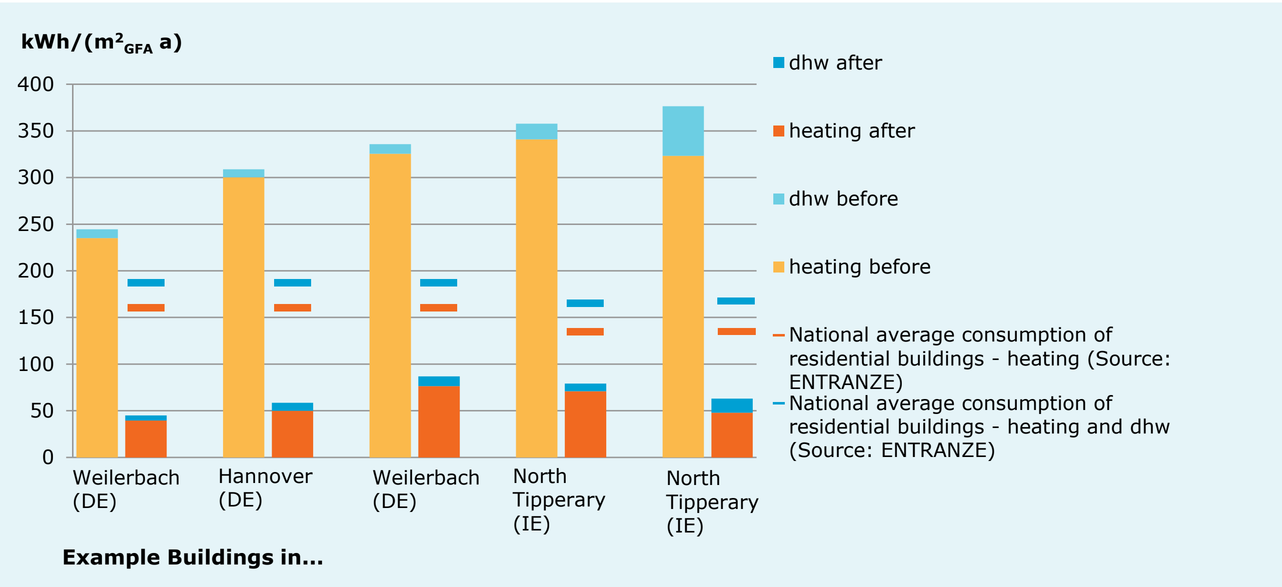


Figure 3.4: **Examples of Final Energy Demand (Calculated) of Refurbished Residential Buildings**

These are not quite "nearly zero", as defined in Section 2.5.3, but some of them use biomass as main heating fuel, which will bring the primary energy demand near zero, as in Figure 3.5. Reasons for lesser favourable performance could be the rebound effect (see Section 3.5.3 and Glossary) or a lack of skills '(see Chapter 7).

3.4.2 What Does Retrofitting Cost?

Figure 3.6 shows the range of absolute refurbishment cost per m² with averages below 500 EUR/m² in Spain and in Austria to over 2 000 €/m² in Denmark and Switzerland, with certain outliers even higher than that.

As part of the economic analysis by the CONCERTO Premium consortium (See also Chapter 5), some costs per kWh saved in retrofitting projects have been analysed, based on a 30 year life-cycle. Figure 3.7 shows costs ranges and averages per site. These costs per kWh have then been compared against the typical cost of gas in the relevant countries in 2008 (a year when all CONCERTO projects were still / already running). On this basis, cost per kWh saved due to refurbishment can compete with gas prices in Austria and Switzerland and are particularly favourable in Ireland. In Hungary, prices are very close. Only Bulgaria is an exception, partly due to the very low gas price there. As many property investors would only consider a time span of 20 years or even less, the message has to be reinforced, that current market conditions do not support the ambitious retrofitting needed to meet 2050-targets. Support programmes are needed to help the necessary technologies and skill base to maturity.

The example in Óbuda (HU) is interesting in as far as the refurbishment of the huge 900 dwelling concrete slab building "panel-block" building had been considered very expensive. This landmark project had to be subsidised heavily with grants from local and national government, totalling three-quarters of the cost. With external wall insulation, new windows and improvements to the heating systems, 50 % of energy could be saved. The below analysis shows that the costs per kWh saved were not far off the gas cost. Perhaps this contributed to neighbouring buildings following this example, even without subsidies.

EU Support programmes should be set up and maintained to help the ambitious deep-retrofitting technologies and skill base to maturity.

Figure 3.6: **Capital Costs for Refurbishments by Country (for Details on Reading Box-Plots refer to Section 5.4.1)**

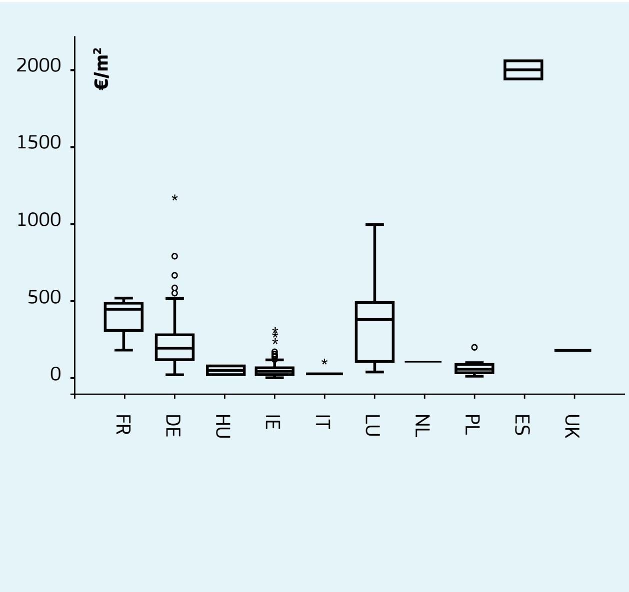
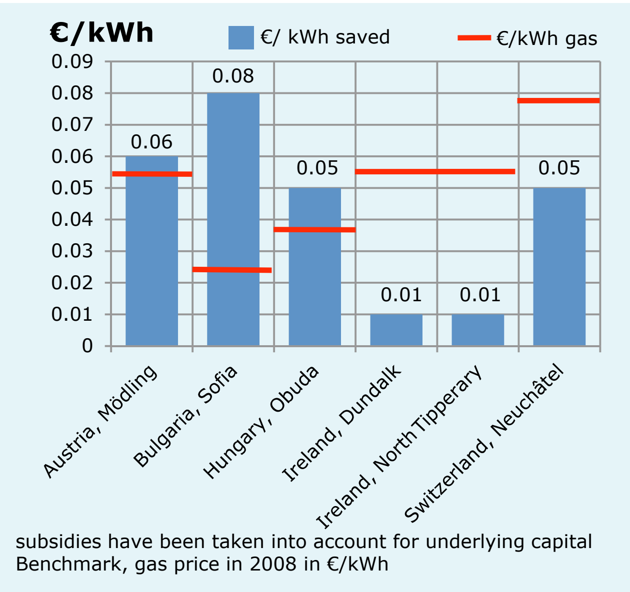


Figure 3.7: **Average Equivalent Price of Energy for Refurbishments**



3.5. Barriers and Solutions to Retrofitting

The urgency to tackle the existing building stock in the EU triggered many research projects, initiatives and other activities in this field. There is general agreement on what hampers progress and if summarizing broadly, the following situations and main problems can be identified:

- For rental buildings, in particular apartment blocks, belonging to a single organisation, the main barrier is that the owner carries the costs but will not benefit from the reduction in energy costs. This is often referred to as the landlord/ tenant dilemma or principal agent issue (see also Section 3.5.2)
- For buildings, in particular apartment blocks, owned by many different parties, regardless of whether they occupy their own apartment or rent it out, the main problem is the decision making process and achieving consent on making the investment.
- For single-family dwellings, the main obstacle is the up-front capital cost, which will be higher per dwelling here than for flats.

Furthermore a lack of understanding for the need and urgency to tackle retrofitting still prevails.

In fact, the issue of up-front capital cost was identified as the key determining factor and deterrent by many CONCERTO co-ordinators, as most private investors will not decide on the basis of payback periods or net present value. The cost issue is further complicated by related economic barriers, such as lack of access to credit, missing or changing tax exemptions and other incentives, as well as a fragmented and underdeveloped market for energy retrofits and related financial services.

Further economic barriers can be explained by looking at the Dutch example: housing associations are not allowed to increase rent following energy efficiency improvements, even though tenants enjoy lower energy bills, affecting projects in Delft and Amsterdam. Thus, housing providers have to search for other possibilities to recover their investment costs. In Amsterdam, the envisaged business model of selling off the first few refurbished flats in order to finance further retrofitting did not work, because the housing market collapsed.

Generally, in urban areas, where there is a high demand for flats and rents could be increased to include a premium that would pay back the refurbishment, it is exactly this demand-driven market that means that dwellings do not get refurbished – someone will always be there to accept them in their current condition. On the other hand, even if rental increases are allowed, they may not be enforceable in a region with dwindling population.

Economic factors underlie, contribute to and aggravate all other factors mentioned. Potential financing models will be discussed in Chapter 5, while consensus building and split incentives are expanded on in the following two paragraphs.

3.5.1. Consensus Building in Multi-Ownership Buildings

It is becoming more and more acknowledged that cost-effectiveness does not determine investments in energy efficiency as much as issues relating to decision making and organisational problems, especially in multi-ownership apartment blocks. A CONCERTO example for simple organisational issues is the former situation in Tudela (ES), where the agreement of 100 % of flat owners was needed to refurbish common areas of a residential building, hence decision making was difficult. The law (Ley 19/2009) has since been changed so that only 60 % of owners (in terms of number of flats and in terms of represented floor area) have to agree in order to decide on alterations. Owners that do not agree with these plans are also still obliged to pay. Such barriers can often only be removed at national, legislative level.

When people consider retrofitting, there are some indisputable risks and uncertainties that decision makers face: financial risks, risks of technical failure etc. These, however, are often compounded by the apartment owners' higher valuation of risks pertaining to new solutions than the valuation of risks inherent to the status quo, such as risks relating to energy price increases, critical deterioration of the building fabric etc. The fact that short-term gains are often valued higher than long-term benefits of energy efficiency (as explained in Section 7.3.2) also play a role.

Ultimately, more proactive solutions to help along decision making are needed. It is now being discussed that an external facilitator should be involved, managing the consensus building and decision making process. CONCERTO projects were at an advantage in this regard, as the project structure, as well as the additional funding from the EC, helped to set up structures fulfilling this role. Extensive liaison work to bring the project about was common and the offer of additional grants for owners helped.

It was found crucial that the right information is presented by the right people at the right time in the decision making process. The right time could be a peak in energy prices – this helped to convince private home owners in Tulln (AT) to decide on retrofitting. The right information may, for example, take on the form of thermographic imaging, providing proof of the actual state of the building and its energy leaks. Equally, Energy Performance Certificates can also be an effective tool for visualising and communicating the state of a building (see also Chapter 7.3). The same information needs to be reinforced from multiple angles: from the contractors, by public relations, by the municipality – the message needs to be clear and consistent and be agreed in advance amongst all involved. Having a resident's office or similar point of call within the area to be refurbished has been proven important in many projects (Tudela (ES), Weilerbach (DE)), taking on a proactive role for the coordination of energy expertise and financing. Such points of call must be clear in their remit and well-staffed in order to avoid false expectations and disappointment. Alternatively, certain stakeholders could take on an enabling role:

- N L Municipalities should take on a more active role in enabling retrofitting in a difficult organisational setting, by both substantially subsidizing refurbishments and by being involved in the delivery process.
- N L Building contractors should be encouraged to include a decision support package for retrofitting in multi-occupancy settings in their service offering.
- N L Facility managers, caretakers, concierges or building management staff should be given support and training for the delivery of consensus on retrofitting of the multi-ownership buildings they serve.

Concerns of residents regarding harassments such as noise, dust and general unrest, if retrofitting an occupied property, need to be taken seriously. They can be alleviated by active tenant care, good coordination of various trades on site and early notice to residents regarding changes in rent and energy costs. Advice should also be given after completion of the refurbishment for a certain period to avoid misuse of the new technologies by the inhabitants, thus also reducing rebound-effects (see also Section 3.5.3). There are retrofitting solutions that only need minimal access to the interior. Prefabrication and modularisation solutions are being increasingly discussed, with various research and demonstration projects under way. These have the potential for ultra-fast retrofitting, as explored in the Austrian research project e80^3-Buildings – "re-construction concepts towards energy plus house standard with prefabricated active roof and facade elements, integrated home automation and network integration".

All these solutions would carry significant costs and hence may need to be subsidised. This would, however, make economic sense, given the high potential for local economic benefits in terms of employment and business activities, as explored in Section 5.3.

N Strengthen the implementation of buildings energy certification and audit schemes which can increase the value of efficient buildings and can stimulate the real-estate market towards green investments.

EU N The development of fast, minimum intrusion techniques, potentially involving prefabrication should be supported.

3.5.2. Split Incentive – Principal Agent Issue

In several projects, the retrofitting of rental properties was hampered by the 'principal-agent-problem'. Investments have to be made by the building owner, but lower energy bills benefit the tenant. Incentives for landlords need to be strengthened, either by regulating allowable rent increases or by including heating costs into the rental charge directly. On the one hand, letting legislation needs to take due account of the benefits tenants are receiving from retrofitting. On the other hand, the cost to landlords needs to be addressed. Contracting solutions could be developed to take away the need for capital expenditure. Alternatively, a three-way split between tenant, landlord and a grant provider has been suggested by some. The Energy Efficiency Directive already calls for both; barriers to contracting and split-incentives to be addressed. CONCERTO findings provide further proof of how necessary this is. Member States must continue to make concerted efforts to eliminate market barriers and administrative bottlenecks, such as those relating to split incentives and rules relating to decision making.

N Letting legislation should be addressed, allowing the increase of rents following energy efficiency measures to a level that is in line with expected energy cost savings.

N Design and enable appropriate contracting solutions for energy efficiency measures as a way of reducing split incentives.

Good Practice for Retrofitting Campaigns – Solutions from Redange (LU):

Redange (LU) has developed a comprehensive package of solutions to tackle retrofitting. These are expected to live beyond CONCERTO and help bring about many more retrofitted dwellings. Key to its success were also the intensive promotion of the benefits of refurbishment as demonstrated on the flagship project "Presbytery" and a 2-stage consultancy service – intensive consultancy only upon committing to actual implementation.

Solution 1 – Provision of Information

The Service Package by the organisation "ENERGIPARK" offers eco-refurbishment packages which guarantee the following:

- tailor-made, attentive service
- quality of workmanship and maximum energy savings
- reduction of overall carbon footprint
- personal worries kept to a minimum

Solution 2 – Innovative Financing Concept

The financing concept based on flexible long-term loans was developed by ENERGIPARK in partnership with the Luxembourgian Fortuna Bank. It adheres to the following steps:

1. Undertaking an energy audit
2. Developing an energy strategy including energy costs calculation before and after the measures and appropriate financing plan

Image 3.3: **Retrofitting of the Old Presbytery, Redange (LU)**

3. After the customer's approval, ENERGIPARK takes over the formal handling of the following
   - Client data collection for the bank institute
   - Help with developing a sound financial plan in order to reduce the customers overall financial charges (length of the credit & repayment frequency).

The agreement with the bank also explicitly provides the option of funding through energy saving performance contracting. Through very flexible loan conditions (e.g. longer repayment periods than usual), very specific financing models can be offered to the customer.

Solution 3 – Mutual Fund

A mutual fund for energy efficiency and RES projects – including sustainable buildings – was set up between ENERGIPARK and the Fortuna Bank.

Solution 4 – Virtual Energy Saving Power Plant / ESCO

The ESCO finances the refurbishments with:

- a loan
- by selling the saved energy to the community – this will allow to compensate the financing costs and to fix the heating costs for low income earners at the current level.

Solution 5 – Tackling Fuel Poverty

Assistance from the municipality for the heating costs of low income households, in order to reduce their energy costs, thus targeting the fact that increasing energy costs will also become a social problem.
This takes the form of selling the heat needed after the refurbishment (contracting) for a contracted price.

3.5.3. Prebound, Rebound and Awareness

Often calculated savings cannot be achieved (see also Figure 7.1). On the one hand, this could mean that the original consumption was over-estimated, for example by assuming the whole dwelling is being heated, whereas residents only heat part of the dwelling, which is used most. This could be either for financial reasons or indeed energy conscious behaviour. This overestimate at point of baselining is sometimes referred to as pre-bound effect. On the other hand, savings are sometimes not being achieved, due to occupiers wanting greater comfort by either now heating previously unheated or under-heated spaces or heating to higher temperatures than before, for the same cost as previously. This latter phenomenon is commonly referred to as the rebound effect.
This can be illustrated with a CONCERTO example from Weilerbach: many people there have comparably large houses (average of 200 m²), which are only partially heated. Hence calculated energy and financial savings will not materialise, if calculations are done on the basis of heating the whole house. Energy advice had to be tailor-made, based on actual bills. It was found that often only insulation of lofts/ roofs, basement ceilings and of more efficient heating systems were viable – not improvements to walls and windows – though windows were often done for aesthetic reasons.
Monitoring results from Lambeth show the issue in even greater detail.

Lambeth, London (UK)

Within their three retrofitted high-rise social housing blocks, the expected savings of 80 % did not initially materialise. It is not clear whether this was due to an incorrect baseline, or a rebound effect. It is likely to be a combination of both. Plug-in top-up heaters were probably used extensively, but their energy consumption could not be captured as a separate electrical use before refurbishment. In addition, unexpectedly high temperatures were found after refurbishment. Two groups (test group and control group) received logging equipment without displays, logging temperatures and electricity. Both groups had an identical distribution of bedrooms and total occupants and almost identical cooking fuels and appliances. The test group received energy advice. Residents in the flats were visited by two people – one giving advice and one installing meters. This took around 40 minutes per flat. The control group only received logging equipment. Logging results showed that comfort temperatures were much higher than generally assumed in the modelling for plant sizing, generally exceeding 24 deg (see Figure 3.8). C for the test group and even higher for the control group. Hence energy advice showed a notable, albeit small, effect on demand temperatures. Clearly, there is huge scope for behaviour change following further awareness measures[7].

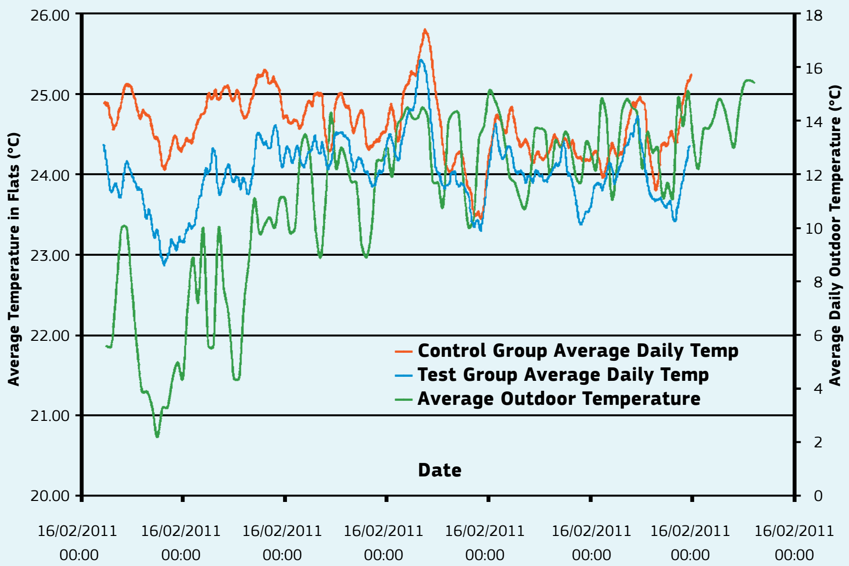


Figure 3.8: **Average Daily Internal Temperatures in Control and Test Groups vs. Daily Outdoor Temperatures**

On the other hand, the partnering projects in Weilerbach (DE), Redange (LU), Słubice (PL) and Tulln (AT) found that the relative savings achieved through energy efficiency refurbishments were much higher than those achieved on average in the respective countries. This can be attributed to the very intensive consultation activities in the SEMS core regions which encouraged house owners to undertake more ambitious refurbishments, pointing towards the importance of actively managed awareness.

3.6. Wide or Deep or Cost Optimal Retrofitting?

The energy efficiency directive has coined the term "deep renovation" (refurbishments or retrofits) and more specifically calls for (Art.4) "policies and measures to stimulate cost-effective deep renovations of buildings, including staged deep renovations;"

According to the EPBD, the Commission should lay down a comparative methodology framework for calculating cost-optimal levels of minimum energy performance requirements. Member States should use this framework to compare the results with the minimum energy performance requirements which they have adopted. The methodology for cost optimality calculations is set out in Regulation (EU) No 244/2012.

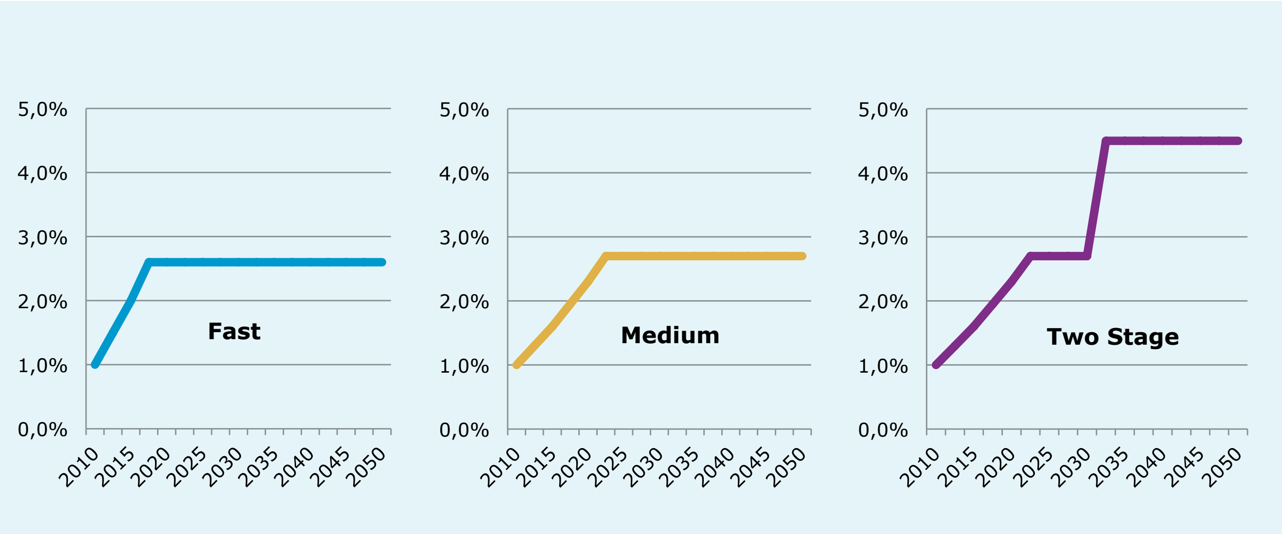
While both the EPBD and the Energy Efficiency Directive call for substantial savings to be achieved by retrofitting, the question that is currently being much discussed is, how realistic NZEB-refurbishments are for the whole of the European building stock and indeed whether this is advisable on cost grounds and on environmental grounds. Studies dealing with energy consumption forecasting for the EU, or more specifically with retrofitting roadmaps, look at the following scenarios, which are illustrated in Figure 3.9:

- Business as usual (low or medium energy saving ambition, low rate)
- "Deep refurbishment"
- Two stage refurbishment: basic refurbishment now followed by deep refurbishment later

[7] Monitoring Results – Ethelred Estate, London, Chris Dunham, Carbon Descent, 19th June 2012

The two-stage approach shows the highest savings, in the expectation that new technologies will become available and others will become cheaper and more readily available. It does however hold the risk that the assumed refurbishment cycles will turn out to be much longer in reality, meaning that suboptimal performance remains "locked-in", causing more CO_2 to enter the atmosphere in the meantime.

Figure 3.9: **Alternative Acceleration Paths for the Building Refurbishment Rate**[8]



The question arising is therefore how "deep" is "deep" and would overall savings not be greater if the same amount of money that would pay for one deep-refurbishment, was spread across a large number of properties, providing all with certain basic, cost-effective measures?

CONCERTO has examples for both approaches: examples from eastern European projects refurbishing precast concrete blocks (sometimes referred to as "panel buildings") show that savings of 30 % could be achieved with simple improvements to the controls of the heating system. This could mean providing thermostatic radiator valves, where previously tenants could only control temperatures by opening windows. Similarly, in North Tipperary (IE) a rural retrofitting campaign promoted packages of cost effective measures such as roof insulation and cavity wall insulation (see Figure 3.10). Attic insulation, cavity wall insulation and fitting of heating controls are those implemented most often.

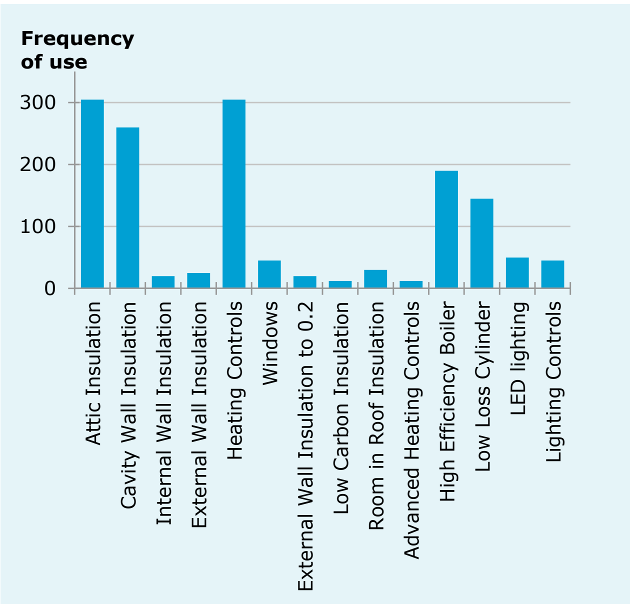


Figure 3.10: **Frequency of Measures Installed in North Tipperary**

These led to an average energy consumption for space heating of 86.7 kWh/m²/a final energy or 71.1 kWh/m²/a fossil primary energy consumption. On the other hand, projects in Mödling (AT) and some buildings in Hannover (DE) achieved very high percentages of savings, however these showed costs of up to 1300 €/m² and long payback periods of up to 80 years. Nevertheless, such savings will need to be achieved, one way or another, if the CO_2 reduction targets of 80-95 % by 2050 are to be achieved. And indeed, academic interest has already moved from nearly zero refurbishments to energy-plus refurbishments. These are indeed possible with a handful of examples around Europe and in particular several projects realised in Austria, for example the previously mentioned project e80^3-Buildings – "reconstruction concepts towards energy plus house standard with prefabricated active roof and facade elements, integrated home automation and network integration".

[8] Kaderják, 2012, p . 10

Case Study Hannover – Ahlem (DE)

A building typical of the 1930s semi-detached house, with a floor area of 160 m² has been refurbished. The statutory requirements for new builds were exceeded by 30% by implementing:

- 18 cm external wall insulation using expanded polystyrene (U=0.16 W/[m²K])
- 30 cm roof insulation using mineral wool (U=0.12 W/[m²K]) basement ceiling insulation ceiling of 10 cm expanded perlite loose-fill insulation (U=0.38 W/[m²K]), triple glazing (U=1.0-1.1 W/[m²K])
- airtightness n50= 1.48 h-1
- heating system: 650 l storage tank with an integrated gas-condensing boiler and 10 m² flat-plate solar collector to support both hot water and space heating
- efficient mechanical ventilation system with heat recovery
- final energy savings of 69% and CO_2 savings of 79% could be achieved.

Image 3.4: **Refurbished Single Family Dwelling in Ahlem (DE)**

2nd Deep Retrofit Example – Mödling AT:

The „Karl Lowatschek" Building was refurbished throughout.

The new heating system consists of a high-efficiency gas boiler and a traditional tiled wood burning stove ("Kachelofen").

The house received triple glazed windows, a new, insulated roof and external wall insulation.

Energy demand for heating, hot water and lighting: 75 kWh/m² *a.

Image 3.5: **Single Family Dwelling in Mödling (AT), Before & After Refurbishment.**

Figure 3.11: **Cost per m² Refurbished CONCERTO Buildings in Relation to Achieved Energy Savings**

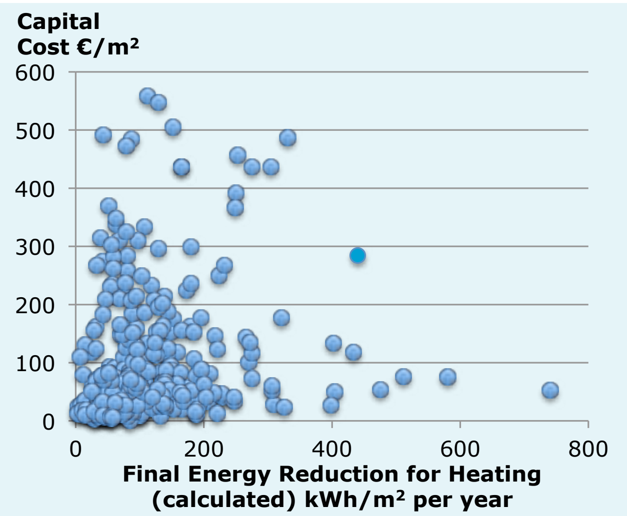


Figure 3.12: **Dynamic Payback Period of Refurbishment Measures in CONCERTO**

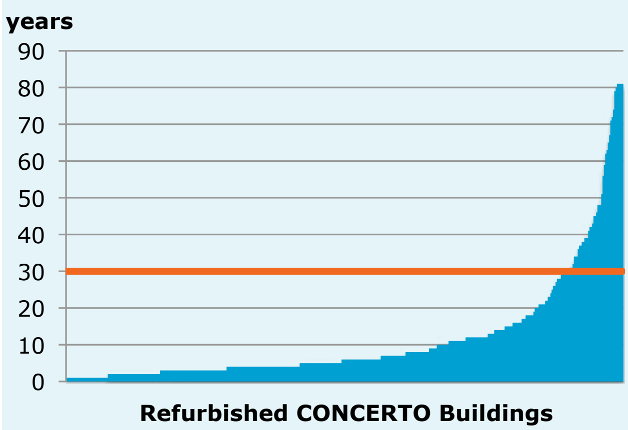


Figure 3.11 shows that a large proportion of CONCERTO projects saved up to 200 kwh/m²/a with capital cost for retrofitting measures of under 200 €/m². A few saved much more with the same level of expenditure, while others were much more expensive, without necessarily saving more. However overall, more than 50 % of CONCERTO retrofits have a dynamic payback period of less than 5 years, about 90 % pay back within the typically assumed refurbishment cycle of 30 years and only few exceed this (Figure 3.12).

If taking into account achievement of CO_2 reduction targets, investment considerations and positive employment effects, according to a study by BPIE, it seems that the results of the two-stage retrofitting scenario provides the best balance of these factors, if comparing all scenarios.

The problem, however, with not aiming for a deep refurbishment straight away is firstly, that such measures only pay back in combination with the basic measures – "deep" on its own will have very unfavourable payback. Secondly, it means a 'lock-in" of suboptimal performance for many years until the next refurbishment cycle, which may not happen after the 30 years that are often assumed.

However, in Germany, a study found that costs for retrofitting have risen far more than those for new buildings (30 % and 25 % respectively since 2 000, compared to an increase in cost of living of 24 %). It finds furthermore that research should concentrate on developing solutions for the mass market rather than focussing on ever more ambitious ways of refurbishing. The study calls for a commission with the specific agenda of lowering refurbishment costs – recommendations that can only be good for other Member States, too.

Two further issues need to be considered: Firstly, the expected savings are not always being achieved, as either the baseline was miscalculated or occupiers do not assume energy conscious habits, as explained previously. Secondly, costs can sometimes be prohibitive and cannot be justified in the light of the first risk. Decarbonising the energy supply at the same time could be brought into the equation, as hinted at previously in Section 3.4.1. So, where a building has the potential to generate low or zero carbon energy on site and also store part of this energy, moving from energy consumer to so-called "prosumer", the need to reduce energy demand to the absolute minimum may not be quite so necessary any more. This would allow for retrofitting options that only implement those measures that are cost effective now, such as insulating roofs and improving heating controls.

Single energy generation measures such as PV-installations have been promoted by many CONCERTO projects (Neckarsulm (DE), Weilerbach (DE), Redange (LU), Zlín (CZ), Falkenberg (SE)), thus reducing the carbon footprint of homes and although not necessarily improving the building fabric, nevertheless reducing the CO_2-footprint of these buildings. Though these are commendable achievements, the approach has to be viewed with a certain amount of caution, as the previous discussion of primary energy factors in Section 2.5.2 hints at, also. Ultimately on a larger scale, all energy efficiency and renewables potentials have to be exploited fully in order to bring the building stock as close to "zero energy" as possible for 2050.

EU N L — For tackling existing buildings, fabric efficiency measures and renewables should be seen as a package.

EU N — Simple but effective, reproducible retrofitting solutions should be developed.

EU N L — Funding for demonstration projects has to be made available in order to stimulate the development of technical solutions in order to bring down costs and create a market for such measures eventually.

EU N L — More examples for energy-plus retrofitting projects should be created to stimulate the ambitions of all retrofitting projects.

3.7. Listed Buildings and Conservation Areas

The EPBD states:

Member States may decide not to set or apply the requirements to the following categories of buildings:

(a) buildings officially protected as part of a designated environment or because of their special architectural or historical merit, in so far as compliance with certain minimum energy performance requirements would unacceptably alter their character or appearance;

(b) buildings used as places of worship and for religious activities;

Key Points:

Energy efficiency refurbishments of listed buildings are often an inflammatory topic, which is sometimes used to discredit all types of retrofitting. There is considerable fear of losing history, beauty and the identity of places behind layers of styrofoam. In fact, this issue only affects a small percentage of buildings, which can well be left until all other buildings are dealt with. At this stage it will help to simply build up an evidence base with a large number of exemplary projects, to publicise these in order to rationalise the debate and ultimately convince all relevant stakeholders that it can be done. Fabric measures that do not impact unduly on the aesthetics of historic buildings are roof insulation and window replacements, though the latter can turn out to be prohibitively expensive. Often, the easier approach is decarbonising the supply side – for example, by connecting to low-carbon district heating or installing biomass-fired heating. Discussions should move on from calling for exceptions to energy performance requirements for conservation buildings, and focus on specific funding measures to support tailor-made and often expensive measures.

There are already many examples of retrofitting measures applied to historic buildings and CONCERTO helped to increase their number: Hoche Quay, community centre for local associations, Island Machines cultural facility, shopping centre Beaulieu, Best E - cultural centre Ca n'Amat , Bezirkspensionistenheim Weiz (AT), Einfamilienhaus Winterleitner (AT), Einfamilienhaus Gogeissl (AT), Secondary Modern School Weiz (AT), Elementary School Peesen, Primary School Gutenberg Bezirkshauptmannschaft Weiz (AT) Secondary Modern School St. Ruprecht/Raab Arquata residential buildings (IT) Castle Judenau (AT) Municipal Office Atzenbrugg, Gatekeeper's House (AT), Cultural Centre Bettborn "Op der Fabrik" (LU).

Montieri (IT): The main feature of this project is the highly innovative geothermal district heating system by using high-enthalpy fluids. 425 dwellings in the historic centre are to be connected to it. The total heated volume of these homes adds up to 110 000 m^3, while the output of the geothermal system is estimated to be approx 5 500 kW.

The historic buildings in Montieri (IT) represent a challenging site for the integration of renewable energy technologies and retrofitting measures as the potential for intervention in the building envelope is limited. Only natural materials are acceptable that conform to the medieval city structure. The following measures are possible:

- central skylight openings with low-emissivity glazing;
- insulation for roofs, party walls and floors;
- partial internal insulation to solid walls, high quality double glazing in timber frame windows;
- utilisation of the buildings' high natural ventilation potential supported by skylights;
- reducing air infiltration rates during winter.

Image 3.6: **Installing Geothermal District Heating in the Historic Centre of Montieri (IT)**

Tulln (AT) – Castle Judenau

The district heating project of an educational institution in the castle of the municipality Judenau, includes a 350 kW boiler fired with wood chips from Judenau, saves 190 tons CO_2 per year and generates 680 MWh. The investment of the district heating system Judenau amounted to € 300 000.

Image 3.7: **Castle Judenau – Tulln (AT)**

Key Recommendations are

N Develop progressive guidance on retrofitting for national and other authorities tasked with the protection of historic buildings.

3.8. Retrofitting at Neighbourhood Scale

The CONCERTO approach of tackling retrofitting at neighbourhood scale rather than addressing individual buildings has many advantages:

- There is potential for standardising the approach, leading to economies of scale, as often buildings within the neighbourhood will be similar.
- The scale of the completed project allows for greater impact, often improving the image of a whole neighbourhood– sometimes halting ghettoisation processes (e.g. Tudela (ES)).
- At a technical level, the use of district heating (or cooling) opens up new avenues for low carbon solutions: biomass district heating was used by many CONCERTO projects allowing to cut emissions in inner city areas (e.g. Tudela (ES)), where similar cuts would not have been achieved by individual solutions. A thus decarbonised energy supply can improve the balance of buildings that would not reach high savings due to efficiency measures alone, for example if they are heritage buildings that cannot be insulated externally. Larger network supply systems covering a whole neighbourhood can also benefit from balancing loads of different users, with peak demands at different times of the day and week.
- The size of such projects provides a reliable stream of work and income for the construction professionals involved, hence bringing local economic benefits.

3.8.1. High Replication Potential

In summary, CONCERTO retrofitting projects were large projects, which, due to their size, made a difference not just to a few isolated households, but to whole neighbourhoods, proving to local residents that energy and money could be saved and that comfort would improve. Despite economically difficult times, many have led to follow-on project activities, which often happen with much less financial support.

During the course of the CONCERTO project in Lyon (FR), another nearby retrofitting project that was happening at the same time, collaborated closely in order to learn from the demonstration site.

In Galanta (SK) three multi-storey buildings were initially retrofitted using CONCERTO funding and three other multi-storey buildings were retrofitted by using bank loans. The fact that residents could see that it is possible to realise such a project, that it looks good, that it is worth the expense and shows results in savings on heating, has convinced residents, who now want to retrofit their own blocks of flats.

In Redange (LU) the best practice example of a public building, as well as the now readily available information on energy and technical and financial aspects are expected to lead to the refurbishment of a further 350 buildings in the years following the CONCERTO project.

In Tudela (ES), in the district of Pamplona, an area will be regenerated based on the CONCERTO approach. The project is called 'effi-district' and contains 1 500 dwellings with an old district heating network. The plan is to demonstrate that an effective refurbishment of district heating systems is possible, instead of the usual approach of abandoning district heating in favour of individual systems in each unit, as part of refurbishment work.

Hence there is tangible proof that the funding of pilot projects is an effective political tool to jump start on-going retrofitting campaigns.

3.8.2. The Role of Municipalities

Municipalities are crucial players in bringing about neighbourhood scale projects. Apart from influencing projects through the planning process, they can bring together and coordinate different stakeholders and exert leverage over their own property assets. They should set a dedicated retrofitting strategy for their geographic area, using spatial planning to drive the agenda. Furthermore they can run campaigns for the promotion of relevant financial support offers, such as that currently being rolled out in the UK to promote the green deal – see Section 5.5)

To exploit the potential of larger scale district-wide networks, the municipality needs to get involved. Finding land for the necessary infrastructure, plant rooms and fuel storage can be an issue. An idea developed under CONCERTO proposes that publicly owned space should be made available for these – this could even be the space under roads, car parks and school yards.

Close cooperation with municipal energy companies, where they exist, can open up an option for offering micro-contracting solutions for retrofitting measures, such as new central heating pumps, new boilers or even renewables.

L Cities should set energy requirements for designated urban regeneration areas or declare a housing improvement district.

L If a municipal energy company exists, it should be used as a vehicle for offering micro-contracting solutions for retrofitting measures.

3.9. Moving Ahead with the Retrofitting Agenda

In summary, what needs to happen now is a roll-out of a critical mass of pilot projects for NZEB refurbishments. In principle, technical solutions for retrofitting, even to energy-plus standard, exist now. Both approaches are reliant on a combination of efficiency and renewable energy measures. Research should focus on mass-producible solutions, possibly including prefabrication. Potential benefits are considerable, both in terms of improving standard of living and local economic business opportunities. And indeed, in the recent submissions received by the European Commission on the public consultation for the post 2020 energy and climate package, there appears to be a sense that the retrofitting messages are now beginning to get through to policy makers, decision makers and stakeholders in Brussels and across the Member States. Stakeholders range from business associations, professional bodies, environmental pressure groups, government agencies and representatives of the energy supply sector. However, the BPIE Report „Energy Efficiency Policies in Buildings – The Use of Financial Instruments at Member State Level" states that, at the moment, the financial instruments in place are only meeting today's level of retrofit. There is a need for scaling-up retrofitting efforts which must form part of a long-term strategy. As previously mentioned, funding for demonstration projects has to continue in order to stimulate the development of technical solutions in this area and in order to bring down costs and create a larger market for such measures eventually. The development of simple but effective, reproducible and affordable solutions needs to be supported in particular by funding related research and development activities. The following recommendations are also supported by findings from CONCERTO projects:

- **EU** **N** A retrofitting roadmap should be developed to strengthen existing legislation with binding targets and measures for the refurbishment, supported by progress monitoring and reporting plans.
- **EU** EU-funding streams such as EU Structural Funds and the European Investment Bank are increasingly important as funding sources for retrofitting and can play an even greater role in the future, but they must have energy criteria firmly designed into their conditions.
- **EU** **N** In order to achieve greater impact and unlock further private investment for deeper refurbishment, adequately ambitious financial programmes must be in place (see also Chapter 5).

3.10. Summary & Recommendations

In summary, retrofitting Europe's largely inefficient building stock is a key challenge in reaching the EU's energy and climate change targets. Due to reduced demand for new-build in the wake of the global financial crisis, many CONCERTO projects shifted emphasis onto retrofitting. Though these projects had to tackle the typical barriers of lack of skills and awareness, split incentives, rebound effects, the difficulties of historic buildings and lack of funding, these projects now provide an extensive body of experience and real-life examples of successful retrofitting projects, in 23 different countries with varying climates and socio-economic settings. A concerted effort is now needed to roll out this experience and to step up ambitions, if EU energy targets for 2020 and 2050 are to be reached.

- **N** **L** The public sector should take on a more active role in enabling retrofitting in a difficult organisational setting by both substantially subsidizing refurbishments and being involved in the delivery process.
- **N** **L** Building contractors should be encouraged to include a decision support package for retrofitting in multi-occupancy settings in their service offering.
- **N** **L** Facility managers, caretakers, concierges or building management staff should be given support and training for the delivery of consensus on retrofitting of the multi-ownership buildings they serve.
- **N** Letting legislation should be addressed, allowing the increase of rents following energy efficiency measures to a level that is in line with expected energy cost savings.
- **N** Design and enable appropriate contracting solutions for energy efficiency measures as a way of reducing split incentives.
- **N** The implementation of buildings` energy certification and audit schemes should be strengthened, so that they can fulfil their potential in increasing the value of efficient buildings and thus stimulate the real-estate market towards green investments.
- **EU** **N** The development of fast, minimum intrusion techniques, potentially involving prefabrication should be supported.
- **EU** **N** **L** For tackling existing buildings, fabric efficiency measures and renewables should be seen as a package.
- **EU** **N** Simple but effective, reproducible retrofitting solutions should be developed.
- **EU** **N** Funding for demonstration projects has to be made available in order to stimulate the development of technical solutions and thus bring down costs and create a market for such measures eventually.

EU N L More examples for energy-plus retrofitting projects should be created to stimulate the ambitions of all retrofitting projects.

N Develop progressive guidance on retrofitting for national, and other authorities, tasked with the protection of historic buildings.

L Cities should set energy requirements for designated urban regeneration areas or declare a housing improvement district.

L If a municipal energy company exists, it should be used as a vehicle for offering micro-contracting solutions for retrofitting measures.

EU N A retrofitting roadmap should be developed to strengthen existing legislation with binding targets and measures for the refurbishment, supported by progress monitoring and reporting plans.

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EU N In order to achieve greater impact and unlock further private investment for deeper refurbishment, adequately ambitious financial programmes should be in place.

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4. Public Buildings as Trailblazers for Smarter Cities

4.1. Introduction

The total volume of public spending is equivalent to 19 % of the European Union's gross domestic product and public buildings represent about 12 % of total built floor area. For this reason, the public sector constitutes an important driving force for stimulating market transformation towards more efficient products, buildings and services, as well as for triggering behavioural changes in the energy consumption of citizens and enterprises.

Furthermore, decreasing energy consumption through energy efficiency improvement measures can free up public resources for other purposes. Many CONCERTO projects therefore included public buildings. Due to their pivotal role, this entire chapter is dedicated to them.
`Public buildings´ is a term either used for buildings owned by the public sector or for buildings that are highly frequented by the public. This chapter refers mainly to the first definition, but does not exclude the second. In fact, it is important to expand the potential of all buildings that interact with the public to showcase better, more energy-aware building practices.

4.2. EU Policy Context

In the European Union, several directives are in place, which contribute to the achievement of Community level climate and energy policy goals through the improvement of energy end-use efficiency. These regulatory instruments include the Energy Efficiency Directive (EED) and the recast Energy Performance of Buildings Directive (EPBD 2). The EPBD 2 sets, with the year 2018, an earlier date of compliance with nearly zero-energy efficiency requirements for new buildings owned and occupied by public authorities, than for private or commercial buildings. The displaying of Energy Performance Certificates within buildings frequented by the public, not limited to those owned by public authorities, is also stipulated.

"Member States shall take measures to ensure that where a total useful floor area over 500 m^2 of a building for which an Energy Performance Certificate has been issued is occupied by public authorities and frequently visited by the public, the Energy Performance Certificate is displayed in a prominent place clearly visible to the public. On 9 July 2015, this threshold of 500 m^2 will be lowered to 250 m^2."

In a nutshell:
As of 2018, all new public buildings within the EU have to be "Near Zero-Energy Buildings".

The new EED introduces a quantified refurbishment target for central government buildings. However, the rest of the public sector will not fall under this provision and is also not affected by energy efficiency requirements for purchasing products, services and buildings. Both the EED and the EPBD 2 emphasise the importance of the role of the public sector in setting examples and triggering market transformation. The EED states that an annual rate of refurbishing buildings, owned and occupied by central government on the territory of a Member State, is to be set to upgrade their energy performance. This obligation is supplemented by the EPBD 2, which requires Member States to ensure that when existing buildings undergo major refurbishment, their energy performance is upgraded so that they meet minimum energy performance requirements.

> "Member States need to establish a long-term strategy for mobilising investment in the renovation [retrofitting] of the national stock of residential and commercial buildings, both public and private. This strategy shall encompass the exemplary role of public buildings. Each Member State shall ensure that, as from 1 January 2014, 3% of the total floor area of heated and/or cooled buildings owned and occupied by its central government is renovated each year to meet at least minimum energy performance requirements."

Furthermore, the EED obliges central governments to lead by example and make energy-efficient purchasing decisions with regard to the procurement of certain products and services and the purchase and rent of buildings. Member States should encourage all public bodies to take energy criteria into account when making purchase decisions.

4.3. Low CO_2 Public Buildings are Cornerstones for Reaching the 20-20-20-Targets

The public building sector is a major area of opportunity in local CO_2 reduction strategies. The construction of low energy buildings, energy efficiency retrofits and energy management in public buildings do not only directly reduce emissions and energy costs for the public authority, but can also have an important role model effect for the private and commercial sectors. They can demonstrate to private and commercial players possible ways to act and also encourage them to choose efficient solutions. Putting the municipality's own premises in order also lends additional credibility to the local energy and climate change policy. As part of a "low carbon public procurement strategy" it also sets incentives for local companies to invest in energy efficiency, low-carbon technologies and related skills.

The status and strategies of energy efficiency actions in municipal premises varies widely. While some forerunner cities like Växjö or Copenhagen already have a long standing track record and well-established energy management for their buildings, with considerable achievements to prove it, others lag behind. In the CONCERTO municipality of Trondheim (NO), for example, a new municipal energy and climate action plan was adopted by the City Council in June 2010. One measure within the plan is that the energy standards for all new municipal buildings are to be at least 25% better than the national standards.

Often, the financial situation makes investments in energy efficiency difficult, even though they would pay for themselves to a significant extent and would save money in the long run.

In a nutshell:
Energy efficient public buildings reduce public spending on energy in the long-term (fossil as well as renewable energy). Instead of spending money on imported energy, money spent on public buildings is money spent locally.

4.4. Smarter Public Buildings – Lessons from CONCERTO

Due to their great importance, all but a few of the CONCERTO sites have integrated new public buildings or the refurbishment of existing public buildings into their project. The projects include different types of public buildings: offices, schools, kindergartens, libraries, health care centres etc. Based on the different uses and the different user groups, every building type has to fulfil different requirements and also demonstrate their solutions to different groups of users and visitors.

The majority of public buildings within CONCERTO are office buildings, providing workspaces for the staff of public authorities. Non-administrative public buildings cover a wide range of different uses, for example, leisure and cultural facilities, schools, health care facilities and social housing, meaning that building types range from swimming pools to town halls and hospitals.

Public buildings within CONCERTO are set within different climatic conditions, different cultures and different levels of prosperity. Many public authorities in Europe have a long history, which is often reflected in the buildings they occupy. Often municipal buildings represent some of the oldest buildings within the municipality and listed buildings are not unusual.
To summarise, the characteristics of public buildings are:

- They are typically located in the city centre.
- They are typically office, leisure, cultural and educational buildings.
- They are usually subject to regular public visits.
- Public authority buildings usually form part of most urban areas.

To achieve exemplary buildings, the energy performance specifications need to be fixed up-front, embedded into the procurement process and subscribed to, by all participants, early in the planning stage. The architect has to collaborate with energy consultants and other specialist engineers from the very beginning of the planning & design process. The agreed energy targets have to then be followed through, throughout the detailed planning and construction process, and have to therefore be embedded within the responsibilities and tasks of all stakeholders (architects, engineers, site managers, builders, managers, maintenance staff and occupiers). At the point of hand-over to the public authority, a comprehensive commissioning process has to take place, which is to include detailed operation and maintenance instructions, as well as several readjustments to all building services components. Such a comprehensive hand-over is not yet common and needs to be written into tender documentation from the beginning.

As public office buildings and cultural buildings are often historical or listed buildings, specialist knowledge to assess opportunities and barriers for retrofitting is required. To overcome this problem, it is necessary that experiences concerning the retrofit of the energy performance of the buildings, from past and present, be shared and spread. The implementation of a network for the retrofitting of historical buildings could be very helpful.

L For public building retrofitting projects, energy specifications including firm energy targets should be fixed and accepted by all participants early in the planning stage.

N Due to the very specific challenges of historic and listed buildings, which are often in public hands, the exchange of expertise and practical positive experiences is necessary. A network of specialists for energy efficiency improvements to historic buildings should be set up.

4.4.1. Low Energy Office Buildings

The challenge of office buildings is to guarantee the indoor temperature and humidity to create an effective work environment – with the lowest possible energy consumption and CO_2 emission. Other challenges are the high electric and cooling requirements for IT equipment. Many CONCERTO municipalities have accepted this challenge and built innovative, efficient office buildings.
These municipalities are: Ajaccio (FR), Birštonas (LT), Dundalk (IE),Geneva (CH), Grenoble (FR),Heerlen (NL), Hillerød (DK), Høje-Taastrup (DK), Neuchâtel (CH), North Tipperary (IE), Ostfildern (DE), Redange (LU), Sandnes (NO), Słubice (PL), Stenløse (DK), Szentendre (HU), Tudela (ES), Tulln (AT), Turin (IT), Viladecans (ES), Weiz-Gleisdorf (AT), Zagorje (SL) and Zaragoza (ES).

Image 4.1: **Plus Energy Office Building in Grenoble (FR)**

An Exemplary Energy Plus Office Building in Grenoble (FR)

An especially high performing office building has been built in Grenoble (FR). The energy plus office building in De Bonne is now a special landmark in the city. Over the course of the year, it generates more energy than it requires. It uses 70 % less energy than the value required by French building regulations. The energy consumption for this four-storey office building with a gross floor area of 1 865 m² is calculated at 9.5 kWh/m²a. This is less than 7 % of the 140 kWh/m²a calculated according to national standard. The CO_2 emissions are reduced by 4 336 kg/m²a compared to national standard.
The compactness of the building volume, efficient external insulation, special attention to the avoidance of cold bridging and a high share of natural daylight result in these low figures. The windows have a very low emissivity triple glazing and automatic, movable, external solar protection in the form of tilting louvers. Furthermore, a special innovative internal shutter system has been integrated that is mechanically movable from the ceiling in front of the windows and is intended to seal the windows at night and at times when the building is unoccupied. When these shutters are closed, the heat transfer coefficient of the windows is 0.15 W/m²K. A reversible heat pump has been installed for heating and cooling and direct cooling with a ground water heat exchanger provides cooling on summer days. Together with the root-like concrete pillars, the 425 m² photovoltaic power plant on the roof is the building`s main architectural feature.

In a nutshell:
A plus energy office building is possible!

4.4.2 Smarter Education Buildings for Every Age

A considerable part of public buildings have educational uses. This starts with day-care centres for infants through to kindergartens or preschools, primary schools, secondary schools and colleges, continuing through to universities and other forms of adult education. Common to such buildings is their high requirement for temperature regulation and fresh air supply. Additionally, it is important that they have good acoustic comfort to guarantee an effective learning environment. At the same time, protection from dangerous or toxic materials is rated particularly high in schools and kindergartens due to the higher sensitivity of children to these.

Schools represent an ideal location to connect low-carbon buildings with education and training. They also provide valuable means for capturing the interest of children, parents, teachers and the wider community in issues relating to climate change, energy use and renewable technologies. Having lessons within these educational buildings has the potential to change pupils` views and their understanding regarding energy efficiency and renewable energy. The effect is, however, not just limited to these. Children who learn about energy efficiency and renewable energy in their school have been found to go on to educate their parents about energy saving measures and low-carbon buildings. Hence schools play an important role, not just as exemplary buildings with high visibility, but also as nodes from which to spread energy knowledge with teachers and pupils acting as multipliers (see also Section 7.4.3). Educational establishments were included in many projects, as they could be particularly well tied into the awareness raising programmes required for all CONCERTO projects. Schools have been built or refurbished in the following cities within CONCERTO: Almere (NL), Cernier (CH),Galanta (SK), Grenoble (FR), Hannover (DE), Hartberg (AT), Helsingor (DK), Hvar (HR), Lambeth (UK), Lapua (FI), Morahalom (HU), Neckarsulm (DE), Slublice (PL), Stenlose (DK), Trondheim (NO), Tulln (AT) and Växjö (SE).

Within the CONCERTO sites in Lambeth (UK) and Neckarsulm (DE), there were special funding activities called “solar schools”, bringing solar thermal systems to school facilities and referring to them in lessons. The PV plant at the Teleborg Centrum School in Växjö (SE) is also put to educational use. A further example from Växjö is the Araby School with a floor area of 2 714 m², that was built in 1963 in the north of the city centre. The municipal real estate company VöFAB started the refurbishment in 2010. Insulation has been added to the walls and roof, and the windows have been replaced. New systems for ventilation, lighting and heat recovery have also been installed. The intention is for students in the school’s science programme to be involved and to be given the possibility to study energy and technical installations in a more practical way. PV panels with a capacity of 15 kW and a total area of 120 m² have been installed on the roof of the school. The energy consumption is expected to be around 21 % lower than national average for schools, which means 122 kWh/m²/a for heating and 28 kWh/m² /a for electricity. The PV plant started operating in August 2010 and produces more than 14 MWh of electricity per year.

Image 4.2: **The Araby Schoolin Växyö (SE) is being Refurbished and a PV Plant is Installed on the Roof**

Looking at the youngest building users, the project in Viladecans included a new day-care centre. The construction or refurbishment of kindergartens took place in Hartberg (AT), Mödling (AT), Moraholem (HU), Neckarsulm (DE), North Tipperary (IE), Salzburg (AT), Sofia (BG), Stenlose (DK), Szentendre (HU), Växjö (SE), Weiz-Gleisdorf (AT) and Zargoje (SL). The municipality of Trondheim received recognition from the Norwegian Ministry of Environment for the development of teaching material regarding energy use, which has since been adapted for use in kindergartens with the aim of using it in other cities/municipalities in Norway.

Furthermore, there are student apartments in Delft (NL) and a university in Växjö (SE).

Public Buildings

Retrofitting of a Historic Childcare Building in North Tipperary (IR)

A particularly interesting example is the refurbishment of a childcare facility in Cloughjordan in the sparsely populated rural region of North Tipperary in the centre of Ireland.

Apart from its extensive residential retrofitting campaign, a project objective in North Tipperary (IE) was the upgrading of 10 000 m² of non-residential buildings within the region. The aim was to reduce energy consumption by at least 40 % within these buildings and to bring them in line with the building regulation standards of 2006. The childcare facility was built in the 19th century on the main street in the village of Cloughjordan. The original building was a 107 m² two-storied building. The net wall area of the existing building was 151 m². The walls were of solid stone construction; therefore initially the U-value in the wall was 1.43 W/m²K. There was one room in the roof on the first floor and a small attic space. However, the existing building had no insulation installed. Heating had been retrofitted into the building at some stage, but the source of this heating was electrical storage heaters. Therefore there were no automated controls that would turn the heaters on or off, according to demand. A new extension was added and the whole building received an energy efficiency refurbishment. Double-glazed windows were retrofitted into the building.

Figure 4.1 illustrates the reduction in delivered energy through the actions implemented in the project. It shows the effect of each energy demand measure on the energy performance of the building. Starting from an energy consumption of 340 kWh/m²/a, each measure reduces the consumption down to the figure indicated behind it, all the way down to the final consumption of 41 kWh/m²/a. Hence the changes to the heating system and controls were the most effective measure, leading to a reduction of 111 kWh/m²/a, while the change to low energy lighting only managed to achieve a reduction of another 8 kWh/m²/a.

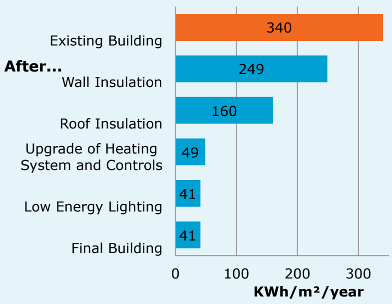

Figure 4.1: **Energy Performance Achieved after Implementation of Measures (in a Childcare Facility in North Tipperary)**

Regarding the financing of the measures, the CONCERTO grant level was capped at 30 % capital cost and 17 €/m², so the total grant fund available was just over € 1 800. This meant that the CONCERTO energy efficiency grant offered 30 % of capital costs for the new high-efficiency boiler, the heating controls and the low energy lighting and lighting controls. The total cost of investment in energy efficiency was approximately € 13 850.

A solar panel was also installed with financial support from the CONCERTO renewables grant.

In total, the overall energy performance of the building improved by 87 %. The total kWh saved have been calculated at 31 992 kWh per annum. Compared to the original building, this is over € 2 500 of savings per annum or 17 tonnes of CO_2. The total energy efficiency grant was € 1 800. Therefore the overall simple payback is 5 years, showing overall that especially old, uninsulated buildings can achieve dramatic savings – in energy, CO_2 and monetary terms (the internal rate of return is calculated as 7 %).

Most importantly, the building has been transformed into a warm, bright, comfortable and most of all energy efficient space.

In a nutshell:
An upgrade in energy efficiency of 87 % in a building that is over 100 years old and used for childcare, is possible with a short payback period.

Schools play an important role, not just as exemplary buildings with high visibility, but also as multiplier nodes for energy knowledge diffusion by teachers and pupils, who take their learning home with them. This potential should be fully exploited.

N L The retrofitting of fabric efficiency measures and renewable energy sources in schools should be prioritised due to the high CO_2 saving potential and their function for knowledge diffusion regarding energy efficiency and the use of RES.

N Energy efficiency measures should be included into school science programmes, thus carrying energy knowledge beyond the school boundaries.

EU N Especially for childcare and school buildings, energy performance standards should be supplemented with wider sustainability requirements, for example including non-toxic materials and indoor air quality standards.

4.4.3. Requirements for Sport and Leisure Facilities with Low Emissions

Another important area of public buildings with high energy demand and CO_2 emissions is sport and leisure facilities, such as sports halls, swimming pools and changing facilities.

Sports buildings have been built or refurbished in the following cities within CONCERTO: Delft (NL), Hannover (DE), Montieri (IT), Mórahalom (HU), Neckarsulm (DE), North Tipperary (IE), Ostfildern (DE), Stenløse (DK), Trondheim (NO), Tulln (AT), Viladecans (ES), Weilerbach (DE) and Valby (DK).

Special requirements result from the fact that users include people of all ages and that these buildings have particular hygiene requirements as challenges that are related to air quality. In a typical sports centre, energy costs are second only to labour costs, accounting for as much as 30 % of total running costs - a higher figure than in most other sectors.
Due to the high heating requirement, a range of sport facilities within CONCERTO integrated solar thermal systems into sport facilities. Swimming pools pose particular challenges, due to their very high energy consumption for water and space heating, as the latter has to be kept above the water temperature. This is not just for comfort purposes, but also in order to avoid excess evaporation and condensation. Consequently, the bill for water and space heating represents a particularly powerful driver for efficiency improvements for pools.
The following are the most important measures to reduce heating demand of swimming pools:

- Pool covers (mechanical or chemical) can reduce evaporation, allowing for space temperatures to be lowered at night.
- Pumps and fans should all have variable speed drives – these have a knock-on effect reducing space and water heating requirements.
- Solar thermal energy is particularly well suited to pools, especially outdoor pools used in summer.
- Due to their constant base loads, pools are particularly suited to be part of district heating systems, especially if CHPs are used for these.

Image 4.3: **Water Cultural Centre Valby (DK).**

Image 4.4: **Water Cultural Centre Valby (DK).**

Enthusiastic Reports from Visitors to Valby Water Culture Centre

The Valby Water Culture Centre, south-west of Copenhagen, is an indoor swimming pool which was finished in 2011. Besides state of the art sauna facilities, it offers a hot tub, waterslides, a paddling pool, a counter flow channel, caves etc. The facility uses 25 % less energy than similar facilities elsewhere in the country. In preparation of the construction of the Valby Water Centre, all 13 modern low energy swimming pools in Denmark were analysed before setting the requirements for the lowest–energy swimming pool, based on the best available knowledge to date.
The architects and engineers have worked closely together to make this possible. Important features are the compactness of the building envelope, the well-chosen roof openings and south windows with triple glazing and insulated frames to allow daylight, low energy illumination, the optimised air circulation system based on fluid dynamics that allows for the least amount of air changes, the energy efficient heating system of the building and filtering, plus disinfection of the water. The installation of pool covers to prevent evaporation outside opening hours was not considered, because there is no experience with these in Denmark. Results could be improved further by installing these in future. In addition, 19.1 kW solar cells were installed. The building is in use and reports from visitors are enthusiastic, especially regarding the successful combination of daylight and artificial lighting.

In a nutshell:
Visitor are enthusiastic about an energy efficient pool centre in Valby (DK).

Looking beyond CONCERTO, an indoor swimming pool in Bamberg (DE) is setting new benchmarks for future projects to follow: a passive house indoor pool has been realised there.

N

Due to the very specific requirements of different sport facility buildings, the interchange of positive and negative experiences is necessary. This should be facilitated in implementing a network for professionals with experiences in energy-related fabric and the retrofit of sport facilities.

4.4.4. Low CO_2 Health Care

Although medical care and the care of elderly people has been privatised to a lesser or greater degree in many EU countries, a large part of it remains in public hands. Hospitals, health care centres and care facilities for the elderly form the main part of the buildings in this category. Due to the sensitive state of the ill and elderly, these buildings have special requirements regarding temperature and noise regulation. High energy requirements can arise from laundry, laboratories etc. Furthermore, fail-safe operation has to be prioritised above all else. Hence emergency power systems, private wires and CHPs are not uncommon in this sector.

Buildings in the health sector have been built or refurbished in the following cities within CONCERTO: Birštonas (LT), Delft (NL), Dundalk (IE), Lapua (FI), Salzburg (AT), Stenløse (DK), Trondheim (NO) and Weiz-Gleisdorf (AT).

Image 4.5: **The Sustainable Health Centre Händellaan, in the Buitenhof District of Delft (NL)**

The Sustainable Health Centre Händellaan (NL)

The Health Centre Händellaan, is in the Buitenhof district of Delft (NL), which is an area based on ideas of a garden city: green, open and light. As for other developments in Delft (NL), the municipality put sustainability at the top of the agenda during the initial phase of the project. The building houses a non-clinical health centre for five medical experts and 21 supervised apartments for mentally disabled people. The building's energy consumption is very low, almost meeting passive house standards. Passive design measures such as the use of canopies and a compact design were employed. Technical solutions include heat storage, a heat pump, solar collectors and solar panels. In addition to the low energy use, the following sustainability measures were taken: environmentally friendly building materials, Forest Stewardship Council (FSC) certified wood, water saving measures, waste reduction measures and high consideration for health aspects. The sustainability was assessed using the Dutch GPR-method (comparable to BREEAM). Total energy savings were calculated at 66 % for heating, 52 % for hot tap water and 8 % for the lighting of the common areas compared to the standards. In total, the energy performance in the building permit is over 30 % better than national regulations. There were high extra costs, mainly due to heat storage and the heat pump, extra space for equipment and ventilation equipment above the ceilings. The municipality supports the project with a grant from its energy fund for the insulation measures and RES equipment.

EU N

Especially for health care buildings, energy performance standards should be supplemented with wider sustainability requirements, for example including non-toxic materials and indoor air quality standards.

4.4.5 Preserving and Renewing – Energy Efficiency and Renewable Energy in Cultural Buildings

Cultural buildings such as theatres and operas, but also community halls and youth centres, are highly frequented and can therefore be used as ambassadors for energy efficiency measures and the use of renewable energy. Due to their use, they have special requirements on noise reduction. One challenge is that many of these buildings are historic or listed buildings. There are only a few cultural buildings that have been built or refurbished within CONCERTO. These are in: Ajaccio (FR), Hannover (DE), Heerlen (NL), Helsingør (DK), Hillerød (DK), Montieri (IT), Nantes (FR), North Tipperary (I), Redange (LU), Stenløse (DK), Trondheim (NO), Turin (IT), Valby (DK), Viladecans (ES), Weilerbach (DE), Zagorje (SL) and Zaragoza (ES).

Due to the positive cultural experiences people associate them with; inspiring low-carbon cultural facilities can result in a very positive awareness of what it means to save CO_2. An outstanding example is the Klaverfabrikken in Hillerod, which is a local music venue in a converted, former piano workshop. It has received enormous attention for becoming the first CO_2-neutral music venue in Europe (or possibly the world). In Klaverfabrikken, a large number of staff and volunteers are now aware of the advantages of PV. Klaverfabrikken has been granted the status of a regional playing venue (one of only 18 in Denmark), which offers the opportunity to attract a wider range of names from different parts of the world. A large part of this is due to the fact that they are carbon neutral. It is being considered a huge success from a disseminative point of view with good, positive stories in the media about the fact that they have become carbon neutral.

In a nutshell:
Carbon neutrality can push media attention.

A project in Hannover shows that cultural buildings within urban redevelopment projects provide an opportunity for ambitious projects, while the local residents´ key focus is on maintaining and reviving the overall appearance of the area. Refurbishing the cultural centre has served as a role model for other redevelopment phases of the area and has attracted a great deal of publicity.

Image 4.6: **The Retrofitting of the Kulturhaus Hainholz (Hainholz House of Culture) in Hannover (DE)**

A new Urban Hub: the Retrofitted Hainholz House of Culture in Hannover (DE)

The retrofitting of the Kulturhaus Hainholz (Hainholz House of Culture) in Hannover is an inspiring example of how an old cultural building can become energy efficient. It was built in 1905 and is located in a specially designated urban area under the German government's programme entitled "Urban areas with special development requirements – cities with a social spirit" (Stadtteile mit besonderem Entwicklungsbedarf – die soziale Stadt). After periods of uncertainty about its future, the Kulturhaus Hainholz is today used as a cultural meeting place and as an adult education centre. The Kulturhaus Hainholz is connected to the local district heating system. The initial goal was to achieve the CONCERTO standard for non-residential buildings by reducing the final-energy demand by around 50 %. This was later extended to 60 %. The building shell was fully insulated (12 cm of thermal insulation to walls, top-storey ceiling: 15/30 cm; basement floor insulation: 2 cm, windows with Uw= 1.4 W/m²K). Furthermore, all of the technical installations were replaced, the toilets refurbished and wheelchair access was provided, which required the construction of an external lift. An outside patio was added to the western side and larger windows were added to the ground floor and basement to increase daylight entry.

In the absence of a reliable measured baseline, it had to be calculated, coming out at 256 kWh/(m²a). The target was to reduce this to 100 kWh/(m²a). The actual measured consumption after refurbishment was found to be only 85,8 kWh/m²a. The total costs for rebuilding and redeveloping the House of Culture were around € 2.85 million. Energy efficiency improvements account for 16 % of the total, consisting mainly of planning and quality control (€ 55 000) and insulation (€ 426 000). (The replacement of technical installations had to be financed anyway, so these do not cause additional costs.)

The project had to face a number of challenges:

- The south façade could not be insulated because the existing design elements and connecting points to the roof would have been too complex to deal with. The classicist south façade was, however, returned to its former glory.
- Existing building and insulation materials had to be removed because they either contained asbestos, polycyclic aromatic hydrocarbons (PAHs) or artificial mineral fibres.
- Due to the weather, the refurbishment programme had to be postponed by five months.

However, the redesign of the interiors and the larger windows creating more daylight, were key foundations for achieving a high level of acceptance and a positive response. Within a short space of time, the cultural centre has become the new hub of this area of the city, as is demonstrated by its extensive use by groups, associations and the adult education centre.

L

Public bodies should make full use of the potential of cultural buildings and other landmark buildings to inspire visitors and thus carry energy awareness into the community, while also exploiting their potential to transform an urban area.

4.5. Barriers and Solutions for Low-CO_2 Public Buildings

Failure to procure truly low-CO_2, new public buildings or achieving very high energy standards in retrofitting public buildings can arise from a lack of familiarity with best-practice examples for the various building types and simple lack of knowledge amongst decision makers of what is possible. Overall, it is obvious that the main barriers in the construction or retrofitting of public buildings are, on the one hand, the lack of information exchange. On the other hand, there is the problem of finding partners that have the knowledge and skills to deal with energy efficiency and the use of RES within the special requirements of the different buildings types and often listed buildings.

The advantages of such buildings, not least in economic terms, have to be fully understood in order to warrant the often higher, up-front capital costs. This cost can be a decisive barrier for cash-strapped municipalities, which also have a duty to society to use tax payers' money frugally and responsibly. Contracting can offer solutions, as explained in Section 5.6.2. Public buildings are often listed historic buildings, which have to be treated sensitively, requiring costly, bespoke measures (see also Section 3.7). If ambitious standards are understood and agreed on with financing ensured, the challenge remains to include these into specifications, tender documents and contracts, as well as service and maintenance agreements in a fail-safe way. This is particularly important if using contracting or public-private partnerships.

The Austrian state of Styria demonstrated very effective actions in relation to the retrofitting of public buildings. It developed a retrofit roadmap for all their public buildings. The first step of their plan was the development of Energy Performance Certificates for all buildings of the Landesimmobiliengesellschaft (LIG). Armed with the analysis of the weak spots regarding energy efficiency and the use of RES in all buildings, a retrofitting plan was developed and a respective roadmap set up. This plan includes energy efficiency measures and renewables options as well as financing options, which include public-private partnerships (PPP).

Ultimately, the best public building can only deliver energy savings, if it is run by skilled, energy-aware building managers and maintenance staff and if a general culture of energy awareness exists in the municipality as a whole. Having mastered all of these pre-conditions, success should be communicated to the public by displaying Energy Performance Certificates (EPCs). The EPBD should be followed in spirit, not necessarily the letter of the law – EPCs should be displayed, regardless of whether these are legally required or voluntary, for a specific building.

In a nutshell:
Systematic retrofit planning can make the implementation of energy efficiency and RES measures more effective.

- EU N L — Energy criteria should be included into specifications, tender documents and contracts, as well as service and maintenance agreements for all public buildings.
- EU N — Financial support from national governments and the EU has to be provided for cash-strapped municipalities in order to ensure best practice buildings.
- EU N L — All public building should be retrofitted to the highest possible technical standard. Relevant requirements at EU-level should be strengthened to exceed those of the Energy Efficiency Directive.
- EU N L — Public bodies should survey the energy status of all their buildings as a basis for developing a public building retrofit plan and roadmap with fixed goals, timelines and financing instruments.
- EU N L — Public authorities should display Energy Performance Certificates in all their buildings, regardless of whether they are open to the public or frequented solely by employees and regardless of size.

4.6. Summary & Recommendations

In summary, the projects demonstrate how the construction of low energy public buildings, energy efficiency retrofits and energy management can reduce emissions directly and lower energy costs for public bodies. These demonstrate opportunities to act to private and commercial players and encourage them to choose efficient solutions. Low energy public buildings can set incentives for local companies to invest in energy efficiency, low-carbon technologies and related skills.

- L — For public building retrofitting projects, energy specifications including firm energy targets should be fixed and accepted by all participants early in the planning stage.
- N — Due to the very specific challenges of historic and listed buildings, which are often in public hands, the exchange of expertise and practical positive experiences is necessary. A network of specialists for energy efficiency improvements to historic buildings should be set up.
- N L — The retrofitting of fabric efficiency measures and renewable energy sources in schools should be prioritised due to the high CO_2 saving potential and their function for knowledge diffusion regarding energy efficiency and the use of Renewable Energy Sources.
- N — Energy efficiency measures should be included into school science programmes, thus carrying energy knowledge beyond the school boundaries.
- EU N — Especially for childcare buildings, schools and health care buildings, energy performance standards should be supplemented with wider sustainability requirements, for example including non-toxic materials and indoor air quality standards.
- N — Due to the very specific requirements of different sport facility buildings, the interchange of positive and negative experiences is necessary. This should be facilitated in implementing a network for professionals with experiences in energy related fabric and retrofit of sport facilities.

L — Public bodies should make full use of the potential of cultural buildings and other landmark buildings to inspire visitors and thus carry energy awareness into the community, while also exploiting their potential to transform an urban area.

EU N L — Energy criteria should be included into specifications, tender documents and contracts, as well as service and maintenance agreements for all public buildings.

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EU N L — Public authorities should display Energy Performance Certificates in all their buildings, regardless of whether they are open to the public or frequented solely by employees and regardless of size.

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5. Sustainable Energy Projects – Economic Aspects

5.1. Introduction

This chapter looks at lessons to be drawn and recent developments regarding funding and financing solutions. Many of the CONCERTO projects were hit by the effects of the economic crisis, the banking crisis and the Euro crisis at sensitive project stages, constituting the single biggest issue the projects were faced with. Often projects had to be flexible and change their goals, but ultimately good results were achieved. Two main economic aspects will be considered: how to leverage funds for energy efficient buildings and the funding aspects of renewable energy installations, including suitable business models.

5.2. EU Policy Context

The need for financial support for sustainable energy projects of various kinds at national and EU level is generally acknowledged in the relevant EU legislation. There are various references to funding in the EPBD (2010/31/EU), the Energy Efficiency Directive (2012/27/EU) and the Renewable Energy Directive (2009/29/EC), asking Member States on the one hand to implement national support schemes for energy efficiency and renewables and on the other hand, stressing the importance of the European level institutions in helping with this and providing their own support schemes. Both the Renewable Energy Directive and the Energy Efficiency Directive stress the importance of SMEs. At Union level, the most important financial instruments include those of the European Regional Development Fund, with one of its aims under the header of "Regional competitiveness and employment" being to stimulate energy efficiency and renewable energy production and the development of efficient energy management systems. It has been amended to allow increased investments in energy efficiency in housing. Furthermore there is the Council Directive 2009/47/EC regarding reduced rates of value added tax, the Structural and Cohesion Funds instruments JEREMIE (Joint European Resources for micro to medium enterprises) and ELENA (European Local Energy Assistance).

5.2.1. The Bigger Economic Picture

In 2013, the EU has been increasingly emphasising the need for cheap energy cost and competitiveness, pushing for the use of shale gas, which constitutes a shift from the previous emphasis on long-term climate change goals. Consequently, an overall tone appears to currently prevail in the energy debate, that sustainable energy projects are now expected to be mostly self-financing.

The EC has calculated the benefits of meeting the EU's 20 % efficiency target for 2020 to be enormous. Saving 368 Mtoe primary energy in 2020 means that 2.6 billion barrels of oil do not have to be imported per year, equating to € 193 billion saved, if assuming an oil price of 73 €/barrel per year. The cost of not filling in the energy efficiency gap on the other hand is too high. Imports of 1.4 billion barrels of oil result in € 107 billion being 'exported'. If not achieving the savings, the EU GDP is expected to lose the net positive impact of energy efficiency of at least € 34 billion and 400 000 jobs will not be created.

Realising investments of € 60 billion per year, as deemed necessary, will require incentivising many millions of stakeholders across the EU and will require substantial effort from national governments. Energy prices are low – sometimes artificially so – and so are carbon prices, hence acting as barriers rather than the incentives they could be. If an increase of renewable energy and energy efficiency is to be brought about solely by market forces, fossil fuel subsidies would need to be phased out and carbon prices would need to reflect the real cost to society caused by emissions. Insufficient accounting for and internalisation of external costs of CO_2 and other environmental impacts, as well as certain Value Added Tax (VAT) rules, would need to be addressed. The "polluter pays" principle is not common. Mostly society as a whole pays for the damages inflicted by industry or by certain life-style choices.

Furthermore, it has been argued that discount rates applied for marginal abatement calculations for emission reduction measures often do not reflect European practices and actual energy price increases of recent years. More technical diligence is needed and appropriate discount rates should be used for policy analysis. Discount rates applied do not reflect behavioural factors either: public financing in terms of targeted subsidies and public bank financing can play a role in changing attitudes by lowering costs for consumers, hence building up a track record for other lenders and investors.

The EIB-Fund ELENA (European Local ENergy Assistance) in particular can play an important role here. This joint EIB-European Commission initiative helps local and regional authorities to prepare energy efficiency or renewable energy projects, with the aim to mobilise more than € 1.6 bn in investments over the next few years. EU funding under JEREMIE (Joint European Resources for Micro to Medium Enterprises) and JESSICA (Joint European Support for Sustainable Investment in City Areas) also contributes here. JEREMIE was developed in cooperation with the European Commission to offer EU Member States, through their national or regional Managing Authorities, the opportunity to use part of their EU Structural Funds to finance small and medium-sized enterprises (SMEs) by means of equity, loans or guarantees, through a revolving holding fund acting as an umbrella fund. JESSICA offers support for integrated, sustainable urban renewal projects. A range of sophisticated financial tools are used including equity investments, loans and guarantees, offering new opportunities for the use of EU Structural Funds. However, such instruments have at times remained unused, while in some instances cohesion fund money was not used as intended, funding technical measures with extremely long payback times.

The map below shows the instruments in Europe employed to further the use of renewable energy.

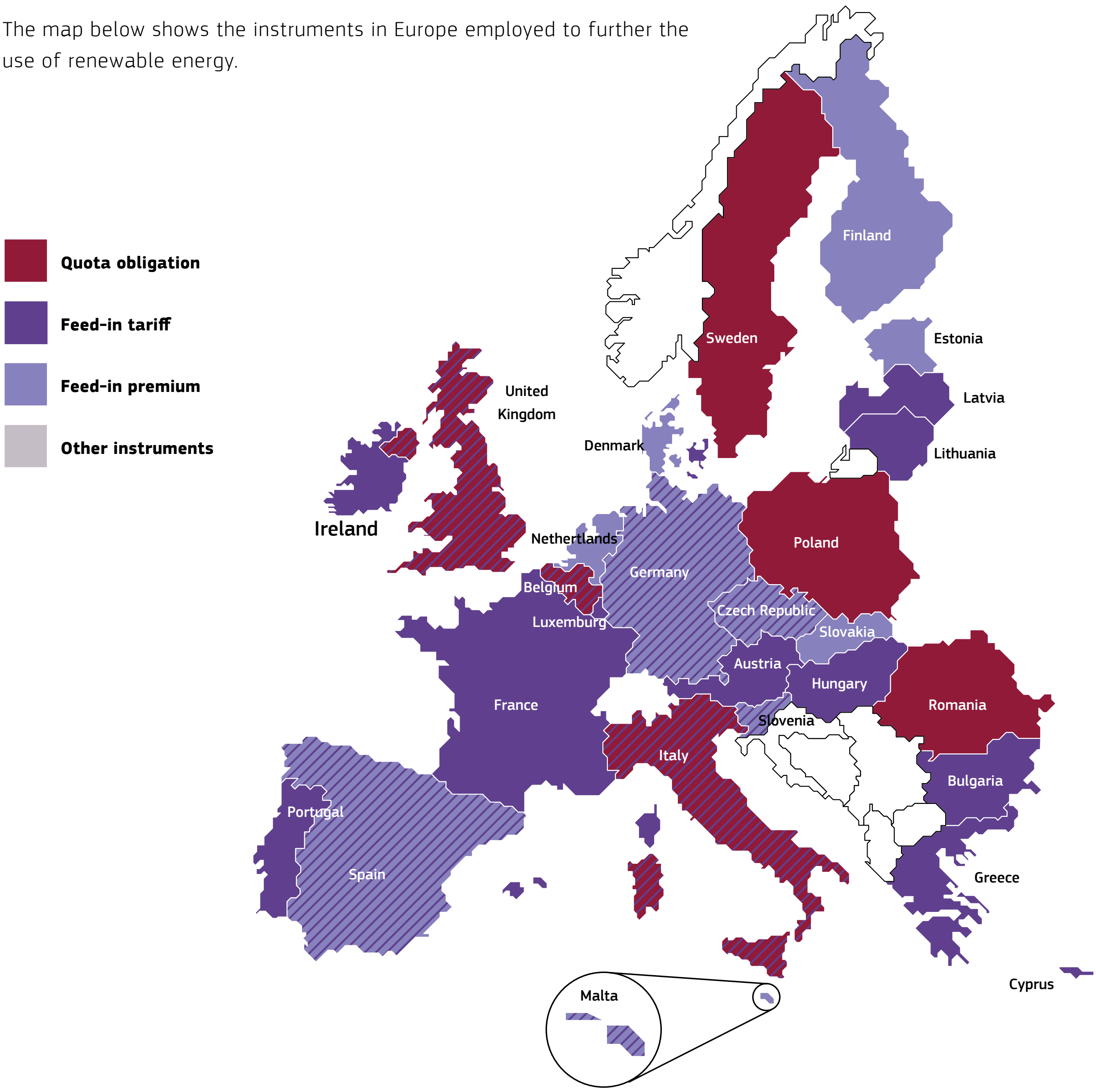

Image 5.1: **Map of EU Countries According to their Support Mechanisms for Electricity from Renewable Sources[9].**

[9]Gephart et al, 2012

5.3. Local Economic Benefits

In 2012, approximately 1.1 million people were employed in the renewable energy sector across Europe and the European Commission sees a potential for 3 million jobs by 2020. OECD data shows that 90 % of emissions can be attributed to 10 global industries which account for a mere 16 % of total employment. Whereas there is huge potential to develop, manufacture, install and run low carbon technologies, which create jobs in a variety of sectors – from research and development to manufacturing, installation and operation, to management, sales and administration. Furthermore, in June 2013, within their current Medium-Term Renewable Energy Market Report (MTRMR), the IEA stated, that power generation from hydro, wind, solar and other renewable sources worldwide will exceed that from gas and be twice that from nuclear by 2016. It also stated that despite a difficult economic context, renewable power is expected to increase by 40 % in the next five years.

If thinking of the actual installation and maintenance of renewables, new buildings and retrofitting measures, the required work is typically undertaken by local professionals. Hence such projects can be good for the local economy, because they have the potential to keep money flows inside the region, which may otherwise go on imported fuel, such as gas imported from Russia or oil from the Middle East. The German government-owned bank KfW underpins this with findings that each Euro spent by the state on the promotion of energy-efficient new builds and refurbishments generated revenue of approximately 2 € to 5 € in the form of additional tax revenue and social security contributions and a reduction in unemployment costs. So national governments should fund positions for proactive energy advisors or coordinators for each municipality, as revenues from VAT and income taxes, from the activities they instigate, will exceed their cost.

The Buildings Performance Institute Europe (BPIE) explored six retrofitting scenarios, ranging from business as usual over "slow and shallow", "fast but shallow" and "medium" to "deep" and "two stages" (see also Section 3.6). When considering these purely in terms of the investment required, they range from around twice the investment for the "business as usual" for the scenario "slow and shallow", through to over five times the "business as usual" level for the "deep" scenario. These are considered achievable, as long as there are coherent policies and market stimulation mechanisms in place across Europe. At a time of rising unemployment and increased energy dependency, the employment and energy saving benefits to consumers from an accelerated retrofitting programme would provide a boost to many economies, which are still suffering in the wake of the credit crunch. Job creation would be highest for the "deep" scenario (see Table 5.1), higher than that for "two-stages", which would, however, yield the highest CO_2 savings. Supporting measures at all levels of the building value chain, from a well-trained workforce (from designers to tradesmen), to a continuing and growing range of energy-efficient products and to effective awareness and information programmes, are essential.

Table 5.1: **Average Annual Net Jobs Generated per Scenario (Source: BPIE)**

Scenario	**0**	**1A**	**1B**	**2**	**3**	**4**
Description	Baseline	Slow & shallow	Fast & shallow	Medium	Deep	Two-stage
Average annual net jobs generated	0.2	0.5	0.5	0.7	1.1	0.8

There is plenty anecdotal evidence on local economic benefits from CONCERTO projects, however data proving direct causal impacts is limited. The following examples provide an insight.

In a nutshell:
A "deep retrofitting" scenario will be the best option to create the most jobs.

A Biogasplant in Måbjerg (DK) Saves Hundreds of Jobs

The sewage sludge fuelled biogas plant in Måbjerg was developed under CONCERTO in 2009 and, at the time, was the largest such project in Europe. The company responsible, MBE Drift A/S, entered into agreements on the purchase of manure and return of the wet fraction with local farmers, thus solving a big environmental problem resulting from the large sewage arisings. Therefore this biogas plant has two economic upsides: Firstly, it provides cheaper, clean energy to the local authority; secondly it represents a crucial precondition for safeguarding 300 jobs in livestock farming, which would disappear had the facility not been built. The total investment required was € 50 million and the net turnover is € 6 million per year. Total economic benefits of around € 125 million over 20 years have been calculated.
To give an impression of the scale of the operation, here some more figures, which are indirectly of economic relevance:

- It transforms an annual 650 000 tonnes of biomass into energy – heat and power
- It produces an annual 17.8 million m3 of biogas
- Energy production equals heating for 5 388 homes and power for 14 381 homes
- It reduces CO_2 emission by 50 000 tonnes / year

Image 5.2: **Biogas Plant in Måbjerg (DK)**

Image 5.3: **Biogas Plant in Måbjerg (DK)**

Calculating Capital Flows Related to Energy in Rural Areas in Europe

The sites Redange (LU), Tulln (AT), Weilerbach (DE) and Słubice (PL) were partners and jointly worked out the following rule of thumb calculation: "Let's take, as an example, a region with about 50 000 inhabitants that is characterised by small and medium-size towns with rural surroundings and that engages in an energy transition process over a period of 20 years from 2012 on. Then about € 1 500 per year and inhabitant can be turned back into the region due to the changes introduced in the electricity and heat sector alone. Each year, an ever increasing share of the capital flow that leaves the region, for paying conventional energy imports, can be turned back into the region. In 2032, this share will amount to € 75 million per year.

Local Economic Benefits for Weilerbach (D) from Energy Transition

Specifically for Weilerbach (DE), € 47 million have been invested in total in renewable energy installations, the retrofitting of existing buildings and some new-build houses, much of which by private households. During the course of the project, this raised approximately 7.5 million in VAT on goods and services (which is shared between national government and the federal state, but not directly by municipalities). This will easily pay for the post of the local energy manager who facilitates the process. So, speaking in terms of macro-economics, it is economically advantageous for national governments to fund positions for proactive local energy advisors or coordinators.

From EU Project to Local Business Opportunity

Another CONCERTO legacy and further local economic benefits could be observed in Redange, where as a legacy of CONCERTO, a number of professionals involved in retrofitting projects together founded an association, marketing the thus gained combined expertise to other retrofitting projects.
Under the name of "ClimEEC", they offer a one-stop shop, providing comprehensive packages for delivering renewable energy and retrofitting projects, which covers the whole planning and construction process and all necessary trades.

These examples suggest the considerable potential for local communities by supporting sustainable energy projects. In order to spread this message, more and more precise data is necessary.

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Municipal, national and EU bodies should capture and communicate data and information on economic activities within and around sustainable energy projects. They should also encourage other organisations, within their influence, to do the same.

5.4. Economic Data on Renewable Energy and Energy Efficiency Measures

CONCERTO projects date back to a period when financial support for renewable energy and energy efficiency was available or in some cases, just being introduced in some Member States. In the wake of the global financial crisis, but also due to other developments in the economic landscape, this has changed fundamentally. In so far an economic analysis of CONCERTO projects can only be seen as representative of that time period (broadly 2005-2010 for the first funding round, 2007 to 2013 for the second with a third round still on-going and hence without finalised data yet).

In the meantime, some types of renewable energy technologies have now reached a level of maturity that make the goal of self-financing renewable energy installations a realistic goal, as can be demonstrated on the example of PV, using CONCERTO figures. The compilation of prices paid for PV by various projects at various times between 2005 and 2010 shows wide variations in cost per kW_{peak} paid (Figure 5.1) and all the following calculated are sensitive against these. Overall, a considerable downward trend in cost is apparent. Capital cost per kWh-$_{peak}$ has almost halved and the dynamic payback period has also almost halved (Figure 5.2) and well below the technical lifetime (typically assumed to be at least 20 years, for economic calculation, but exceeded in practice). This consequently leads to a reduction in the costs per kWh electricity generated from PV, which gradually approaches the market price for electricity from the grid (e.g. in Germany in 2012, this was 24 cents/kWh and rising). With that, solar power generation will be economically viable without subsidies in the foreseeable future.

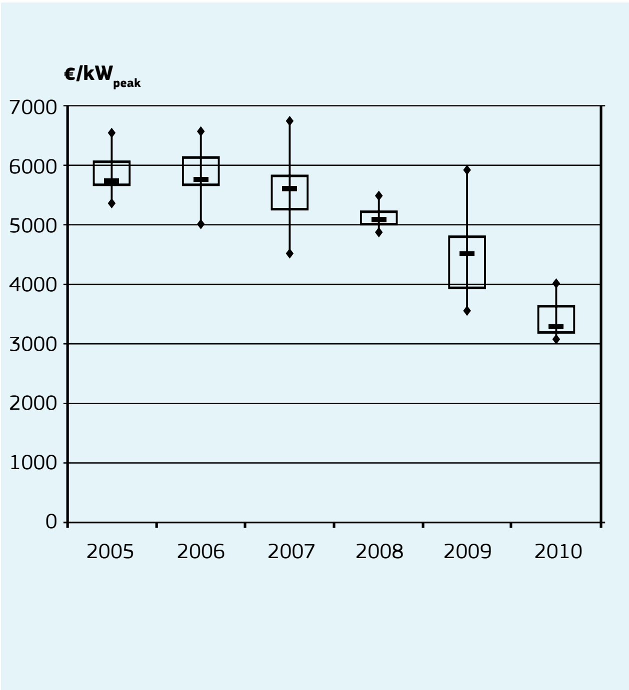


Figure 5.1: **Specific Capital Costs of Small PV Systems in CONCERTO (for Details on Reading Box-Plots refer to Section 5.4.1)**

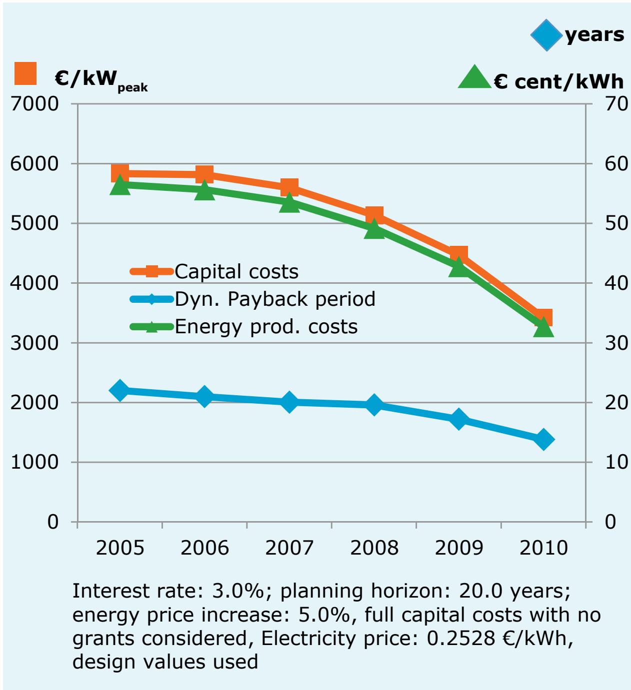


Figure 5.2: **Performance Indicators of Small PV Systems in CONCERTO**

In a nutshell:
Economic viability of some renewable energy technologies is realistic in the foreseeable future.

5.4.1. Cost Figures from CONCERTO

Having outlined this context, some key figures from an analysis of CONCERTO data will be presented in the following figures. These show cost per kWh of renewable or low-carbon energy generated, cost per kWh saved in CONCERTO, as well as absolute costs per m² for new build and refurbishments, all showing wide variations. These would need to be followed up project by project, which is not within the scope of this study, but can be done with the help of the Technical Monitoring Database. Hence figures are here only provided to illustrate the funding challenge of these projects, which are the subject of the following paragraph.

How to Read Boxplot Diagrams?

Boxplots indicate information on the variance of a given dataset by simultaneously displaying five statistical indicators: Median, Minimum, Maximum, Quartiles and Outliners. The „box“ defines the middle (second and third) quartiles. Inside the box the median is displayed. The lines extending vertically from the boxes (whiskers) indicating variability outside the upper and lower quartiles. The Median Outliers are plotted as individual points.

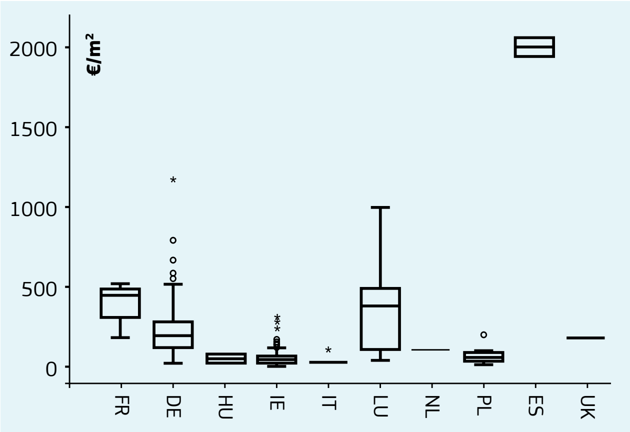


Figure 5.3: **Capital Costs for Refurbishments by Country [€/m²]**

N=488 data sets of all building types and sizes included: full costs for measures (planned ; VAT included; price level: 2010), full costs for measures (invoiced, VAT included; price level: 2010), reference unit: total gross floor area

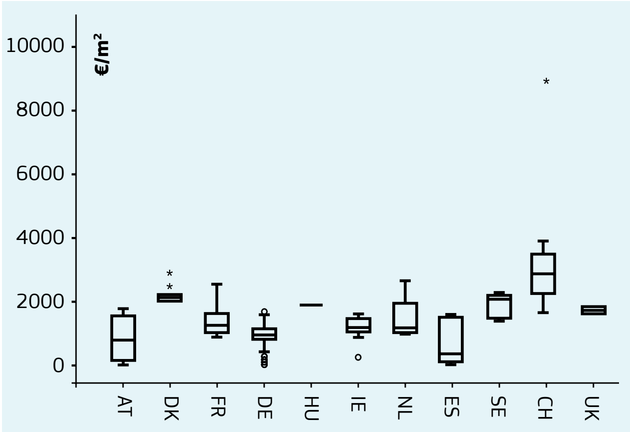


Figure 5.4: **Construction Costs for New Buildings by Country in [€/m²]**

N=243 data sets of all building types and sizes included: VAT included, price level 2010, reference unit; total gross floor area

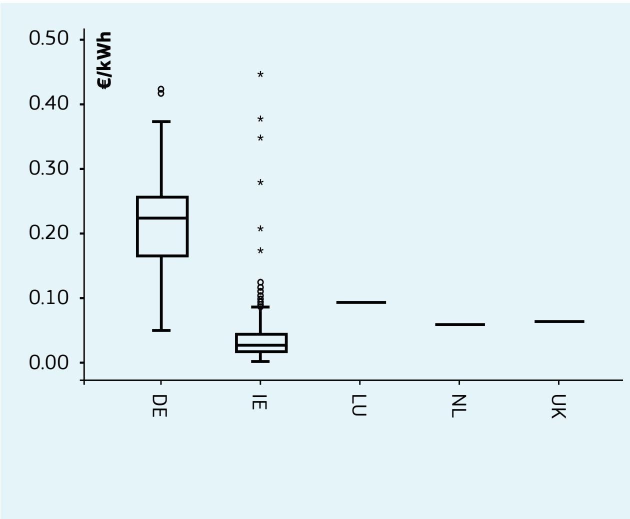


Figure 5.5: **Equivalent Price of Saved kWh Final Energy Demand-Based in [€/kWh]**

N=395 data sets all building types and sizes included, VAT included, price level 2010, discount rate: 3 %, reference study period: 30 years

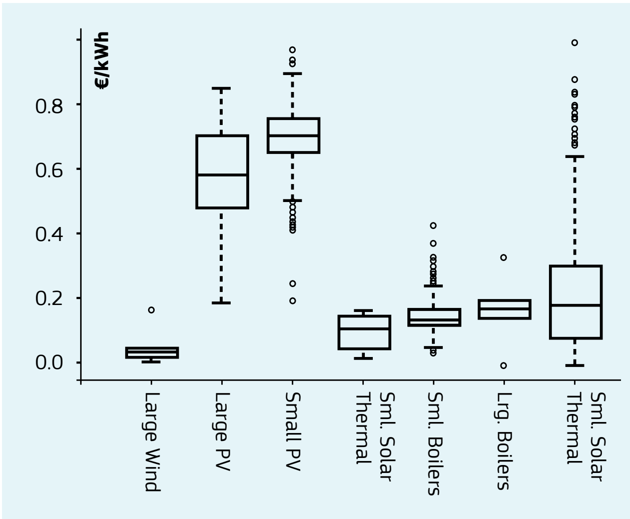


Figure 5.6: **Energy Production Costs of CONCERTO Energy Supply Units in [€/kWh]**

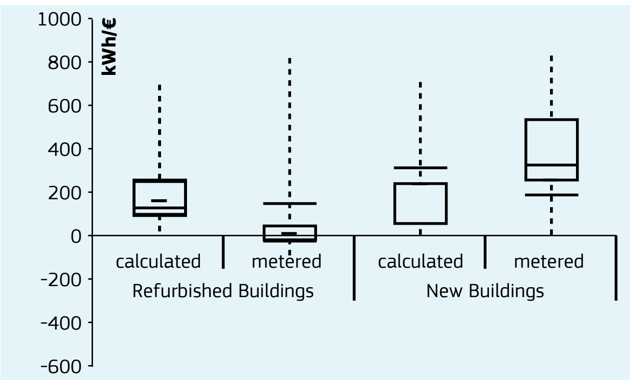


Figure 5.7: **Fossil Primary Energy Reduction per Euro of Grant – Space Heating**

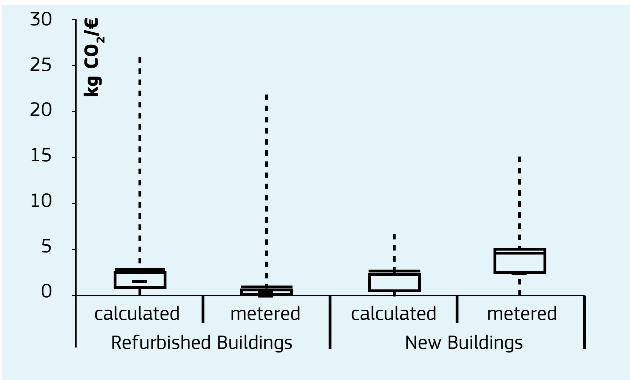


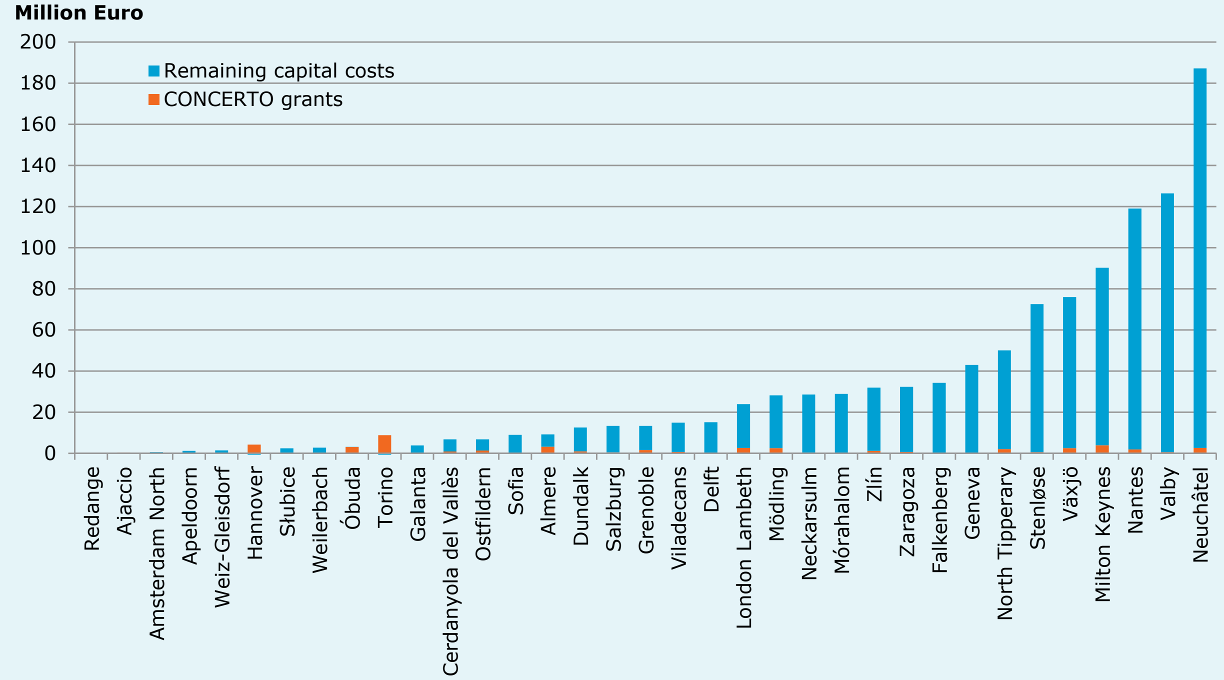
Figure 5.8: **CO_2 Emission Reduction per Euro of Grant-Space Heating**

5.4.2. The Financing of the Pilot Projects

In CONCERTO projects, supply-side measures, i.e. renewable energy installations are combined with demand-side measures, i.e building efficiency measures. These two components have different funding challenges. It can broadly be said that for renewables, appropriate remuneration for the energy generated needs to be ensured and feed-in tariffs or "roll-back" meters (as in Denmark) have proven very effective in increasing uptake. For energy efficiency measures, up-front cost is the major deterrent, which is a far greater issue for the refurbishment of existing buildings than for super-efficient new buildings, as the latter often only carry a premium of a few percent for a higher efficiency standard.

For buildings, financial support from CONCERTO represented typically a very low percentage of the total construction costs. The funding was 35 % of eligible costs (i.e. the additional cost for better energy performance expected by the EC which were set at 50 €/m² in the first funding round and at 100 €/m² later). The support from CONCERTO was meant to cover part of the costs of additional measures to improve the energy efficiency of buildings above the national regulation. For example in Denmark, typical estimates for extra costs for a low energy building are 5 % above those of a regular building. This equals 100 to 200 €/m². Thus the CONCERTO support in round 1 represented 9 to 18 % of the additional costs. The eligible costs were lower in the earlier CONCERTO projects than in the following funding rounds. For the use of renewable energy sources (RES), the funding from CONCERTO is generally around 35 % of the total costs and offered flat rates for PV at 5 500 €/kW installed and solar collectors: 500 €/m² installed.

Figure 5.9: **Total Investment Costs and Share of CONCERTO Grants per Site**



* For the major part of the projects VAT is included in the capital costs; for some projects no information about VAT is available

Figure 5.9 above shows that the overall proportion of CONCERTO funding is very small in comparison to total capital cost. And indeed, for many projects, this very small incentive was enough to stimulate other investment. However, if other public subsidies were also included, the picture would look very different for many projects or part projects (see for instance the example of Óbuda (HR) in Figure 5.10).

Both types of funding challenges for both energy efficiency and renewable energy measures will be looked at in the following sections.

5.5. Leveraging Funding for Energy Efficient Buildings

Standards have risen quickly throughout the EU in recent years. As mentioned before, bringing a new building up to a high-efficiency standard or even nearly-zero-energy standard is not necessarily that much more expensive than 'compliance-only' construction.

Comparatively small grants can trigger ambitions on the client side. An example of this is the German cheap loans and grants distributed by the KfW bank. Most clients will opt for at least their basic standard in order to get € 50 000 of their loan with a subsidised interest rate. However, as a consequence of the global financial crisis and low carbon prices (which feed the relevant funding pot), these funds have also been cut.

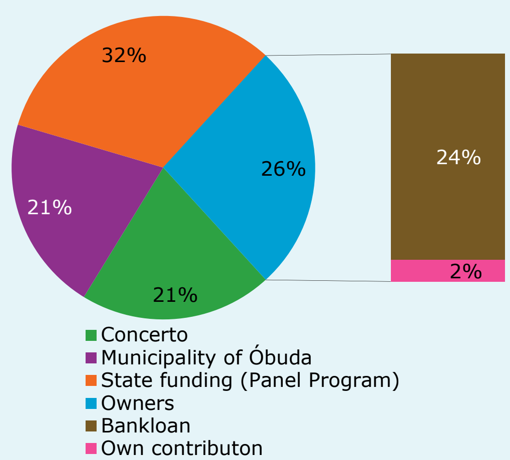
The larger financing challenge is posed by the existing building stock. As mentioned previously, capital expenditure is the biggest obstacle for owner occupiers, but also ultimately for landlords of rental properties. Economic barriers for retrofitting have been explained in Section 3.5. There is a difference between private people contributing to renewable energy installations – they will do it, if it pays – and asking them to retrofit their homes. In the latter case, payback times are generally acknowledged to be long and up-front costs considerable.
Research by BPIE found that, especially with regard to retrofitting, the financial instruments in place are only meeting today's level of retrofit. There is a need for scaling not just targets and strategies, but in particular the financial instruments to support these in order to have greater impact and unlock further private investment for deeper retrofits.

EU An EU Deep Retrofitting Fund should be set up to complement national financing schemes. It could be administered by the European Investment Bank. Any such fund, including those under Structural and Regional Development Funds, should define and enforce minimum requirement for cost-optimal energy efficiency measures and renewables.

In a nutshell:
The amount of money that Europe-wide funding streams from EU Structural Funds, European Investment Bank and the like can offer for retrofitting projects is increasingly important and can play an even greater role in the future.

As CONCERTO grants only covered a small proportion of refurbishment costs, many CONCERTO municipalities mobilised their own resources to subsidise projects further or drew on regional or national funding pots. These often came from urban renewal schemes (e.g. ANRU in FRANCE) or environmental funds.

Generating Funds for Retrofitting through Carbon Offset Fund in Milton Keynes
Milton Keynes devised a particularly innovative way of generating funds for low carbon development. Milton Keynes's plan is to achieve 'zero carbon growth': the city must expand without significantly increasing its CO_2 emissions. Uniquely, the Local Plan establishes a Carbon Offset Fund into which new developments pay a premium according to the predicted amount of CO_2 emissions. The fund is used for mitigation measures in older developments. Where developers cannot meet on site the sustainability criteria set out in planning policy, they are allowed to pay instead into a carbon neutrality fund, as a cost effective, simple alternative. This solution helps ensure the policy's overall goals are still met and development is not restricted. The fund is working well and has funded a considerable number of retrofitting measures (See also Section 6.7.5).



Source: BECO, Faluház maintenance office

Figure 5.10: **Financing of the Óbuda Project**

The project in Óbuda is unique within Hungary. It received matching funds from the EU, the Hungarian Government and the local municipality. Finance came from:
Municipality of Óbuda-Békásmegyer (including EU funds): € 1.67 million
Hungarian Government (Panel Plus Programme): € 1.43 million
Owners' own resources: € 1,17 million
The householders raised their own contribution towards costs through individual property savings contracts – a mortgage-free loan for which there is state support – and the municipality underwrote 6 % of the interest. Hence on average the funding contribution from each flat was € 1 670, which was reduced to € 1 300 by funding support, which, counted over an 8 year repayment period, means a monthly payment of about € 11-15. The savings made on the district heating are guaranteed to be bigger than this.

5.5.1. Private Households Chipping in to Local Projects

Ultimately, CONCERTO projects had to try various approaches to overcome the reluctance of home owners to invest in comprehensive refurbishment of their home, which is often due to high up-front costs and low subsidies.

Leveraging this type of private investment is crucial for bringing about the change in culture and critical mass of technical installations needed to further an EU-wide energy transition. Private individuals contributed to the following projects: Almere (NL), Neckarsulm (D), Cernier (CH), Óbuda (HU), Falkenberg (SE), Redange (LU), Galanta (SK), Serve (IE), Grenoble (FR), Słubice (PL), Hannover (DE), Szentrendre (HU), Hartberg (AT), Tudela (ES), Hillerød (DK),Tulln (AT), Høje-Taastrup (DK), Valby (DK), Lambeth (UK), Weilerbach (DE), Lapua (FI), Weiz-Gleisdorf (AT), Mäbjerg (DK), Zaragoza (ES), Montieri (IT) and Zlín (CZ).

When their own money and their own homes are concerned, people have very particular notions of what they want or need, making decision processes difficult. With fragmented ownership in many apartment blocks, projects face risks, as a small number of objections could jeopardise the whole project. If private households had to contribute, it is likely that they had to take on loans or apply for grants in order to finance their share of costs. Providing assistance with this will have been a crucial factor in winning their support for the project (e.g. in Tudela (ES), Zaragoza (ES), Weilerbach (DE)). On the other hand, failure of private households to secure finance may result in failure of the overall project. It is therefore important to capture and disseminate information regarding the successful involvement of private individuals.

Financial assistance that can help private households and act as incentive are subsidies (grants), cheap loans, and tax rebates. Recently, specific forms of contracting have emerged, referred to as "Pay as you save" (PAYS) schemes, such as the Green Deal. Further details on these can be found in Sections 5.5.1-5.5.3.

In Hannover, home owners of the CONCERTO areas (Ahlem, Vinnhorst, Hainholz and Vahrenwald) could benefit from the services of a so-called 'Energy Assistance' which was first introduced by the Climate Change Mitigation Agency in Ahlem with the consultation campaign "start well advised" ('gut beraten starten'). Private owners who wanted to retrofit their homes in an energy efficient way were supported by the offer of an initial consultation by the 'energy assistant', helping to apply for loans and grants, calculating energy balance and providing quality assurance for the refurbishment work; for this initial consultation they received a voucher of € 2 500 from the Energy and Climate Protection Agency of the city of Hannover. Private owners that applied the CONCERTO standard for retrofitting their homes received a CONCERTO grant of 40 €/m^2; owners that applied the 'Kronsberger Sanierungsstandard' for retrofitting received a CONCERTO grant of 50 €/m^2). This sizable offer of "free money" proved to be an effective instrument to instigate retrofitting projects.

Reducing CO_2 with Cheap Loans

The German model of providing cheap loans and certain grants administered by the government owned 'Kreditanstalt für Wiederaufbau' (KfW) has often been recognised internationally as an exemplary mechanism for the promotion of energy savings and CO_2 reductions in the building sector. Between 1990 and the end of 2009, subsidies for at least 3.1 million homes were paid out. KfW offers subsidies and loans for renewable energy installations and new buildings as well as for energy efficiency refurbishment that meet requirements of the quality label "Effizienzhaus".

Example Green Deal

Looking beyond CONCERTO, one of the more exciting developments of sustainable energy financing is the so-called „Green Deal" in the UK, which specifically tackles retrofitting. Similar to the two latter options, Pay-as-you-save (PAYS) schemes have become prominent in recent discussions, as the so-called 'Green Deal' was launched in the UK at the beginning of 2013. The Green Deal scheme offers homeowners and businesses the opportunity to make energy efficient improvements without having any up-front costs. The Green Deal takes payments through instalments on the energy bill. In addition, it is only the current bill-payer who the payment applies to (thereby avoiding the principal-agent problem); if they move out of the building, then it falls to the next owner to take over the bills whilst they are living there.

Currently the Green Deal requires homeowners to come forward themselves and sign the loan agreements. Take-up of the Green Deal has been slow to date, with only four households in the country having finalised Green Deal plans by mid-June 2013, when the first figures were collated. Nearly 40 000 assessments had been carried out by the same date, and at least 240 households were in the process of finalising loans. Critics have stated that taking out a loan with a likely interest rate of around 8 % is putting some people off the Green Deal. But there had also been administrative, legal and IT issues, which are hoped to subside as time goes on. Efforts for greater uptake include initiatives by municipalities – see also Section 5.5.3.

An example of a comprehensive and innovative financing concept can be found in Redange (LU). After the customer's approval of the technical concept, ENERGIPARK takes over the client data collection for the bank institute and helps with developing a sound financial plan in order to reduce the customers overall financial charges (length of the credit & repayment frequency). The agreement with the bank also explicitly provides the possibility of funding through an energy saving performance contracting. Through very flexible loan conditions (e.g. longer running times than usual), tailor-made financing models can be offered to the customer. The scheme is explained further in Chapter 3.

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In order to ascertain stable and predictable conditions for long-term planning of potential investors, financial support measures must be designed for a sufficiently long term and should not rely on fluctuating sources (e.g. income from taxes or carbon allowances).

EU N Information on financial support options from the EU and national bodies should be targeted better.

N National governments should investigate what role utilities can play in providing and facilitating access to funding, as for example through pay as you save schemes.

N Cheap loan funds should be set up as revolving funds – e.g. repayments received on the initial rounds of cheap loans should be recycled into new projects. Contracting (see Section 5.6.2) could be used to manage these.

5.5.2. Tax Reliefs

Incentives can be set through offering tax reliefs, which could be set at local, regional or national level. There could be lower rates for taxes to be paid locally, e.g. business taxes or building-related taxes. Often taxes have to be paid to the state or to a municipality when buying a property and there could be a lower tax rate for certain exemplary buildings. For example, in the United Kingdom, stamp duty (£ 1 500 on a £ 150 000 house up to a maximum of £ 15 000 on houses valued above £ 500 000) had been refunded on any new home that is built to the UK 'zero-carbon home' standard and purchased before 1st October 2012. There could be other tax exemptions that private people or businesses can benefit from, if investing in energy efficiency or renewables e.g. income tax reductions. However, these options do not seem to have been embraced yet by tax systems around Europe – the following only shows tentative examples that CONCERTO project coordinators reported:

In Denmark, people were eligible for an income tax reduction for the amount spent on labour to install EE-measures.

If home owners in Sweden hire someone to install insulation to the house or install solar panels, they can receive a deduction of tax in their tax declaration the year after.

In Germany, the tax law allows for tax relief on payments made for general building works and repairs on the home, meaning that tax paid on this sum can be reclaimed as part of the annual tax return. This also includes refurbishment works of up to € 6 000 per year that up to € 1 200 of tax can be claimed back on. Further tax reliefs concerning energy efficiency retrofits had been discussed since 2011, but were abandoned in October 2012.

In the UK, lower rate tax was supposed to be applied to retrofitting products, but fell foul of EU rules on VAT.

N The possibility of granting tax exemptions for energy efficiency measures and renewables should be investigated and developed further.

EU The EU should review its Value Added Tax rules and/ or provide clearer guidance regarding options regarding favourable tax rules for energy efficiency products and services as well as for renewables.

5.5.3. The Neighbourhood Approach

For retrofitting, a neighbourhood approach can appeal to construction companies on the ground that it is much cheaper to install major measures such as solid wall insulation across several neighbouring properties at once, rather than individually.

In a nutshell:
Retrofitting a whole neighbourhood at once can offer savings compared to addressing each building individually at different times.

However, the neighbourhood approach can also be utilised in another way, making energy efficiency improvements financed by contracting or ESCOs more viable. Such models do exist for energy efficiency improvements, but mainly for industry. The Green Deal for households (see above) is a variation thereof but is still finding its feet. Recent news from the UK now tells of "Squads" of energy advisors and insulation installers, who are to be sent out house-to-house in an effort to increase retrofitting rates and uptake of the Green Deal. This is thought to be the most effective way to get people to sign up and thus not only help meet climate change targets, but also protect them from energy price rises. The UK government has earmarked £ 20 Million for this scheme. It will allow local councils to send assessors and installers through their areas, working street by street. If people are approached in this way, the hassle of seeking out Green Deal offers is removed from them. It means householders will have to opt out of the scheme, rather than opting in. Once the initial £ 20 million is used up, councils will be given the option to continue with the roll-out by applying for money under the UK's Energy Company Obligation. This scheme requires energy suppliers to contribute to a fund for efficiency measures for lower income groups.

5.6. Funding Sustainable Energy Supplies in Neighbourhoods

With regard to supply-side measures, the fact that CONCERTO projects often entailed whole neighbourhoods (or sometimes a large number of installations spread over a larger geographic region), offered up options for financing solutions other than direct investment. Often centralised systems, such as district heating or even private wires (e.g. in Milton Keynes (UK)) were part of the projects. Due to their on-going maintenance requirements, the case for setting up ESCOs was clear and contracting solutions were also sometimes investigated. CONCERTO examples are described in more detail in Sections 5.6.2 The business models discussed in this section would, in principle, also be possible for energy efficiency measures. Some CONCERTO projects explored this option (e.g. Lambeth and Delft), but then did not go ahead, either because they were not found viable under the conditions prevailing at the time or because the difficult economic climate made those responsible shy away from new approaches.

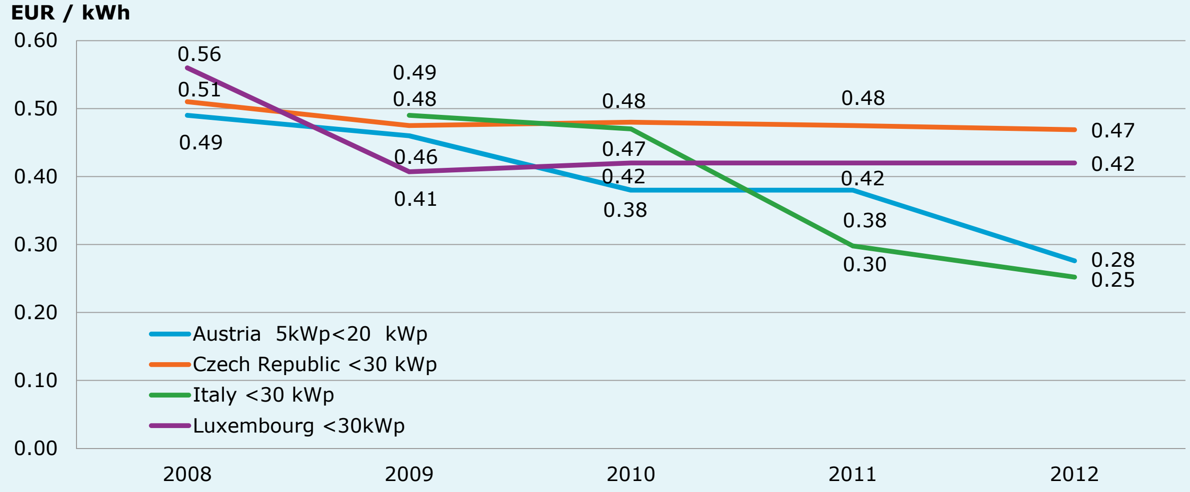
Feed-in tariffs play a pivotal role in making renewable energy viable – either in their own right or within the business plan of a given business model. Hence this will be looked at first.

5.6.1. Feed-in Tariffs

Feed in tariffs had been considered for a long time the most important policy mechanism to bring about a greater share of renewables, especially in the electricity sector .They have the advantage of incentivising the actual production of renewable energy rather than just the installation of capacity that may or may not be used effectively. This has been illustrated well by the early CONCERTO projects such as that in Neckarsulm (DE), where the number of installed PV systems for private households surpassed the expectations of CONCERTO by more than double. This was due to the very attractive feed-in tariffs at the time, combined with a high subsidy towards capital cost offered by the municipality.

Sometimes FITs are designed in a way that does not suffice to notably increase uptake amongst private households, whilst being attractive for large-scale installations of renewable energy undertaken by the state or big companies. At peak times, these large supply units flood the grid, which is not yet designed to cope with this influx. This is one reason why feed-in tariffs had come under criticism. Together with the notion that they are too expensive and distort the market, they were scaled back drastically in many countries, as shown below in Figure 5.11 on examples for PV. In some countries they had only just come into force shortly before being scaled back again, causing confusion and insecurity to investors and the market and also causing many bankruptcies in a once prospering European solar industry. This also added to the economic difficulties of CONCERTO projects, affecting in particular the Spanish projects, but also that in Galanta (SK).

Figure 5.11: **Development of Feed-in Tariffs for Small PV in 4 Member States (2008-2012)**



Both in Switzerland as in Austria, the national programmes of feed-in tariffs had been very successful in principle and a lot of new plants had been installed. Because of budget constraints in Switzerland however, the programmes were frozen with new RES projects being placed on a waiting list, affecting projects in Neuchâtel.

Economic Aspects

“Roll-Back” Meters and Biogas Feed-in in Denmark

A variation of feed-in tariffs can be found in Denmark the so-called ‘nettomålerordning’ or “roll-back meters”, which allow the energy meter to roll back, when PV panels produce energy. This was found to be a very attractive scheme which lead to several PV systems being installed in the CONCERTO area. However, Denmark did not have an appropriate scheme to allow economic viability of the largest European biogas plant in Måbjerg (DK). Positive developments under CONCERTO include that in February 2008, the Danish Government and Parliament entered into force a new political agreement on energy, which gives new incentives regarding biogas. Electricity produced from biogas can be sold for 0.745 DKK/kWh (around 0.12 €/kWh). The Government guarantees a 60 % share of this new, inflation-linked tariff. The implementation of the biogas plant was dependent on this decision and electricity generated by biogas, but consequently could go ahead.

Looking further afield, tariffs for feeding natural gas from biogas plants into a gas network are still unusual, but are also in discussion. There are currently schemes for so-called wind gas, where excess wind energy is used to generate methane, which is then being fed into the national gas grid in Germany, thus providing a storage solution to excess electricity. Methane from biogas plants is also occasionally distributed using the gas grid.

N Stable feed-in tariffs, guaranteeing revenues for a long period (20-30 years) should be provided, as these are crucial to many stakeholders.

N The feeding-in of gas generated from renewables into the gas network should be supported.

There is also evidence coming from Germany that a large solar capacity can bring wholesale energy prices down meaning that the case for renewables is as strong as ever.
Within their current Medium-Term Renewable Energy Market Report (MTRMR), the IEA stated that despite a difficult economic context, renewable power is expected to increase by 40 % in the next five years. This means that renewables are now the fastest growing power generation sector and will make up almost a quarter of the global power mix by 2018. The share of non-hydro sources such as wind, solar, bioenergy and geothermal in total power generation will double, reaching 8 % by 2018, up from 4 % in 2011 and just 2 % in 2006. “As their costs continue to fall, renewable power sources are increasingly standing on their own merits versus new fossil-fuel generation.”

Decarbonising the whole energy supply is only possible, if overall demand is significantly reduced. In the long term, we can only achieve our targets with a much greater emphasis on energy efficiency – the message must be: the more energy efficient we are, the less it matters what the cost of energy is.

5.6.2. Business Models

Having noted in the Section 5.4.2 that projects heavily depend on further subsidies in order to reduce up-front capital expenditure for third parties and on the other hand, being aware that both local and national governments across Europe are cash-strapped due to the continuing Euro crisis, suitable business models are of paramount interest. If applied correctly, they have the potential to alleviate the burden both on public funding providers and private third parties. This is underpinned by findings from a CONCERTO Premium Workshop held in Brussels on 23.10.2012, where CONCERTO coordinators agreed that up-front capital cost was the most important argument in decision making, especially for private households, and that payback over time was only of interest for a small number of stakeholders with a long-term interest (public bodies and housing providers). Though the workshop focused on retrofitting projects in particular, the prevailing argumentation would fit any type of investment decision in the construction sector.
Contracting and ESCO models have been explored for many years now, though the ESCO market is far from mature and still faces many barriers. The Energy Efficiency Directive demands barriers to energy contracting to be removed.
In the following, business models relevant to CONCERTO projects are presented. These models overlap to a certain degree and there are numerous variations and mixed forms for each single business model.

Getting Others to Do the Job-Contracting

Contracting is understood here as the transfer of specific services to a private company that provides the services and thereby relieves the recipient of the services from the need for capital investment. The term Energy Supply Contracting (ESC), refers to the supply of energy of any kind and Energy Performance Contracting refers to delivery of efficiency savings, with a contractually specified share of the realised savings paid as profit to the company. In theory, contracting should result in a win-win situation for both contracting parties, providing the outsourcing party with benefits and savings resulting from the service, compared to the status quo, and enabling the contracting business to apply their expert know-how and profit from the realised savings. However, often the return on investment is, for various reasons, too low. Contracting is a major element in PPPs and ESCOs but can also be used outside of these specific business models.
In Ostfildern, the local utility company SWE outsourced the running of the thermal cooling installations to an external company. An energy contracting model was used for the cooling energy supplied to a company located at the POLYCITY site

(a company dealing in hydraulics). The cooling energy costs have been fixed for 5 years. Costs are higher than those for electricity, as they also contain maintenance costs.
In Weilerbach, a CONCERTO fund was set up at Pfalzwerke (local utility company) for contractors or private people who can apply for aid money out of this fund. A contracting program was set up as part of it. In general, the offer of contracting isn't requested very often, but two builders` businesses have completed installations that used the Pfalzwerke contracting offer. In this case, the client enters a contractual agreement with Pfalzwerke, makes fixed monthly payments and Pfalzwerke retains ownership of the installation (e.g. a heat pump).
For completion's sake, the innovative contracting model for retrofitting projects for private households devised in Redange and presented in Section 3.5.2 should also be mentioned.

L N Energy requirements and their on-going monitoring should be clearly stipulated in contracts.

Public Private Partnerships (PPPs) for Energy Projects

A public-private partnership is the cooperation between at least one private company and a public authority. The company provides a service and in return is paid by the public sector entity which is formally responsible for the provision of this service. Details about the service are stipulated by a contract.
The advantage for the public sector entity is the absence of initial costs, the transfer of operational risks and to some extent the flexibility to increase or decrease the amount of the service in question. From the perspective of the private partners, PPP's are interesting if the contracts promise profits.
In the context of CONCERTO, a new Public Private Partnership (PPP) district heating company was established in Delft (NL), producing, distributing and supplying an equivalent of nearly 20 000 homes with heat and hot water. The company is responsible for the realisation and operation of the new energy infrastructure. Its main task is to technically and financially construct and operate a low-temperature heat transportation infrastructure connecting the individual building locations and their heating systems to the heat sources of the industrial sites.
Another example can be found in Słubice. Because of financial problems of the municipality in Słubice, a public-private scheme was adopted. The PPP scheme allowed for the capital cost and ongoing operational costs to be broken down and combined into instalments. The repayment period has been calculated to be 5 years. The installation of a 250 kW pellet boiler, installation of the oil peak-load and stand-by boiler and the replacement of a hot water pipe to a leisure building could thus be financed.
Potential disadvantages for the public partners are the reduced control over a service, the limitation of long- term strategic planning options, the loss of knowledge and skills inside the organisation, the unequal distribution of (unforeseen) risks and the tendency of private partners to cherry-pick. This lead to a number of examples where the public partner played the role of a 'bad bank' for unprofitable services. The privatisation of public services can also be a politically sensitive issue.
Taken together, PPP can be a suitable business model to enable projects promptly, without extensive up-front capital costs, by mobilising private capital and know-how. Preconditions are acceptance among the relevant stakeholders, sufficient internal legal know-how to determine and monitor the terms agreed and the availability of suitable contractors to provide the services in question.

N L Energy requirements and their on-going monitoring should be clearly stipulated in agreements for contracting Energy Services Companies and Public Private Partnerships. Sample contracts can help.

Energy Service Company (ESCO)

An Energy Service Company (ESCO) is a commercial or non-profit business providing a broad range of comprehensive energy solutions, including the design and implementation of energy savings projects, energy conservation, energy infrastructure outsourcing, power generation and energy supply, and risk management. ESCOS are usually able to finance or arrange financing for the project implementation and their remuneration is directly tied to the energy savings achieved.
Typically, an ESCO may start by performing an in-depth analysis of the property and sometimes at risk, designs an energy efficient solution, installs the required elements, and maintains the system to ensure energy savings during the payback period. The savings in energy costs are often used to pay back the capital investment of the project over a five to twenty-year period, or reinvested into the building to allow for capital upgrades that may otherwise be unfeasible. If the project does not provide returns on the investment, the ESCO is often responsible to pay the difference.
Due to the size of a neighbourhood project and the fact that inevitably the energy infrastructure plays a major role at this scale, often involving district heating or cooling networks, an entity is required to manage and administrate this infrastructure. Many CONCERTO projects therefore used ESCO models. Only a short list will be mentioned here:
Potential problems are illustrated by the cases in Cerdanyola del Vallès (ES) and Cloughjordan (IE). In Cerdanyola del Vallès, the shareholder structure for the ESCO is a public-private partnership, where the share distribution reflects the risks initially assumed by the investors. A private investor (Alba Polygeneration Plant) took on ownership of 90 % of the polygeneration plant, anticipating the connection of a very large number of consumers to the district heating and cooling networks.

However, most of the planned buildings were not realised, due to the economic crisis. Consequently, the plant mostly only served the Synchrotron, which also did not use as much energy as expected when sizing the plant. As a result, the private investor – financed by a bank- now has difficulties with repayments, due to the much lower income than budgeted. Similar problems arose in Cloughjordan (North Tipperary, IE), where the whole biomass district heating system had to be run in order to heat just one house initially and is still heating far fewer buildings than it was designed for, though it has now reached a point of break-even.

ESCO-related Project Development Agreements in Milton Keynes (UK)

The project in Milton Keynes exerted great diligence to avoid problems arising for their ESCO agreement. The ESCO, a joint venture between a local authority and a Danish company, with whom HCA (the Homes and Communities Agency, the organisation responsible for the CONCERTO activities) entered into a Project Development Agreement [PDA]. The PDA gives the ESCO the exclusive opportunity to supply heat and power to all developments within a defined area in Central Milton Keynes. There are detailed provisions in the PDA to ensure the ESCO provides competitively priced supplies to their customers. On its sale of land, the HCA required developers to enter into a Phase Project Development Agreement [PPDA] linking in to the PDA. This commits them to utilise the CHP supply in Central Milton Keynes, as long as it is financially viable for the ESCO to supply heat and power to the development and on the basis it is no more expensive to the developer. This viability assessment requires that the developer contributes all 'avoided costs' [those which would have been incurred in order to heat and power the development via traditional methods] to the ESCO in order to finance connection costs to the CHP supply. The HCA has the option to gap fund projects which fall short of being financially viable, after 'avoided cost' contributions have been accounted for, in order for the development to be connected to the CHP system. One of the ESCO's entitlements within the PDA is that they will receive a financial return on their equity investment in the CHP project.

An ESCO in Måbjerg (DK) running the Biogas Plant Fed by Manure

Måbjerg used a particular model of an energy services company to run their very large biogas project. Måbjerg BioEnergy Drift A/S (MBE Drift A/S) was established in 2009 in order to strengthen the organisation behind the Måbjerg BioEnergy Plant, a newly formed company in its own right. The former company is owned by Vestforsyning Varme A/S and Struerforsyning Varme A/S (these are local utilities in which the municipality is a stakeholder). MBE Drift A/S has entered into agreements on the purchase of manure and return of the wet fraction with farmers, organised in Måbjerg BioEnergy Suppliers a.m.b.a. Further agreements on the supply of biogas and fibre and the delivery of heat have been concluded with DONG A/S, who owns the local CHP plant Måbjergværket. Måbjerg BioEnergy was basically set up as a district heating supply project and not as a profit scheme, which means that any profit or loss will affect the consumer price directly. This also means that no-one (e.g. investors) will benefit from any profit, except that equity might improve. This principle has made it possible to obtain public backing for funding which made it possible to raise money at very low interest rates.

In a nutshell:
Careful, foresightful contract design ensures the viability of ESCOs.

In summary, ESCOS are slowly becoming increasingly common business models, especially in the commercial sector. They have played an important role for realising many CONCERTO projects. In an ideal case, the flexibility and self-financing design of ESCOs ensure the duration of implemented changes beyond the end of a project. However, on the other hand, ESCOs can be jeopardised by market conditions and legal barriers. For example, they can be particularly sensitive against fluctuating and falling feed-in (e.g. if feeding peak-time excess into the grid). Equally, there are sensitivities regarding open market energy prices. If these fall, ESCO customers will feel disadvantaged and may opt out. Legal barriers may stem from the fact that ESCOs, as energy suppliers, are faced with legislation that was largely designed with big, multinationals in mind, containing obligations small companies will find hard to fulfil.

EU N L General market barriers for Energy Services Companies should be removed by setting up a regulatory framework which encourages the development of a well-functioning energy services market.

N L Energy Services Companies offerings for private households and also encompassing energy efficiency measures should be supported in order to become more common.

5.7. The Way Forward

Despite some renewable energy and energy efficiency technologies verging on maturity, financing remains the big challenge if an EU-wide energy transition is to be brought about. The approach to financing in CONCERTO has been relatively conservative, but a few aspects have been found that promise potential. These are, in parts, extensions to the business models considered previously, but deserve mention in their own right.

5.7.1. Municipal Energy Companies

Municipal Energy Companies are understood here as local energy service providers that are in total, or at least by majority, owned by local communities or districts. Their objective is the provision of basic energy services. Municipal energy companies are common across Europe, though uncommon in the UK and France, where large energy suppliers dominate the market. Often local utility companies have been sold off during the course of privatising energy infrastructure and liberalising the energy market. Local generation capacity was also often seen as uncompetitive in comparison with large power stations and consequently has been put out of use. This trend can now be seen to be reversing with cities buying back stakes in their former assets. A new, emerging role for municipal energy companies is being discussed, taking municipal energy companies not as mere energy suppliers but as energy services providers. With cities often holding considerable or even exclusive control over these, alignment with municipal targets will bring mutual benefits. Therefore partnerships with municipal energy companies were instrumental in many CONCERTO projects – for example in Geneva, Grenoble, Hannover, Helsingør, Måbjerg, Neckarsulm, Ostfildern, Torino, Trondheim, Weiz-Gleisdorf and Zlín. In Ostfildern, the energy supply company, "Stadtwerke Esslingen" (SWE), constructed the wood-fired ORC biomass cogeneration plant providing the whole site with district heat. They also implemented photovoltaic systems into the façade and the roof of the power plant and are contractors for biomass powered thermal cooling.

A municipal energy company can take on the role of an ESCO, as in the case of Stadtwerke Esslingen, or it can help set up an ESCO as a separate business entity.

Municipal energy companies are valuable partners for the realisation of energy efficiency or renewable energy projects, due to their expert know-how and familiarity with local constraints and potentials and their options to implement changes directly within the existing infrastructure. Furthermore, it opens up new business opportunities for these companies, helping them compete in a market dominated by a few very large multi-nationals. Being local, and therefore geographically close to their clients, allows them to develop tailor-made solutions, which would not be attractive to the big players. The fact that municipal energy companies are at least indirectly democratically legitimised (depending on the share a municipality holds) and, to a certain extent, obliged to serve the public good, gives them additional authority, which can be utilised to promote sustainability measures. And indeed citizens appear to prefer the energy infrastructure in the hands of the municipality. By way of a petition and a referendum, the citizens of Hamburg decided in September 2013 that the City of Hamburg has to buy back the local energy infrastructure – electricity, gas and district heating networks. The decision went against the wishes of almost all political parties in the City Senate and that of local industry. The City Senate now has to investigate legal issues of buying it back, if not possible, a special commercial vehicle to run the network has to be set up.

L Municipalities should retain and increase their influence over municipal energy companies.

L Municipal energy companies should develop micro-contracting solutions for energy efficiency measures and renewables as a new service area in order to provide local sustainable energy solutions.

[10] www.crowdener.gy

5.7.2. Non-Profit Cooperation Forms

Within the energy context, a cooperative is an association of private persons with the objective to commonly operate energy supply and/or energy distribution infrastructure. Cooperatives are in principle not limited in their number of members which allows even large-scale businesses.

For the realisation of renewable energy projects, cooperatives are a common model – interested parties get together, find land for the installations – or an empty roof on a school. They pool their resources of money and man-power to implement the installation – e.g. a PV array, and share the revenues generated. This model has been common in Germany and Austria for at least a decade, but can more recently also be found in other countries, such as the UK, where the term "community energy" is now being used.

There are large cooperatives such as EWS (Electricity Cooperative Schönau, DE) that repurchased the local power grid in 1997 and since then has established a power supply system. Currently, the EWS provides more than 135 000 German households with mostly carbon-neutral electricity. The largest European cooperative is the MCC (Mondragón Corporación Cooperativa, ES) including more than 100 different companies in various sectors.

Within CONCERTO, the eco-village Cloughjordan is organised as a cooperative. "The Village" project is not only an eco-housing estate; it set out with the objective of 'Building a Sustainable Community' and is putting a number of systems in place to build resilience. As well as the planned 130 high performance homes, renewable energy for heating, an enterprise centre and community buildings, the project is championing community supported agriculture, exploring community currencies, introducing local democracy and governance systems and playing a part in the strengthening of the local and regional economy."

Cooperatives are a very specific form of grass-root financing, operating a service or implementing energy efficiency measures or RES. Given the situation, that a 'critical mass' of people agrees to found a cooperative in the context of a project, logistic and legal support could be provided.

5.7.3. From Crowd-Funding to Crowd-Sourcing

As a recent development, "crowd-funding" is emerging as a special form of renewable energy cooperatives. The difference being that interested parties are not necessarily geographically close nor brought together by a particular interested party, but by a facilitating instance, involving new media such as, for example, the web-service "crowd-energy"[10]. Hence some energy projects appear to be on a par with crowd-funded films and similar novel venture types.

An even more recent concept is "crowd-sourcing", which is the process of getting work or funding, usually online, from a crowd of people. The word is a combination of the words 'crowd' and 'outsourcing'. The idea is to take work and outsource it to a crowd of workers. This appears to feature similarities to the notion underlying a decentralised energy system with a dense network of so-called "prosumers", thus "crowd-sourcing" the currently, still predominantly centralised energy generation. The popularity of such concepts proves that there appears to be a general appetite for decentralised, people-based solutions, which can be utilised for a more resilient energy system that does not rely on public investment only.

In a nutshell:
From crowd-funded films to crowd-sourced energy – what's next?

L — Municipalities should seek to explore the scope for cooperative models and crowd funding in close contact with local citizens.

EU N L — Information on successful examples of community energy models should be disseminated.

5.8. Summary & Recommendations

In summary, many energy technologies are still not sufficiently economically viable, due to their high up-front costs and low profits or low savings achieved. Others are only viable if looking at a long time period. For this reason, financing is a major issue in realising an energy transition. The CONCERTO projects demonstrate on the one hand that it is necessary to provide financial support for renewable energy and energy efficiency projects and on the other hand how to mobilise private contributions – often that of private households. Current business models that hold the potential to overcome the barrier of up-front capital cost have been explored. The importance of collaborating with local and municipal energy companies has been highlighted and options of a new role in offering contracting solutions have been explored.

EU N L	Municipal, national and EU bodies should capture and communicate data and information on economic activities within and around sustainable energy projects. They should also encourage other organisations within their influence to do the same.
EU	An EU Deep Retrofitting Fund should be set up to complement national financing schemes. It could be administered by the European Investment Bank. Any such fund, including those under Structural and Regional Development Funds, should define and enforce minimum requirement for cost-optimal energy efficiency measures and renewables.
EU N	In order to ascertain stable and predictable conditions for long-term planning of potential investors financial support measure must be designed for a sufficiently long term and should not rely on fluctuating sources (e.g. income from taxes or carbon allowances).
EU N	Information on financial support options from the EU and national bodies should be targeted better.
N	National governments should investigate what role utilities can play in providing and facilitating access to funding, as for example through “pay as you save” schemes.
N	Cheap loan funds should be set up as revolving funds – e.g. repayments received on the initial rounds of cheap loans should be recycled into new projects. Contracting (see Section 5.6.2) could be used to manage these.
N	The possibility of granting tax exemptions for energy efficiency measures and renewables should be investigated and developed further.
EU	The EU should review its Value Added Tax rules and/ or provide clearer guidance regarding options regarding favourable tax rules for energy efficiency products and services as well as for renewables.
N	Stable feed-in tariffs, guaranteeing revenues for a long period (20-30 years) should be provided, as these are crucial to many stakeholders.
N	The feeding in of gas generated from renewables into the gas network should be supported.
N L	Energy requirements and their on-going monitoring should be clearly stipulated in agreements for contracting, Energy Services Companies and Public Private Partnerships. Sample contracts can help.
EU N L	General market barriers for Energy Services Companies should be removed by setting up a regulatory framework which encourages the development of a well-functioning energy services market.
N L	Energy Services Companies offerings for private households and also encompassing energy efficiency measures should be supported in order to become more common.
L	Municipalities should retain and increase their influence over municipal energy companies.
L	Municipal energy companies should develop micro-contracting solutions for energy efficiency measures and renewables as a new service area in order to provide local sustainable energy solutions.
L	Municipalities should seek to explore the scope for cooperative models and crowd-funding in close contact with local citizens.
EU N L	Information on successful examples of community energy models should be disseminated.

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6. Planning for Smarter Energy Solutions

6.1. Introduction

Within recent years, the DG Regio has defined an urban vision for the cities of tomorrow, which states that European cities are places of advanced social progress; they are platforms for democracy, cultural dialogue and diversity; they are places of green, ecological or environmental regeneration; and they are places of attraction and engines of economic growth.

The future European urban territorial development should reflect sustainable development in Europe, based on balanced economic growth and balanced territorial organisation with a polycentric urban structure; it should contain strong regional centres that provide good accessibility to services of general economic interest; it should be characterised by a compact settlement structure with limited urban sprawl. Furthermore it should enjoy a protected, high quality of environment around cities. Elements of this vision have since fed into the EU's focus on Smart Cities and related projects.
However, there are many signs that the European model of urban development is under threat. As the urban population has increased, so has the pressure on land. Our present economies cannot provide jobs for all, and social problems associated with unemployment accumulate in cities. In even the richest of our cities, spatial segregation is a growing problem. Cities are ideally placed to promote the reduction of energy consumption and CO_2 emissions, but urban sprawl and congestion, due to commuting, is increasing in many of our cities. A series of challenges must be met collectively if the EU is to fulfil its ambition of a truly sustainable and harmonious development of EU cities[11].
Thus, for the vision set out above to become reality, spatial planning and especially town planning has to deal with the threats described. The main objective of CONCERTO was to reduce CO_2 emissions in neighbourhoods; experience from these projects can therefore contribute especially to this aspect of sustainable urban planning, while often also offering benefits in terms of wider sustainability.

6.2. EU Policy Context
Legislative Background for Sustainable Urban Development

As economic and social integration progresses, national borders within the European Union are continually less divisive. The challenges posed by sustainable spatial development in Europe can be more effectively met with transnational cooperation. Though the EU's sectoral policies have no clear spatial objectives, several of them have a substantial influence on the Community territory as a geographical area through financial aid and policies on energy and transport. These include: Structural Funds, Common Agricultural Policy, competition policy, trans-European networks (TENs), environment policy, research and technological development (RTD).
The proposals from the European Commission for the Cohesion Policy 2014-2020 aim to foster integrated urban policies to enhance sustainable urban development in order to strengthen the role of cities within the context of cohesion policy. So as a basic principle, the European Regional Development Fund (ERDF) should support sustainable urban development through integrated strategies that tackle the economic, environmental, climate and social challenges of urban areas.
The initiative INTERREG and the European Spatial Planning Observation Network (ESPON) are also significant. A reference framework for sustainable development of the European territory is provided by the European Spatial Development Perspective (ESDP) and the CEMAT guideline spatial development – the CEMAT Guidelines (guiding principles for sustainable spatial development of the European continent)
DG Regio funded two generations of URBAN Community Initiative programmes, which have demonstrated the value of an

[11] EU Regional Policy 2011

integrated approach in around 200 cities across Europe, leading to a common European 'Acquis Urbain'. The current programming period aims at spreading the relevant methodological concept to cities and regions across Europe. Therefore, it is also at the core of the JESSICA initiative for loan-based operations in cities and the URBACT programme for sharing best practice on integrated urban development.

Additionally, the 'Smart Cities and Communities European Innovation Partnership', set up by the EC in 2012 and explained in Sections 6.3, is also relevant.

6.2.1. Directives with Impacts on Spatial Planning

There are, however, also a number of directives with relevance to spatial planning:

The Strategic Environmental Assessment (SEA) Directive dates back to 2001, making an SEA mandatory for plans/ programmes which are prepared for agriculture, forestry, fisheries, energy, industry, transport, waste/ water management, telecommunications, tourism, town & country planning or land use.

The Environmental Impact Directive (EIA), originally published in 1985, revised three times and codified in 2011 (2011/92/EU), concerns the assessment of the effects of certain public and private projects on the environment, especially projects that are considered as having significant effects on the environment (e.g. long-distance railway lines, motorways, airports, waste water treatment plants etc.).

Regarding energy in spatial planning, the EPBD 2 states that consultations may serve to promote the provision of adequate guidance to local planners and building inspectors to carry out the necessary tasks.

For new buildings, Member States should ensure that at planning stage before construction starts, the technical, environmental and economic feasibility of high-efficiency alternative systems such as those listed below, if available, are taken into account:

a) decentralised energy supply systems based on energy from renewable sources
b) cogeneration
c) district or block heating or cooling, particularly where it is based entirely or partially on energy from renewable sources
d) heat pumps.

The Renewable Energy Directive concludes that the opportunities for growth and employment that investment in regional and local production of energy from renewable sources bring about in the Member States and their regions are important. Furthermore, Member States shall take steps in order to develop a district heating infrastructure to accommodate the development of heating and cooling production from large biomass, solar and geothermal facilities. This again would need to be driven by planning departments.

The Energy Efficiency Directive states that a number of municipalities and other public bodies in the Member States have already put into place integrated approaches to energy saving and energy supply, for example, via sustainable energy action plans, such as those developed by the Covenant of Mayors initiative. Many have also integrated urban approaches which go beyond individual interventions in buildings or transport modes. These approaches should be encouraged further by Member States. Citizens should be involved in their development and implementation. The importance of SMEs is emphasised.

Account shall be taken of the potential for developing local and regional heat markets. Member States are requested to carry out assessments including a cost-benefit analysis covering their territory based on climate conditions, economic feasibility and technical suitability. Again, these are activities that have to be driven at local level by municipalities.

6.3. Spatial Planning for Sustainable Urban Development

At a macro level, spatial planning affects where construction activities take place and whether these locations encourage or discourage the use of renewable or low-carbon energy generation. Spatial planning departments can influence the energy performance of construction projects, by stating conditions that must be met to obtain planning permission and relevant frameworks are usually set nationally. There are various ways how planning departments can define such conditions for new projects at local level. There are also wider strategies and actions planning departments might use in order to ensure better energy performance. These include strategies for reconciling sustainability and renewable energy with heritage and/ or nature conservation concerns (listed buildings, heritage conservation areas, nature reserves), strategic alliances with surrounding municipalities in place (e.g. close cooperation could help to balance heat demand for larger heating networks).

Over recent decades, urban planning has evolved from being a merely technical discipline into a much more complex matter, as politicians and stakeholders want urban development to meet the needs of cities and people. There are at least five trends that can be identified:

- The moving away from individual sectors towards wider integration within the local or regional economy

- Central governments shifting certain duties to lower levels of government, such as, regions and municipalities – referred to as 'decentralisation' (This is particularly notable in France but, for example, is also happening in the UK.)
- An increasing emphasis on empowering the inhabitants of cities and neighbourhoods
- A shift from universal policies to more focused, area-based policies
- Growing attention on the effectiveness of policies

An integrated approach means an emphasis on partnership, cooperation, governance and networking on the level of regions and cities. The main principles and elements of good practice and successful strategies for sustainable urban development are:

- Developing a city-wide vision that goes beyond single projects and is embedded in the city's regional context; this would include the analysis of target areas; strategy development; defining long- and medium-term objectives, setting priorities, and compiling action plans with concrete measures and projects).
- Increasing the knowledge on energy within the city is a key for sustainable urban development. GIS databases can support the development of energy strategies by mapping energy consumption per building, potentials for renewable energy and energy recovery, mapping of energy networks and potentials of deployment. There is also the option of combining this with urban and socio-economic data, etc. Simplified systems have also been developed – e.g. DECORUM, a model from the UK, which allows the measuring and mapping of emissions on a house-by-house level in order to target emission hotspots by retrofitting campaigns.

Image 6.1: **GIS Map Showing the Energy Consumption Average of Building Blocks in Ostfildern (DE)**

- Using an integrated approach involving local economic development, education and training measures, social inclusion, culture, environmental measures, urban mobility and high-quality public spaces.
- Developing a financing and investment strategy that is sufficient to achieve lasting impacts.
- Increasing the efficiency and effectiveness of public investments – municipalities can save money by coordinating the deployment of energy networks and by targeting investments and subsidies on the more cost-effective measures or buildings typologies.
- Creating strong local and regional partnerships including an increased involvement of citizens and local and regional stakeholders.
- Utilising knowledge, exchanging experience and know-how (benchmarking, networking).
- Monitoring the progress (ex-ante, mid-term and ex-post evaluations, set of criteria and indicators).
- Utilisation of integrated interactive smart technologies.

Focusing especially on fighting against greenhouse gas emissions and building on the Sustainable Urban Development Vision, DG Energy has launched the "Smart Cities and Communities European Innovation Partnership". It invites energy, transport and ICT industries to collaborate on projects with cities, thus to combine their technologies to address the city's needs. This will enable innovative, integrated and efficient technologies to be rolled out and enter the market more easily, while placing cities at the centre of innovation. There will be yearly calls for projects, with funding for 2013 totalling € 365 million. These Smart City projects are direct successors to CONCERTO projects in as far as they are also focused on the reduction of greenhouse gases in neighbourhoods. Some CONCERTO projects have indeed applied for and secured Smart Cities funding, thus expanding on the foundations laid under CONCERTO. The Smart Cities Projects are supported by a "Smart Cities Stakeholder Platform".

L Municipalities should employ energy officers with a remit for coordinating energy demand, energy efficiency, local energy production and the energy system for the whole geographic area of the municipality, working closely with planning departments.

L When devising a masterplan for new urban extensions or regeneration areas, it should respond to the municipality's energy strategy, set energy targets and ensure that these are adhered to by all planning applications and consequent construction activities.

6.4. Use of Planning Instruments in the Pilot Communities

As shown in Table 6.1, many CONCERTO projects have had a masterplan in place that had been agreed by the city council to define CONCERTO new build areas and many municipalities were also able to impose specific energy performance requirements. Some were also able to state the necessary requirements for renewable energy in the form of planning obligation for new buildings or developments or were able to impose obligations to connect to district heating or private wires. In this context, maps that show potentials for renewable energy sources/ technologies and energy models or maps for local energy demand (demand density) were being used. The use of GIS-systems appeared to be relatively widespread, though not always relevant for CONCERTO.

Only few imposed requirements, regarding building orientation or obligation, to submit an energy strategy as part of the project. Sustainability assessment systems (e.g. LEED, BREEAM, DGNB) were also only rarely used.

Whether certain obligations can be stated by planning departments in municipalities usually depends on the national framework. In fact, most CONCERTO projects stated relevant requirements not so much as planning requirements, but as obligations that formed part of sales contracts for land sold for development, that was in public ownership. Despite the limitations, there are examples of partners in international projects learning from each other regarding the use of planning tools to further energy efficiency sustainable construction. The most famous (though outside CONCERTO) is the "Merton Rule" in the UK requiring a share of 10 % on-site renewable energy for larger new buildings in the London Borough of Merton, following the municipality's involvement in a number of EU projects. The rule led to changes to the national planning framework at the highest level and many municipalities have followed since. It is hoped that CONCERTO will leave similar legacies. In fact, many municipalities now impose stricter energy-related planning requirements, following their experience on CONCERTO.

L Municipal planning departments should explore in how far sustainability assessment systems can help them as tools for setting targets for energy and other sustainability issues, communicating these to stakeholders and following targets through.

L Municipal planning departments should use all instruments available to them to push energy performance standards, and learn from international best practice in order to push national boundaries of these tools.

Table 6.1: **Overview of the Use of Planning Tools in the CONCERTO Municipalities and Projects**

Planning tools used in general in the municipality	
A masterplan exists that has been agreed by the city council and which defines what can be/should be built where	
Can the municipality impose specific energy performance requirements?	
Can the municipality impose planning obligation to generate on-site renewable energy for a new building or a development? (e.g. 10 % of total predicted demand of a new building)	
Can the municipality impose obligation to locate new developments near heat-sources for district heating?	
Can the municipality impose obligation to connect to district heating or private wire?	
Can the municipality impose requirements regarding building orientation?	
Can the municipality impose obligation to submit an energy strategy?	
Are sustainabiliry assessment systems being used (e.g. LEED, BREEAM, DGNB...) as a way for the planning department to specify sustainability targets?	
Maps that show potentials for renewable energy sources/techlogies supply	
Energy models or maps for local energy demand (demand density)	
GIS is being used for the mapping of the above potentials	
Planning tools used for CONCERTO	
A masterplan exists that has been agreed by the city council and which defines what can be/should be built where	
Can the municipality impose specific energy performance requirements?	
Can the municipality impose planning obligation to generate on-site renewable energy for a new building or a development? (e.g. 10 % of total predicted demand of a new building)	
Can the municipality impose obligation to locate new developments near heat-sources for district heating?	
Can the municipality impose obligation to connect to district heating or private wire?	
Can the municipality impose requirements regarding building orientation?	
Can the municipality impose obligation to submit an energy strategy?	
Are sustainabiliry assessment systems being used (e.g. LEED, BREEAM, DGNB...) as a way for the planning department to specify sustainability targets?	
Maps that show potentials for renewable energy sources/techlogies supply	
Energy models or maps for local energy demand (demand density)	
GIS is being used for the mapping of the above potentials	

6.5. Setting Targets and Devising Strategies

Many CONCERTO municipalities demonstrated good practice: their projects sat within the broader context of the participating municipalities' energy and climate change strategies. Often CONCERTO involvement influenced these strategic plans and helped to make them more ambitious. In some projects, the development of a comprehensive strategy was a formal project deliverable (for example in Växjö and Delft).

Revision of Local Energy Plan in Växjö (SE)

In Växjö, the local energy plan (a plan which each Swedish municipality must have) had been rather old – CONCERTO provided the opportunity to revise and improve it and make it more ambitious. This activity formed directly part of the activities specified in the CONCERTO contract. The knowledge gained from the CONCERTO project fed into the new local energy plan and helped get it approved. Driving forces are the willingness to take responsibility, regional growth and development and PR, while environmental and energy legislation played a secondary role. The main driving force for the private sector to support it has been the opportunity to get media exposure at EU level.

	Ajaccio	Cerdanyola del Vallès	Cernier	Dale	Delft	Falkenberg	Galanta	Geneva	Grenoble	Hannover	Helsingborg	Helsingor	Hillerød	Høje-Taastrup	Lapua	Lyon	Milton Keynes	Neckarsulm	Neuchâtel	Ostfildern	Redange	Salzburg	Słubice	Szentendre	Torino	Tudela	Tulln	Valby	Växjö	Viladecans	Weilerbach	Zaragoza	Zlín
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Planning

Some cities have developed distinct goals, integrated plans, included participatory elements, included education, training and qualification measures (see Chapter 7), financing elements (see Chapter 5) or have established strong local and regional partnerships (see Chapter 7). A number of participating municipalities have set themselves particularly ambitious goals – these are listed in the table below. Whereas some of the cities have defined by what date the goals have to be achieved, others have not. Without such a date, it is much more difficult to draw up well-defined roadmaps and there is less pressure to actually implement the measures that are necessary to reach the targets.

City	Energy and CO_2 Goals
Ajaccio (FR)	zero energy concepts in buildings
Falkenberg (SE)	100 % electricity demand by wind power
Geneva (CH)	2 000 Watt Society without nuclear energy as source
Helsingør (DK)	- reduce CO_2 by 2 % on a yearly basis from 2008 to 2025 - 30 % reduction compared with present standards in the gross energy consumption for heating, hot water, lighting, ventilation and cooling in new eco-houses - 90 % of the district heating should be based on cogeneration from natural gas and waste - CO_2 neutral in 2050
Høje-Taastrup (DK)	fossil free municipality
Milton Keynes (UK)	zero carbon growth
Tulln (AT)	- "Sustainable Energy City" - 100 percent renewable energy supply
Växjo (SE)	- fossil fuel free city administration 2020 - fossil fuel free by year 2030

In a nutshell:
Absolute targets of "100 % savings" or "zero emissions" are becoming more and more common.

The fact that an increasing number of municipalities now have such high reaching targets means peer pressure on other municipalities is mounting. Albeit requiring a more modest 20 % in savings by 2020, the Covenant of Mayors and similar initiatives underpin this and provide a structured framework of firm commitment and a network for exchanging experiences and support.

L Cities should set up sustainable energy action plans that include,at least the following aspects: energy sustainability indicators, energy efficiency or other goals including a time horizon to reach the goal, future energy consumption, energy efficiency potential, potential to produce energy from local renewables, energy system and storage capacities including local stakeholder in the development process.

6.6. Staying on Track – Avoiding Disengagement

For any project with the aim of constructing highly energy efficient buildings and renewable energy installations, it is a key challenge to fight the risk of losing sight of the energy targets as the construction process evolves. It is therefore essential to bring on board all stakeholders with regard to the energy objectives and to involve them as much as possible within interdisciplinary planning teams. For the construction of high-performing buildings, it is well known that it is necessary to reinforce the collaboration between the architects and engineers. On an urban scale, the situation is similar. The collaboration between urban planners, architects, city energy departments and energy networks` operators has to be reinforced.
Figure 6.1, developed in Lyon, shows possible evolutions of energy performance over the building process. The red exclamation marks highlight common elements that affect the final energy consumption:

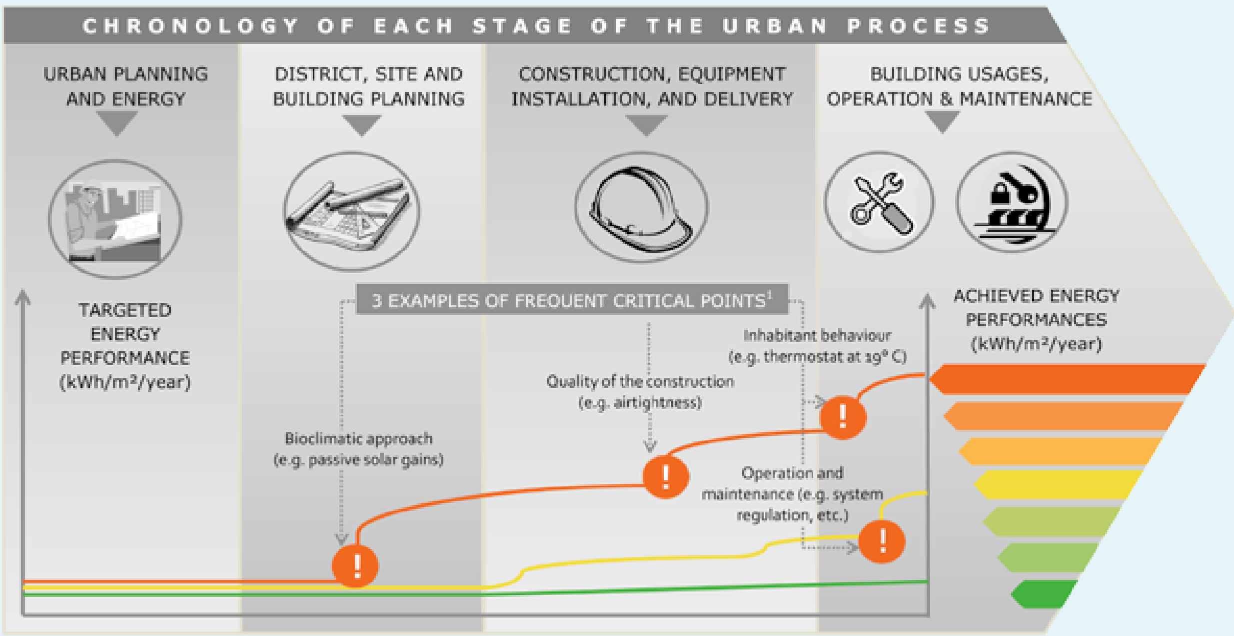
- adaptation to local climatic conditions (bioclimatic approach), including the definition of building orientation and volume to optimise passive solar gains
- the quality of construction techniques
- users' energy saving habits
- operation and maintenance that meet users' comfort requirements with the most efficient energy conversion from final demand to useful consumption.

Three contrasting situations have been considered, represented by the green, yellow and red lines.
Many CONCERTO projects achieved high levels of energy performance in new and refurbished buildings, at significant scale and at reasonable cost. This is possible with existing technological solutions, if appropriately planned and if using three leveraging tools effectively:

- Tightly defined contractual objectives
- Provision of expert support to project stakeholders
- Awareness raising and training of enterprises and users

Chapter 7 looks at social aspects and expands further on the last two points.

Figure 6.1: **Chronology of Urban Process**



¹Please note that the actual impacts of breaking points on the overall energy performance are not necessarily proportional to the one represented on the graph.

3 Examples

— A buildig that is properly designed with ambitious low-energy objectives (i.e. through dynamic thermal simulation software) can perform poorly if successive stakeholders do not take into sufficient consideration the risk of critical points.

— Even if a project anticipates all disengagement risks during design and construction phases, problems may appear during operation and maintenance and jeopardise targeted energy performances.

— Good energy performances are achievable by paying special attention to energy issues all along the design, construction and operation processes.

If thinking beyond the delivery of individual physical projects, and moving towards a broader overall delivery strategy for an energy transition, a systematic framework and clearly defined roles of a number of pivotal stakeholders helps. This has been explored by the partnering projects in Redange (LU), Słubice (PL), Tulln (AT) and Weilerbach (DE) (see below).
Another possibility is the use of sustainability assessment systems, which results in a label or certificate at the end. If the achievement of a particular assessment result and label is set as a key objective at the beginning and all stakeholders are made to commit to it, losing the label and the status and marketing advantage associated with it will very likely be deemed unacceptable.

In a nutshell:
A recipe for keeping on track with energy targets:
- Tightly defined contractual objectives
- provision of expert support to project stake-holders
- Awareness raising and training of enterprises and users.

Frameworks for Regional Energy Transitions in Redange (LU), Słubice (PL), Tulln (AT) and Weilerbach (DE)

The partnering projects in Redange, Słubice, Tulln and Weilerbach adhered to a well-defined framework designed for regional energy transition initiatives, which had been developed under the preceding project "100RENET". 100RENET defined six steps:

1. Preparation
2. Regional analysis
3. Definition of targets
4. Regional action programme
5. Implementation of measures and projects
6. Monitoring and evaluation (with several iterations of steps 4-6).

It also defines the following entities that play pivotal roles in the transition process:

1. An ideological support/ not-for-profit-support structure
2. A dedicated energy change manager
3. A political process manager: (e.g. the mayor)
4. An organisation for economic operations e.g. an energy agency liaising with grant providers or a contracting facility – a role that could be taken on by a municipal energy company.

This framework has been put into practice by their CONCERTO project and can now be recommended to others in principle, though it always needs to be adjusted to fit the specific context.

In Weilerbach specifically, the local coordination office was very important, but no organisation for economic operations was set up as such, so a partnering organisation was used instead. In addition to the standard model, the following proved important: instead of the non-profit support network, a multi-level support network at regional level was used. It links players at different administrative and political levels (association of municipalities, the region, the federal state). The multi-level support network allows achieving better efficiency in the implementation of various tasks that need to be completed as part of an energy transition.

Image 6.2: **Solar Map – Weilerbach (DE)**

A series of similarly focused projects built upon each other to gradually move the region closer to the ideal of 100 % renewable energy. For Weilerbach, this started in 2001 with the project ZEV (Zero Emission Village), which identified a strategy of 10 % reduction in electricity consumption, 40 % reduction in heating energy consumption and full utilisation of locally available renewable energy potential. CONCERTO could build on this existing strategy. Other projects supporting the same aims as CONCERTO were RECORA and 100RENET. Furthermore, an energy audit of municipal buildings as part of participation in the "Klimaschutzinitiative in Germany" had been undertaken before embarking on CONCERTO.

In a nutshell:
Run a series of projects to build up action plans and expertise.

L

In order to corral support for energy transitions, multi-level support networks at regional level should be sought out to link stakeholders at different administrative and political levels (association of municipalities, the region, the federal state). Informal networks also have to be put in place by the planning authority.

6.7. Examples of Smart Planning in the Pilot Communities

Some CONCERTO cities which have just realised parts of the planning for sustainable development are described in the following. Pioneering municipalities can enforce tougher standards than those required by their national building regulations.

6.7.1. Sustainable Planning Tools in the French CONCERTO Projects Lyon, Nantes & Ajaccio

The four French CONCERTO projects communicated and collaborated well, altogether moving sustainable energy planning in France forward. A legal instrument used commonly was the "ZAC" (a Concerted Planning area).

Well-Defined Renewable Energy Technology Specifications in Grand Lyon

The CONCERTO project Lyon-Confluence has been a pioneer in terms of developing new planning models including energy criteria and in terms of spreading results at local, regional and national level. The innovative aspect, developed by the CONCERTO project, is the use of the legal instrument ZAC with the introduction of high energy efficiency standards (rational use of energy and renewable energy technology specifications) as compulsory specifications.

These predefined requirements, reflected in the tendering process, have contributed to speeding up the inclusion of sustainability criteria in the private construction sector. Grand Lyon created a ZAC (1 200 000m²) in 1999 with the option for the municipality to have priority in acquiring any piece of land in the area, possibly through expropriation, in order to develop a new urban project. Starting in 2004, all construction had to respect a range of criteria of High Environmental Quality (HQE®) such as reinforced insulation, choice of materials, energy management and use of rainwater. This process could be applied to the very first housing blocks to be constructed in "Lyon-Confluence", and energy performance criteria have been increased little by little during the following phases of the project. In this way it was possible not only to impose the highest potential energy standards to the 1 200 000 m² to be constructed later in the "Confluence area", but also to set up a defined procedure called "Réferentiel Habitat Durable" for social housing and any other construction plan in the ZAC of the conurbation of Lyon. This experience has also enabled the creation of a similar set of criteria for social housing at regional level (référentiel QEB de la Région Rhône Alpes).
In Lyon, a dedicated operational body for the implementation of the urban project was established in July 1999 under public-private status; the so-called "SEM Lyon-Confluence" (for "Société d'Economie Mixte Lyon-Confluence"). All permits and authorisations are within the competence of the city council. In order to finalise the purchase of the land from the SEM Lyon-Confluence, the three developers had to comply with detailed guidelines, which included energy efficiency targets and renewable energy technology specifications (CONCERTO specifications). The final purchase of the land occurred only when the building permit was delivered, in order to make developers comply with the guidelines. In Lyon, CONCERTO results influenced a local action plan which focuses on the energy efficiency refurbishments of privately owned housing co-ownerships in the Ste Blandine district and also had impacts on the development and enforcement at regional level (Rhône-Alpes) of a powerful low-energy new social housing support policy, based on a regional set of requirements for energy performance.

Charte Chantier Vert in Grenoble and Nantes

Similar procedures have also been developed in the projects in Grenoble and Nantes with the creation of a charter (Charte Chantier Vert). This has been one of the key tools to put in place the objectives of the construction site and the assignment of a person responsible for its implementation.
Also, the so-called "cahier des charges de cession de terrain" (CCCT) is one tool for stating energy requirements as part of the spatial planning system. It is an instrument of local law, but is a contract rather than a law. The "cahier des charges" existed before CONCERTO, then concentrating on architectural objectives. For CONCERTO, energy requirements have been integrated and these now apply for all projects that have been started since.

Combining Urban Regeneration and Energy Efficiency in Ajaccio

The CONCERTO project in Ajaccio, Corsica is smaller than the other French projects; hence the role of the local planning department was less prominent. However, the project is a good example of how energy requirements can go hand in hand with urban regeneration. The project benefited from financial support for the Urban Regeneration Programme (ANRU) in Cannes-Salines district. The (ANRU) support has been much more important from a financial point of view than the CONCERTO funding, but the Urban Regeneration programme did not cover energy improvement measures. The CONCERTO programme imposed measurement standards that endorsed the use of energy efficiency. The combination of these two incentives (ANRU, Concerto) has led to a positive mix in terms of standard and cost effectiveness.

6.7.2. Self-Builders as Innovators in Almere (NL)

In Almere, housing construction was firmly dominated by developers. In 2006, a new alderman, responsible for building, came in. He wanted drastic changes – the goal was to not build in the traditional way. So the CONCERTO land was divided into three parts; 1. for rent, 2. for sale, 3. for self-builders, a very different target group. During the recession, self-builders were less affected, as they did not need to worry about profit margins. It meant, however, a big change in communication for the project team, as they were now dealing with a large number of people and a very heterogeneous group. Intensive communication efforts were required upfront. In the beginning, success seemed unsure as there was no structured feedback from the group either. One third of the municipality`s ambitions depend on self-builders and luckily, according to monitoring results, the self-builders' results are looking much more positive than expected. There was, for example, large scale uptake of PV, better EP-figures significantly better, more innovative solutions, pushing boundaries and passive houses.

In a nutshell:
Self-builders can play an important role in pushing construction standards, as they build for their own comfort, not for profit.

6.7.3. New Binding Energy Standards in Zaragoza (ES)

The project in Zaragoza faced a number of barriers initially: limits for feeding in wind power, due to grid balance issues, inefficient design and improper maintenance combined with excessive use of heating leading to excessive losses (46.3 %) etc. These struggles lead to numerous amendments of municipal orders, in order to promote energy efficiency refurbishments and the use of renewable energy sources. The following was necessary:

1. To revise numerous ancient laws such as the so-called "Horizontal Ownership Law", the "Urban Development Legislation" and the "Urban Renting Law"
2. To reinforce the legal capability of local authorities to impose refurbishment works in some particular districts (deteriorated, historical)
3. To take an example from the French comprehensive approach to urban renewal (social, economic, environmental), including the creation of dedicated regional agencies

Now a new local by-law exists with the result that all new buildings need to use CONCERTO standards. Zaragoza now has a regulating and legal tool compelling every new building and fully refurbished dwellings in the municipal area to comply with guidelines on energy saving, energy efficiency and use of renewable energy. This is a landmark municipal regulation. Local and national policies benefit from CONCERTO due to:

1. Official approbation at national level of the master plan used in the urban extension called Valdespartera as pioneering development and advisable for replication.
2. Numerous amendments of municipal orders favouring energy efficiency retrofitting and introduction of renewable energy sources.
3. A series of agreements between the Ministry for Housing, the Government of Aragon and the City of Zaragoza to develop a massive refurbishment program for low-income and vulnerable families in Zaragoza, based on the pilot experience led in the area of El Picarral. The experience of Zaragoza in Valdespartera and Picarral has influenced national policy improvements.

In a nutshell:
Learning across national borders on best practice spatial planning is possible.

6.7.4. Proactive Planning and Regulation Process in Egedal (DK)

The planning and regulation process applied in the urban development of Stenløse syd in Denmark is special in the sense that the municipality of Egedal has actively sought to challenge both existing planning and building practices in order to promote energy efficient buildings on ordinary market terms. More specifically, the process has been aimed at facilitating changes in local building projects by rethinking the municipal role and putting new types of planning instruments into use. Through this process, the municipality has succeeded in committing ordinary building developers to construct residential buildings with higher energy efficiency. This represents a change of local building processes, since most building projects today tend to only comply with the energy efficiency levels prescribed by the national building regulation. The planning and regulation process in Stenløse syd hence represents an important learning process of how to promote energy efficient buildings through a reflexive planning approach, where the municipality plays an active role as facilitator of change.

In a nutshell:
Challenging both existing planning and building practices can bring about energy efficient buildings on ordinary market terms – the municipality plays an active role as facilitator of change.

Due to the perceived lack of implementation of sustainability strategies (e.g. Local Agenda 21) the municipality of Egedal proactively developed its own locally-embedded plan. Based on their Municipal Plan 2002, the formulation and implementation of sustainable strategies in planning documents is imposed by the Danish Planning Act.
Initially, the municipality of Stenløse initiated the urban development of Stenløse syd, but due to a structural reform, this municipality was merged with the municipalities of LedøjeSmørum and Ølstykke, hence forming the municipality of Egedal. The ambitions in Stenløse syd have been carried on by the newly merged municipality of Egedal.

Image 6.3: **Arial Photograph of Stenløse South (DK) in 2007**

In form and content, the municipality of Egedal combined the Local Agenda 21 strategy with the Danish Planning Strategy Report. These two planning documents are compulsory for a Danish municipality to develop. The municipality chose to emphasise sustainable buildings in the strategy. The technical administration arranged a study tour, where politicians were introduced to innovative urban development projects, and this engaged the municipal council in the vision of developing a sustainable Stenløse South (DK). The ability of the technical administration to establish such a strong political will to implement energy efficient buildings, has represented an important prerequisite for adopting such a proactive role.
Sequentially, Egedal put a lot of effort into the assessment of the level of energy performance to be required in Stenløse syd and worked with assessment methodologies at different scales. On the territorial and urban scale, the intention has been that the development project should address specific environmental issues of the local area. On the building scale, the intention has been that the project is both ambitious and realistic in terms of promoting energy efficient technologies and solutions. For this reason, the municipality aimed at finding a viable level of energy efficiency requirements based on the idea of implementing already available energy efficient technologies that developers and contractors would find acceptable.
The promotion of energy efficient buildings is based on the implementation of local minimum energy requirements that are tightened compared to the national requirements regarding energy performance of buildings. This is in line with the approach determined by the European Commission, and transposed to Danish building regulation. The actual level of energy performance required by the municipality was assessed by considering the economic implications of different levels of energy performance.
The municipality of Egedal set up so-called “functional requirements” on the basis of a theoretical calculation of the energy performance of buildings. This approach is also applied in the Danish Building Regulation. The functional requirements

mean that the requirement is to comply with a specific outcome, whereas the methods used for doing this are optional. This means that developers and contractors can combine a number of different technologies and initiatives in order to comply with the required energy class. This represents a way to promote energy efficient technologies, in relation to the building construction itself, without locking in on a specific technology. The energy requirements were, to some extent, imposed by the EU CONCERTO programme, since specific types of technologies were required, in accordance with the call of the EU CONCERTO programme.

One of the main challenges in terms of motivating relevant stakeholders to get involved in the project relates to the economy, since the building lots in Stenløse syd were seemingly less attractive for developers compared to other building lots in the region. The reasoning of the municipality had been that investment in an energy efficient building project is viable if seen in a whole life costing perspective.

By making the savings over time in the usage phase more visible, the technical administration of the municipality showed that the low energy buildings in Stenløse syd actually had a competitive advantage in a whole life costing perspective.

In a nutshell:
Making the savings over the usage phase time from low energy buildings more visible means buildings with low running costs have a competitive advantage - an argument for attracting investors!

L As in Egedal, municipalities should calculate, emphasise and present whole life costs of low energy buildings as a potential competitive advantage for attracting investors in such projects.

6.7.5. Zero Carbon Growth in Milton Keynes (UK)

Milton Keynes has been identified as one of the UK's main potential growth centres with the population potentially doubling within the next 30 years. Designated in the 1960s as a planned new town, it is located close to London. Key structuring principles of the Master Plan have defined the character of the city. Of particular note is the unique 'grid' pattern of main roads – intersecting at approximately 1 km intervals – serving dispersed land uses throughout the City. The dispersal of homes and jobs allowed for an even distribution of traffic and the road system was designed to avoid the rush-hour congestion associated with towns with a radial road system, not necessarily for sustainable transport. However, Milton Keynes Council also has a reputation in the UK as an energy pioneer, with a consistent record in supporting low-carbon homes, from pioneering sustainable homes in the 1970s followed by large scale CHP and food waste bio-digestion plants today.

The Council recognises the many benefits of energy conservation and carbon management and taking part in CONCERTO was part of its commitment to continually improve energy efficiency in the municipal area, with the ultimate goal of ensuring the comfort and well-being of its people.

Milton Keynes Council- Relevant Policies: Milton Keynes's plan is its aim to achieve zero carbon growth: the city must expand without significantly increasing its CO_2 emissions. The 'Local Plan' established a carbon offset fund into which new developments pay a premium according to the predicted amount of CO_2 emissions. This scheme is part of Milton Keynes' Policy D4, which forms part of the 'Local Plan' adopted of 2005.

The fund is used for mitigation measures in older developments. Where developers cannot meet on site the sustainability criteria set out in planning policy, allowing them to pay into a carbon neutrality fund instead provides a cost effective, simple alternative. This solution helps ensure the policy's overall goals are still met and development is not restricted. A not–for-profit company (United Sustainable Energy Agency) administers the fund to ensure that it delivers carbon savings at least equal to the new developments in the borough. At present, the fund is buoyant and has allowed homeowners in the city to obtain discounted insulation and other energy saving measures. So far the fund has insulated over 5 000 MK homes. Having funded significant improvements to the fabric energy efficiency of existing housing, emphasis is now moving onto upgrades of domestic heating systems. The fund is providing clear benefits for city residents and encouraging the development of the local green economy.

First and foremost, new developments are expected to be carbon neutral. If this standard cannot be met, money has to be paid into a central carbon neutrality fund, which allows a very cost effective and simple alternative option for developers where carbon neutrality is difficult to achieve on site.

In the meantime, a number of authorities (e.g. Ashford Borough Council) have introduced similar financial payment mechanisms. These municipalities hence aim for "zero carbon homes" much sooner than the UK requirements of reaching this standard for all new homes in 2016, and Near Zero Energy Buildings requirements of the EU set for 2018/2020.

There are similarities in this scheme to the principle of "ecological compensation measures" in Germany, where environmental impacts have to be compensated for by measures improving ecology on and around the building, making up for loss of land, or – if this is not possible – by making payments into schemes enhancing ecological diversity remote from the site in so-called "compensation sites". This suggests that there may be scope for CO_2-compensation schemes outside the UK, too.

L As in Milton Keynes, municipalities should consider setting CO_2-neutrality as a target for new buildings, and also consider local CO_2-offsetting funds as a cost effective alternative. This should then be used for local CO_2 saving measures.

6.8. Summary & Recommendations

In summary, in sustainable energy projects at neighbourhood scale, such as CONCERTO, a combination of different planning tools has to be employed. Experience shows that defining the frameworks, the tasks and responsibilities well for all parties involved is crucial for these projects. So are firmly and universally-agreed energy targets. Additionally, intensive links and interactions between different levels of planning, local and regional as well as energy specific planning, are conducive to project success. So is the participation in networks to share best practice experiences.

- L Municipalities should employ energy officers with a remit for coordinating energy demand, energy efficiency, local energy production and the energy system for the whole geographic area of the municipality, working closely with planning departments.
- L When devising a masterplan for new urban extensions or regeneration areas, it should respond to the municipality's energy strategy, set energy targets and ensure that these are adhered to by all planning applications and consequent construction activities.
- L Municipal planning departments should explore in how far sustainability assessment systems can help them as tools for setting targets for energy and other sustainability issues, communicating these to stakeholders and following targets through.
- L Municipal planning departments should use all instruments available to them to push energy performance standards, and learn from international best practice in order to push national boundaries of these tools.
- L Cities should set up sustainable energy action plans that include at least the following aspects: energy sustainability indicators, energy efficiency or other goals including a time horizon to reach the goal, future energy consumption, energy efficiency potential, potential to produce energy from local renewables, energy system and storage capacities including local stakeholder in the development process.
- L In order to corral support for energy transitions, multi-level support networks at regional level should be sought out to link stakeholders at different administrative and political levels (association of municipalities, the region, the federal state). Informal networks also have to be put in place by the planning authority.
- L As in Egedal, municipalities should calculate, emphasise and present whole life costs of low-energy buildings as a potential competitive advantage for attracting investors in such projects.
- L As in Milton Keynes, municipalities should consider setting CO_2-neutrality as a target for new buildings, and also consider local CO_2-offsetting funds as cost effective alternative. This should then be used for local CO_2 saving measures.

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7. The Social Dimension of Local Sustainable Energy Measures

7.1. Introduction

The social issues considered here are measures and developments in the context of CONCERTO projects that can be solely or partly traced back to social processes and/or configurations that directly or indirectly influence project outcomes. These include economic and environmental matters, in so far as the decisive mechanisms to increase energy efficiency (EE) and/or the use of renewables are based on social coordination among involved parties.

In general, social measures can aim at different social units (individuals, households, buildings, neighbourhoods, cities) and their relation towards each other or towards objects (e.g. acceptance of technologies, communication between stakeholders). They can address the introduction, consolidation, strengthening or refinement of processes, functions or configurations that are considered positive. They can also aim at the reduction of those considered negative.
On the one hand, the focus, within CONCERTO projects, is on mechanisms of decision making, behavioural changes, and relations between players and/or communication processes. On the other hand, systematic training, often for large numbers of stakeholders involved along the construction process, is a key feature of these projects. Quality control is seen as part of the latter, with a strong human component.

The collection of social data highly depends on the concrete context at a specific point of time. Target groups, national and local context, temporal and social configurations, current public debate and situational dynamics vary greatly and need to be taken into consideration if measures are to be transferred to other projects. The following Chapter identifies general social issues, relevant within CONCERTO projects, to highlight aspects and factors to be considered within future project contexts.

7.2. EU Policy Context

There are many references in the directives considered here regarding the need for awareness measures and training measures.
The EPBD 2 (2010/31/EC) emphasises the necessity of energy-related awareness measures such as smart meters or energy labelling, the building of a skilled labour force and the consistency of certification processes among the European Union by independent accredited experts. Thereby the consensus already found in the Renewable Energy Directive (2009/29/EC) from 2009 is continued.
The recent Energy Efficiency Directive (2012/27/EE) concretises this emphasis on training measures, steps towards the raising of awareness about energy related behaviour, labelling issues and the diffusion and roll-out of RES.
The Ecodesign Directive 2009/125/EC has the aim of reducing the environmental impact of products, including the energy consumption throughout their entire life cycle. It establishes a framework for the setting of eco-design requirements and a labelling system to raise the awareness of the consumers` influence on purchasing decisions. First and foremost, these concern household appliances and more recently lighting, which can, to some degree, seen as integral components of buildings, though more recently new categories, such as imaging equipment, have come in. Together with the Energy Performance Certificates for buildings, these labels aim to empower the consumers, which can be seen as a core element of the Directive.

7.3. The Need to Increase Awareness and Acceptance

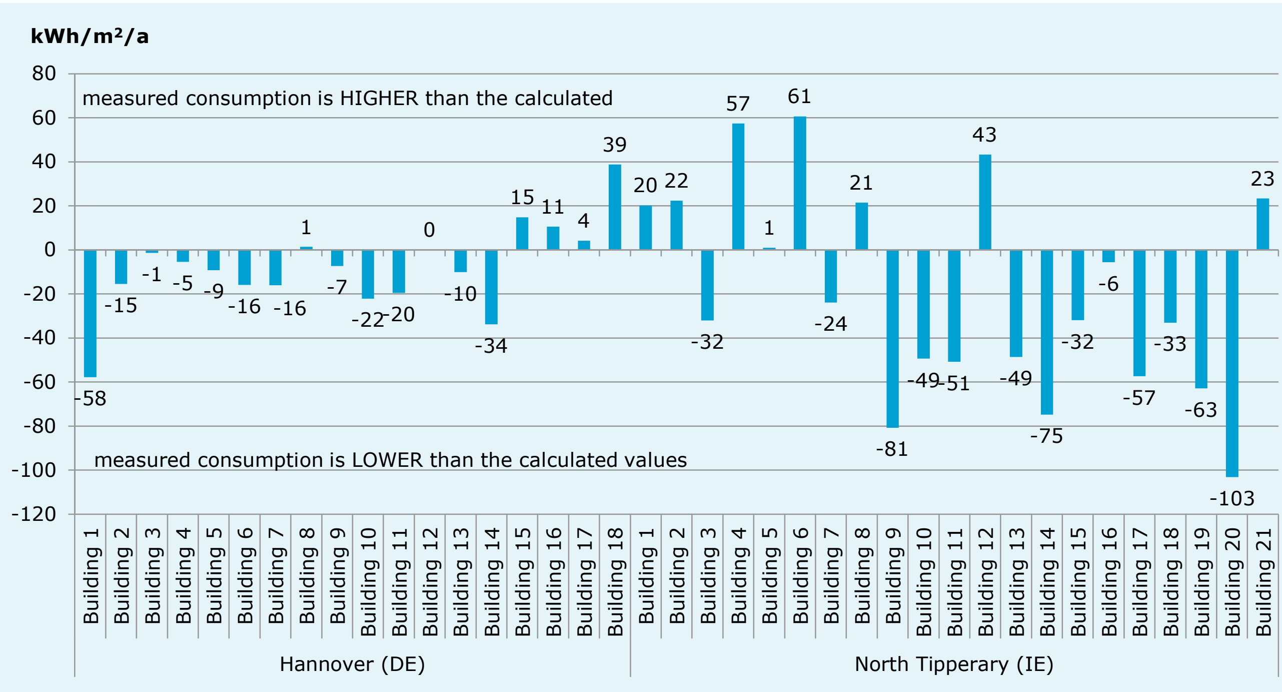
Changes in the build environment often pre-structure people's everyday life but the knowledge and awareness about energy-related behaviour is the important second half of the equation in order to avoid rebound effects (see also Section 3.5.3; Definition see Glossary) and realise efficiency potentials.

The difference between technically feasible and actual realised savings or efficiency gains often originates from insufficient changes in user behaviour. Depending on whether this is due to a lack of acceptance or insufficient information, different measures are required to remedy the situation. Conducting surveys, e.g. post occupancy survey, can be used as a way to provide and receive information about realised measures, their performance, further training needs and also to indirectly raise awareness.

In particular the issue of addressing energy inefficient existing buildings, as set out in Chapter 3 hinges on energy awareness and the necessary construction skills to implement improvements. Figure 7.1 shows differences found in CONCERTO between calculated and actual energy consumption across a number of exemplary buildings in Hannover and North Tipperary. The calculated values are estimates concerning the effect of energy efficiency measures. The deviations from the measured values (blue bars) can go either way and while this can also be due to inadequate calculation methodologies or unclear system boundaries, it is clear that variations in the awareness of residents can explain part of it.

A key point on awareness measures, which also applies to organisational matters mentioned in the following, is that they need to be part of a long-term plan with a reasonable level of continuity.

Figure 7.1: **Difference between Calculated & Measured Energy Consumption (kWh/m²/a)**



7.3.1. Raising the Awareness for Energy Efficiency Measures

To keep the gap between theoretical and actual energy efficiency potentials as small as possible, sufficient information for stakeholders is crucial. Thereby information should be provided in a target group adequate format. The accessibility of information needs to be as easy as possible. The amount of information should be graded, allowing short overviews as well as detailed insights. Too little information for interested players can be as problematic as an information overload for an incurious audience. Personalised information and direct face-to-face interactions can be seen as a promising route, as proven by activities in a number of CONCERTO projects. Besides this emphasis on direct, personal doorstep contacts, local events and announcements in the local press and a homepage with Sections directed at different target groups were used to raise awareness among the population.

One of many prominent examples of awareness activities within CONCERTO is the big event in Almere (NL), which was organised for the inauguration of the solar island. The opening was broadcast on several TV shows. Others include open days on building sites, fairs, public lectures, children's activities and short films distributed via the internet – e.g. Weilerbach's energy version of the tale of three little pigs (http://vimeo.com/17464098)

Conducting surveys, e.g. post occupancy surveys, can also be used as a way to provide and receive information about realised measures and thereby indirectly raise awareness.

L Technical measures should always be combined with awareness and acceptance measures to avoid suboptimal realisation of energy efficiency potentials and rebound effects.

L In order to avoid indiscriminate and hence largely ineffective information campaigns, an effort should be made to identify "windows of opportunity", i.e. target groups and time slots that have a realistic potential for starting an energy project. Awareness measures should be tailored and targeted at a specific audience to avoid information overflow.

L Whenever possible, awareness measures should entail face-to-face interactions, as these are more effective than "cold mailing"


Image 7.1: **Faruhaz-Building in Óbuda, Budapest (HU)**

Decisions and Habits

Related to awareness is the basic distinction between informed decisions and habits. Most investment decisions are informed decisions. The decision maker actively gathers information and balances the available information and sources against each other. To promote energy efficiency measures, the knowledge about possible options among decision makers is the prerequisite for such an active, directed information search. In contrast to this, many everyday decisions are based on habit; they follow routines and are mostly unconscious. Depending on the kind of behavioural change required, information measures using different information formats and media can be effective. Changing (continuous) everyday routines is more difficult and protracted than changing conscious (often singular) decisions regarding investments in physical, energy efficiency measures. Timing, format and content can differ significantly depending on the kind of effect an awareness measure is aiming at.

Visibility

One basic precondition to ensure awareness is a certain amount of visibility of the changes made. Even if information about realised efficiency measures reaches the audience, there is a need to connect this knowledge with concrete situations in order to trigger behavioural changes or investments. Besides the reminder effect of visibility, the possibility to gain social valuation by being able to show outward signs of changes can be a motivational driver of behavioural changes or investments – both to ensure valuation or to avoid social sanctions. A major problem of energy efficiency measures is the fact that changes in terms of energy are mostly invisible and therefore abstract. In Óbuda (HU), a huge, prominent housing block, with almost 900 dwellings near a busy road, was chosen for retrofitting measures. The actual construction progress was monitored by a live webcam. Both the dominant position of the building and the emphasis on visibility via the web cam ensured the visibility of the changes made. Technological solutions that are particularly visible include photovoltaic or wind turbines. Such settings and devices can have direct awareness effects but can also be starting points for public debate. This is why high visibility, real-life best practice showcases are so important – see also Section 7.3.2.

In a nutshell:
The lower the visibility, the higher the need for other awareness measures.

N L Results from measures implemented should be directly visible and recognised by the local public to motivate follow-on projects.

Energy Labels Energy Performance Certificates (EPCs)

One way to ensure awareness and visibility of energy efficiency in the context of product purchasing decisions is the communication via energy labels for appliances and Energy Performance Certificates for buildings, which have come in under the Ecodesign Directive and the EPBD respectively. Generally speaking, these allow for abstract and often complex issues to be simplified providing straight forward information and imply recommendations to act on. For labels and certificates, the awareness about their existence and trust in the validity of their content are fundamental. They can be an appropriate way to raise awareness in the case of purchasing or renting decisions. The EU energy label for appliances and the corresponding Ecodesign Directive, which puts greater emphasis on lifetime energy use and other environmental aspects during the conception and design phases, is a success story. These labels are now known and recognised by most European consumers. In the appliance sector, the labels led to rising standards and an expanding range of products to be included. Starting initially with just a small number of household appliances (fridges and washing machines), labelling requirements now encompass items as diverse as light bulbs and cars.

Energy Performance Certificates were part of the first EPBD in 2002. They are known under various terms, such as „energy labels“ or „energy ratings“ for buildings, but the term “Energy Performance Certificate” is the most general one at EU level and refers to all types of certificates, independent of methodology used, building type, and whether they are for a new or existing building. Different countries use different rating methodologies, which may be based on calculated or measured energy consumption. Questions regarding the reliability and meaningfulness of these methodologies surface occasionally. However, they are, in so far a particularly important outcome of recent energy legislation, that they are visible and hence have the potential to affect the wider public as part of documentation for property sales or lettings or when displayed within public buildings. Apart from providing consumer information and raising awareness, Energy Performance Certificates can be used in a useful strategic role, if used as intended by the EPBD:

- They can play a role in analysing the status quo of a single building or a building portfolio (e.g. an average rating of “D” or “yellow” across the portfolio).
- They can help with target definition for retrofitting or management changes – e.g. all buildings in “red” must be brought up to at least “yellow” or all buildings should be at least “C”.
- They can be used for measuring and communicating success – by re-rating the building afterwards. The tenant then receives a document as a visible and tangible sign, which shows their dwelling is now better than before.

As mentioned in Section 2.5, as part of the EPBD, the European Union wants to develop a voluntary common certification scheme for the energy performance of non-residential buildings. As a first step, a tender for a market study has recently been awarded, with results expected in 2014.

While especially the newly-built CONCERTO buildings had Energy Performance Certificates, they did not appear to play a prominent role either in a strategic sense or in awareness campaigns. The exception to this is the Irish projects in North Tipperary and Dundalk. Visiting these, there is a sense that EPCs have truly entered the common knowledge of construction professionals and building users. The images below show two examples – firstly, a rating profile for refurbished buildings in North Tipperary, showing the distribution of ratings before (orange) and after (green) as well as the Irish average. Previously, in the SERVE region, most houses had a building energy rating between C1 and G. The Building Energy Rating (BER) is the Irish Energy Performance Certificate and covers annual energy use for space heating, water heating, ventilation and lighting, calculated on the basis of standard occupancy. The Irish label has a scale of A-G. A-rated homes are the most energy efficient and G the least efficient.

Secondly, Figure 7.3 shows an example of an unrelated Irish project in Ballynagran that is aiming to become a rural zero carbon district, which based its strategy on EPC assessments.

Figure 7.2: **Example of using EPCs to Measure Energy Performance Improvements**

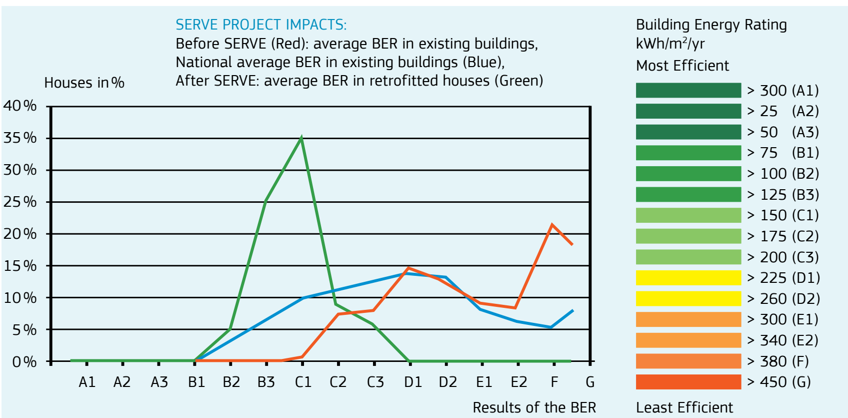
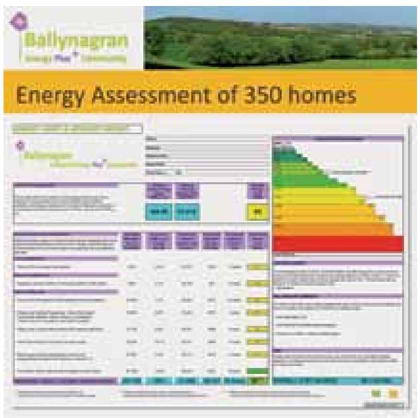


Figure 7.3: **Strategic use of EPCs in Ballynagran (IE)**



EPCs and Property Value

A good way of drawing people’s attention to energy is via the value of their home, as money tends to attract people’s attention. The study “Energy Performance Certificates in buildings and their impact on transaction prices and rents in selected EU countries” found that property transactions and listings from residential property markets (both sales and lettings) in Austria, Belgium, France, Ireland and the UK showed overwhelmingly that energy efficiency is being rewarded, although there are some regional anomalies.

More specifically in Austria, the property market in Vienna and the surrounding region showed an 8 % value increase in the sales market and 4.4 % in the lettings market for an energy efficiency improvement of one rating step or one "letter". Generally, the estimated rental premium for energy efficiency was found to be lower than the estimated premium on sales price. This suggests that owners reap a benefit that is additional to the ongoing monthly benefits, i.e. reduced energy bills, which fall to all occupiers, whether owners or tenants, but also reinforces the split-incentive dilemma discussed in Section 3.5.
However, the study also found that there appeared to be some public confusion regarding various points in EPCs, such as whether they represent actual consumption (something they can relate to, as it appears in bills) or not and what the benefits of the improvement recommendations would be. It has been suggested that they have often been designed more with an energy expert in mind rather than the tenant or buyer. The study detected an information gap, preventing people from making decisions that fully express their actual preferences for lower energy bills or better energy performance. Due to a lack of visibility of the EPC at the point of decision making, lack of understanding of the information contained and a lack of trust in that information, EPCs have so far only partially been able to fill this gap. On the other hand this implies that if EPCs are used as intended and are visible, they have the potential to support more energy-conscious decision making. They can also play a role in bringing about the local economic effects discussed in Chapter 5.3.

L Promote the voluntary use of Energy Performance Certificates, which should be reissued regularly to show improvements.

N Information that appeals to end users should be included in Energy Performance Certificates, for example, actual consumption be on the certificate in some way, rather than calculating it or normalising it. This could initially be added as voluntary additional information.

Smart Meters and Displays

An active way to raise awareness in everyday day life can be direct feedback on energy consumption using smart meters and other monitoring devices. The more direct and immediate the feedback information is, the better it can be matched to certain actions or behaviour. A critical issue here is data privacy – by whom, when and for what reason can data be accessed. The possibilities to meter and evaluate energy consumption in short time intervals to provide user feedback were used in several CONCERTO sites e.g. in Dundalk (IR) or Växjö (SE) and many others.

Image 7.2 : **Large Real Time Energy Display in Grenoble (FR)**

Image 7.3: **Real Time Energy Display within all CONCERTO-Flats in Växjö (SE)**

In a nutshell:
Sufficient user awareness is an essential part of energy efficiency measures to avoid gaps between theoretical and achieved potentials.

7.3.2. Options for Increasing Acceptance for Smarter Energy

When there is a lack of acceptance amongst groups directly affected by a measure, emphasis must lie on convincing these players by exploring the reasons for their opposition and removing, or at least reducing, the controversial matter where possible. Participatory measures can be an option towards creating acceptance if the implementation process allows it. In this case, the balance between the time and resource needs of such a process and possible improvements must be considered. The effect of introducing participatory measures on the acceptance of changes decreases relative to the advancement of the implementation of the measure (for more details see Section 7.5).

Image and Information

Missing acceptance of energy efficiency measures can come from incorrect information about measures, technologies or possible effects, as reported by many CONCERTO projects. The image of a measure within a given local context can vary depending on, for example, existing experiences with the measure nearby and local stakeholder configurations (including those with conflicting interests). Furthermore, type and content of media coverage about the topic in question plays a role as well as what existing or potential alternatives there are to the proposed measure. For energy efficiency and renewable energy measures, often their image is affected by prevailing notions that these are too expensive, ineffective, unnecessary or even damaging to health and/or environment (insulated buildings grow mould, wind turbines kill birds). Hence the prevailing image of a measure within relevant stakeholder groups has to be explored and an endeavour has to be made to shape it, also by providing information and clarification on uncertain issues, if these exist. The CONCERTO project, GEOCOM, for example, assessed and evaluated the public perception and understanding of the technological measure in question – in this case geothermal energy. Within other CONCERTO projects, there are similar attempts to monitor and shape user opinions in favour of energy efficiency and renewable-based technologies (e.g. in Neckarsulm (DE), Neuchâtel (AT), North Tipperary (IR), Kortrijk (BE), Växjö (SE) Milton Keynes (UK)).

"Quote: – it is crucial to present the right information, and that it is being presented by the right people, info needs to be reinforced from multiple angles: from the contractors, by public relations, the municipality, a clear and consistent message – Our project created its own norm for getting the message across. " (CONCERTO in North Tipperary)

In a nutshell:
It is not enough that users know about energy efficiency measures. Users need to actively accept the changes to be motivated and to uphold behaviour changes in the long-term.

The existence of everyday experiences with new technological or social solutions within the circle of acquaintances is often an important source of acceptance. Local pioneers for specific measures are therefore an important target group to create real life examples and increase the acceptance by reducing the impact of myths, fears and misinformation.

- EU N L The potential of real world examples should be recognised and exploited – they can create acceptance by proving feasibility and value and to reduce fears and negative myths.
- EU N L Information standards should be defined in order to ensure correct information is given at the right time, at all times.
- EU N L Support of pioneers and early adaptors for new forms of energy production or utilisation should be provided in order to accelerate its diffusion.

People's Perception of Cost

Another acceptance aspect is the difference between advantages at point of the initial investment (e.g. low up-front costs) and future benefits (e.g. continuous saving of running costs). Direct low costs usually weigh higher compared to lower operating costs. In economics, this phenomenon is referred to as 'time preference' or 'discounting'. Direct investment costs are one single current payment whereas benefits from lower operation costs come over time, in relatively small amounts, if compared with the investment sum. The reduction of such a single payment is now gradually becoming more acceptable than uncertain future bills. As in the building context, the costs involved for energy efficiency are high. This aspect was found to be the single biggest barrier for energy efficiency measures within CONCERTO projects. Running costs can be adapted more easily to changes in the social setting (birth, death and change in relationship) and corresponding needs (household size, devices, services…). This leads to an overestimation of (direct) costs for energy efficiency measures compared to running costs. In economics, this phenomenon is referred to as 'risk aversion'. In order to bridge this misperception of costs effectively, financial instruments like contracting that can shift people's perception away from capital on to running cost. (See also Section 5.6).

In a nutshell:
People often value short-term gains higher than long-term benefits.

Finding an Umbrella Topic

There are many reasons why people are simply not interested enough in their energy use and resulting emissions. The issues surrounding the perception of cost, as set out above, being one of them. To galvanise support for energy projects, connections may have to be made to topics that are higher on the agenda of the target group. This may mean increasing emphasis on comfort or health benefits – for example, better indoor air quality, reduction of draughts etc. Alternatively, it could be a topic of economic and cultural importance to the municipality or region, such as eco-tourism.
In Tudela, clean, sustainable energy was seen as an important part of being a 'clean, unpolluted' region, which is important to their reputation in producing high quality agricultural produce, as expressed by the label "Agrifood City of Tudela".

EU N L Energy efficiency should be tagged onto other topics that people can relate to.

7.4. Energy Efficiency Measures Need Training

New technologies and changes in settings or processes that help to realise resource savings and ensure quality standards, often require more and new skills of planners, those on site, the operating and maintenance staff and end users. The identification of concerned stakeholders for innovative new approaches and the development and proposal of training options, that are suitable and available for specific target groups, are prerequisites for the diffusion of energy efficiency and renewable energy technologies. Coordinating training options, via new or already existing organisations and networks, to spread information and skills can increase the pace and quality of local technology diffusion.

7.4.1. Training for Multipliers

The first step for spreading the knowledge about new energy efficiency measures is the training of trainers for the concerned groups. Existing training infrastructures, professional media and professional associations/networks (e.g. Chamber of Crafts) are adequate places to address those who can act as multipliers by spreading knowledge and skills amongst the relevant professional groups and thus start a diffusion process. Training measures for multipliers were realised frequently in CONCERTO projects.

Due to the involvement of the French Environment and Energy Management Agency ADEME, the experiences gained, when training those involved in CONCERTO in Grenoble (FR), fed into training courses for various stakeholders including construction professionals and clients. These courses are now commonly available.

Image 7.4: **Training Measures for Multipliers in Lyon (FR)**

Airtight construction in particular is crucial to high performance buildings, but is also an area where skills are often lacking. Following initial training sessions for site staff in Lyon (FR), it appeared that the logical step forward was to train trainers in training centres, which host several hundreds of future professionals each year, to exert a leverage effect. The 20 hour training was designed for trainers for professional groups in the building sector, to help them anticipate future thermal regulation. Led by experts specialising in energy performance, the objective was to help trainers integrate airtightness into their own training programme. This action was made possible, thanks to the partnership with the Training Institute in Building and Public Works (IFBTP Rhône-Alpes), the National Association for Training Lyon-Sud (AFPA Lyon-Sud), adult training centres, and the collaboration of the developers of one of the blocks on the Lyon project. Course contents included for example: methods to evaluate airtightness, the most frequent leakage areas in a building, the most appropriate products and materials and the importance of coordinating different professions on site.

7.4.2. Training for Construction Professionals and Maintenance Staff

The issue of lack of skills reoccurs as a barrier in sustainable energy projects. For this reason, CONCERTO projects had been specifically designed to encompass training modules. Due to the size of the projects, a large number of parties and individuals had to learn about renewable energy and energy efficiency in order to allow the projects to succeed – ranging from town planners and clients to architects and builders on site.

As well as professional training centres and associations as mentioned above, trade fairs, conferences and professional media (trade journals) are also places to address specific, professional target groups. Apart from these channels, summer schools and conferences for academics, professionals and politicians were held in CONCERTO (e.g. Óbuda (HU)). Emphasising competitive advantages and assuring easily accessible training opportunities in terms of time, costs and efforts can ensure the diffusion of professional knowledge. Once such knowledge has been gained in the context of one project, it will be carried forth into the next project, too. Ultimately, curricula for university courses for planners, architects and various engineering disciplines and courses for building trades should contain information and training on energy efficiency and renewables. Practicing professionals, also including investors, developers, estate agents and others, would have to be addressed through tailor-made events in collaboration with relevant trade associations. These could, for example, also take on the form of road shows.

An important initiative for educational measures regarding energy efficiency for builders is the EU funded qualification platform BUILD-UP-SKILLS, within the framework of the Intelligent Energy Programme. Its purpose is to support education and training for onsite construction workers, system installers in the building sector and craftsmen, in order to increase the number of skilled workers for high energy performance measures. The initiative addresses skills relating to energy efficiency and renewables in all types of buildings.

As a continuation and development of CONCERTO work, North Tipperary, in collaboration with the national government, is working with the build-up skills initiative to help up-skill the Irish construction workforce. Minimum standards for construction workers and registration processes for construction companies are being developed as currently there are none. Such a scheme would include training and certification on basic energy aspects for all relevant building trades.

In Zagorje (SL), decision makers, students, site foremen, planners and architects were trained to accelerate the diffusion of necessary new skills. In 2011, the University of Ljubljana conducted trainings on software for building physics and systems in buildings. Another training course for decision makers, planners and students on the topic of mine water solutions was conducted in Bourgas (BU).

Image 7.5: **Training Session for Local Decision Makers, Planners and Students in Bourgas (BU)**

A further, important training option is to use demonstration projects as exercise areas. The partnering projects in Växjö, Delft and Grenoble all used an approach of training up their workforce on the first few CONCERTO buildings. Learning increased from one building to the next. Energy efficiency standards were sometimes increased mid-project for those buildings that had not initially been planned to be as ambitious. Especially in Växjö, housing companies realised they could do much more to develop better buildings. They have consequently raised their construction standards. Similarly, growing knowledge and actual proof of what standards are achievable, paved the way for a new type of public tendering and negotiation process. These mean that the city and its publicly owned housing companies are left with lower risks. They also contain an incentive-based tendering approach for fulfilling energy and technological performance requirements (who can do better?). Stakeholder meetings were held to discuss how to create a spill-over effect from the demonstration activities and how to motivate companies to replicate construction techniques developed within the SESAC project, especially those relating to timber construction and passive houses.

Image 7.6: **Logo of the Build Up Skills Project**

BUILD UP SKILLS
ENERGY TRAINING FOR THE BUILT ENVIRONMENT

N Training contents and training campaigns on up-to-date energy efficiency and renewables solutions for architects, craftsmen, estate agents etc. should be developed and made widely available, e.g. also via “road shows”.

L A “practice site” should be designated on which all stakeholders involved can be trained “hands-on”. This should form part of a strategy to roll-out skills to other parts of the projects or other future projects.

7.4.3. Empowering Potential End Users

Ultimately, the decision to implement energy efficiency measures and renewable energy installations depends, to a large extent, on private households and private individuals, even if the latter may act professionally or on behalf of a group or organisation. It is private individuals and households who have to be reached. Often, end users are laymen with regard to new technologies. In contrast to multipliers and professionals, previous knowledge cannot be presumed. Information material and consultancy services need to be simple and accessible. Promoting the available services and, for interested parties, preferably personal contacts, are effective strategies. However, unfocused cold mailing should be avoided to prevent the impression of blanket advertising. The display of information in thematically related environments, in form of brochures or posters, helps to raise awareness. For first contacts, the information density should be low but the materials should open paths for more detailed information for interested passers-by. Internet portals, as set up in Lambeth (UK) and Växjö (SE), can provide information with individually adapted details. There are, however, also a number of professionals that can play a potentially powerful role in reaching these groups. Four will be explored here.

Firstly, schools can play a pivotal role in embedding energy knowledge and awareness into society, with children teaching their parents. This is why schools were often part of CONCERTO projects. Building measures applied there provide first-hand learning, which should go hand in hand with teaching contents within the curriculum. Ostfildern (DE) actively involved schools and offered further hands-on energy events for children to utilise the diffusion effect of pupils teaching their families. Numerous CONCERTO projects took this path, e.g. Trondheim (NO), Lambeth (UK), Zaragoza (ES), Ostfildern (DE). See also Section 4.4.2.

Secondly, builders visiting homes to carry out small maintenance jobs can be trained to do on the spot mini energy surveys, pointing residents towards obvious energy leaks and picking up a new business opportunity at the same time. This is an approach promoted by the UK's Federation of Master Builders in their study – "Building a Greener Britain". Builders have very specific training needs, as detailed in Section 1.3.

Thirdly, in Germany, the cheap loans for especially efficient retrofits and new-builds provided by the central government-owned bank KfW are distributed by the normal banking staff of local banks. This means that the bank clerk is the one telling people that they will be eligible for favourable loan conditions, if they commit to greater energy efficiency in their refurbishment project or renewable energy installations. In principle, this provides an excellent, nation-wide, fine-grained network of advisors in communities. However, it can also mean that clients may end up discussing technical matters relating to energy with bank clerks, who may neither have the knowledge nor the motivation to distribute correct technical information ("No, you do not want to go for the highest standard, it does not pay back. The difference in conditions is not great enough and anyway, we have never funded a project with this standard before"). Yet by clarifying their role and providing additional training as well as clear advice, at which point they should refer to other experts, such clerks could play another key role in delivering awareness.

Other similar ideas include tapping into the roles of health visitors who visit disabled and elderly people in their homes – target groups that can especially benefit from the comfort gains from energy efficiency.

N **L** Multiplier nodes such as schools, craftsmen and grant providers should be identified and training measures targeted at them.

In a nutshell:
The qualification of relevant stakeholders for energy efficiency and RES measures is essential to avoid suboptimal outcomes, foster the diffusion of measures and ensure quality.

7.4.4. Quality Control & Post Construction Checks

Regular post constructional check and quality control ensure the quality and the correct and effective implementation of energy efficiency measures and renewable energy installations. This is a crucial issue that keeps reoccurring as a reason for suboptimal energy performance in buildings. To guarantee high quality services, an independent player or institution, separate to the implementation and maintenance stakeholders, needs to be established. If possible, post constructional checks should be made not only directly after completion, but again after a certain time period (e.g. after one year). This avoids metering only the specific conditions before regular utilisation and allows conclusions on long-term effects of implemented efficiency measures.

Image 7.7: **Thermografic Images in Lourdes, Tudela (ES)**

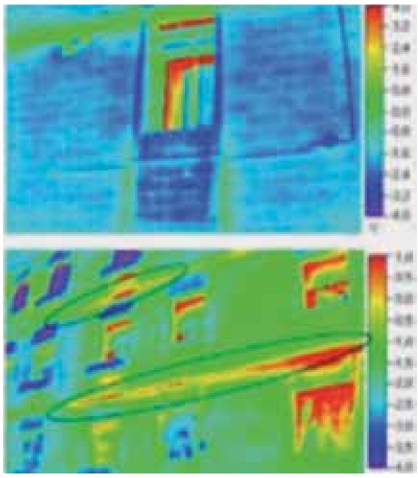


Image 7.8: **Blower Door Test Training in Lyon (FR)**

A good example is the project in Hannover (DE), which provides concrete, step-by-step guidance covering the whole retrofitting process including post constructional checks on their homepage. To assure quality standards and transfer ideas and concepts, short training sessions for involved parties are described and useful information material is provided within an easy to use toolbox. This toolbox is designed to remove barriers in tackling energy issues and consists of a set of sheets based on the experiences gained during the CONCERTO project in Hannover and Nantes.
One of the lessons learnt of the CONCERTO project is that Operation and Maintenance (O&M) of equipment is crucial to guarantee the building's final energy consumption. Its importance increases, the more energy efficient fabric and services of the building are. The building will only deliver its full potential if all building features are constantly checked and readjusted.

In Lyon (FR), it was noticed that equipment operation parameters and schedule were not properly adjusted, affecting the energy performance of the buildings. An in-depth analysis of the causes of these malfunctions shows the following[32]:

- Part of the problem came from the absence of essential information displays in equipment rooms; for example, lists of operations, set points, schematic diagrams, and the values programmed into the controls
- Another issue is the fact that the engineering consultant for the developers did not have an explicit mandate to support O&M companies during the first year of building operation. The transfer of knowledge from the equipment installation company and energy engineering consultant to those maintaining the building was insufficient, considering that O&M companies didn`t have much experience with the innovative technology that had been installed or with low energy buildings in general. These issues point towards a common confusion concerning the responsibilities of each party during the first year of operation and more precisely, a difficulty to distinguish between duties relating to completion by the construction company from ordinary maintenance born by the O&M companies.
- Building management companies often do not have the technical skills to identify problems pertaining to operation and maintenance. During the first year of building use, building management and representatives, who were elected by the general meeting of co-owners, were overloaded with basic problems that were not specific to low energy buildings. These included finishing off certain tasks, heating regulation, overheating in summer, water leaks, etc., this may explain the lack of vigilance concerning failures and malfunctions of the solar thermal and photovoltaic equipment and necessary filter changes in heat recovery ventilation equipment.

EU N

Dedicated quality control regimes for energy efficiency and renewable energy features should be specified

7.5. Participation Measures Increase the Impact of Projects

The early involvement of tenants, neighbours and other concerned stakeholder groups in planning, implementation, adaptation and monitoring processes increases the awareness and acceptance of energy efficiency measures. Besides financial participation opportunities as mentioned in Section 5.7, there are a number of measures for participation.
The integration of local groups (grass root) in urban development tasks can foster the local diffusion of measures. Existing

networks and structures, such as the transition town initiatives or a regional energy association such as ERWG (Energy Region Weiz-Gleisdorf) at the CONCERTO site in Weiz-Gleisdorf (AT), can be suitable partners for projects if they engage in similar energy-related topics. In such cases, the compatibility of goals and possible political implications of such cooperation need to be kept in mind.

Principal questions for participation measures are the adequate addressing of the stakeholder groups targeted, timing of participatory steps, objectives of their participation, extent and degree of freedom for changes on a planned measure and the degree of obligation for owners to implement proposed changes. Furthermore, it matters whether the participatory process relates to new buildings, the refurbishment of buildings or to the implementation of technologies using renewable energy sources.

Early involvement of those affected can increase the acceptance of measures whereas late involvement can cause even negative effects. Of great importance is the degree to which a project can be altered, which naturally decreases, the more the project advances. A further argument for early involvement is the time available for participatory activities, as they need to be incorporated in the overall project time table.

In general, the objective of participation needs to be set with regard to the interests of other stakeholders who are involved and in relation to the core goals of a project. The choice of an open discussion format is only reasonable if a project design is flexible enough to adequately react to possible outcomes of such a participation process. The choice of the kind of participation options depends on the effect a project is aiming at. To foster creative and locally embedded solutions, open formats can be more suitable. The danger here is the onset of frustration, if ideas, for whatever reason, cannot be realised. In case possible variants are already determined, participatory measures should be directed to define the design of given alternatives more closely. Offering a choice of predefined alternatives reduces freedom in exchange of more reliable outcomes. Within participatory processes, the possibilities and resources of stakeholders need to be taken into account when balancing the right to have a say in a matter. Egalitarian, basic democratic rules are only suitable if the potential to change things is distributed rather equally among the participating stakeholders. These potentials and resources submitted to a process need to be taken into account to avoid alienating stakeholders.

On the whole, an important aspect is the transparency of a process and decision making for all concerned parties. Participation is only possible if goals and the ways to achieve them are communicated clearly. Decision processes and decision makers, as well as possible ways to influence them, should be obvious and accessible to relevant parties

Participation measures at planning stages was part of many, but not all CONCERTO projects, for example in Birštonas (LT), Falkenberg (SE), Helsingør (DK), Kortrijk (BE), Mórahalom (HU) and Nantes (FR)

In a nutshell:
Participation increases the motivation of stakeholders and is a desirable goal in democratic societies. Participation is a sensitive process and needs to be handled early and with care for the needs and capacities of those involved.

L Participation and involvement of local stakeholders should start early in the project to foster local integration and acceptance. However, they need to accompany the project throughout its entire duration.

L For participation processes, remits and limits and goals should be clearly defined and kept transparent. This will ensure purposeful outcomes and avoid conflicts, frustration and potentially a feeling of not being taken seriously amongst stakeholders.

L For participation measures, existing networks such as ‘transition towns’ groups should be tapped into.

7.6. The Role of Stakeholder Networks, Memberships and International Initiatives

Communication, exchange and collaboration can take place at two levels:

- Between the various different stakeholders within a given project, which could be a local, national or EU project
- Outside the project, between stakeholders, who may have similar roles and responsibilities. Both aspects are important and can be strengthened by formal platforms and networks.

7.6.1. Organising Stakeholders: Balancing Interests, Acting Together

The introduction of new (technical, social and financial) measures can imply the emergence of new and the redefinition of existing stakeholder roles. Good solutions for one group of stakeholders can imply disadvantages for other relevant groups. This emphasises the need for communication within and between stakeholder groups, to negotiate and organise competences and responsibilities, to share and combine experiences and capabilities, to balance interests and to synchronise reactions to external events. To structure and canalise such necessary communication, the organisation of purpose specific networks is important. Coordination is important but difficult. The responsible parties need to have an authority recognised by all stakeholders involved to balance the diverging interests and given time frames. For this task, an external, non-local party is preferable as they are not involved in local interests and configurations. On the other hand, the coordination requires solid knowledge on the competences and possibilities of the involved stakeholders. Players that are part of the local structures mostly have better insights into the relevant opportunities and limitations. Often such networks are project-based and hence do not continue beyond the duration of a project. Ideally, they should therefore be tied into a broader, local agenda or organisation, to ensure continuity of relationships and ideas.

Take, for example, the RENAISSANCE project in Lyon; a stakeholder platform was established on the municipality web page for CONCERTO and also in the context of the Smart City initiative.

In the partnering communities of Växjö (SE), Delft (NL) or Grenoble (FR) (SESAC project), stakeholder meetings were organised which involved members of the local service sector (e.g. builders, architects, housing companies, etc.). These meetings were used to discuss how the results reached in the demonstration activities could be used in the day-to-day work of these stakeholders.

A variation of tying a number of stakeholders together more tightly, in order to allow them to speak with one voice, is to set up a development company. These can be set up as vehicles for the delivery of a construction project. They can purchase land or buildings and construct or refurbish buildings on it. Sometimes such a company is temporary and it bundles and coordinates the interests of the various parties into one entity. This was, for example, the case with the company "Far West" in Amsterdam. In the context of CONCERTO projects, the use of development companies has proven as an advantageous vehicle to coordinate the efforts to realise energy efficiency and/or RES measures and in France, it has proven beneficial with regard to competition rules requirements.

EU N L Existing networks should be tapped into or new local (and national) platforms should be set up in order to bring stakeholders together and make them communicate with each other, to identify synergies and avoid misunderstandings and conflicts.

EU N L Project-based networks and platforms should be tied into a broader local agenda or organisation, to ensure continuity of relationships and ideas.

7.6.2. Being Part of an International Community

Memberships within international initiatives and participation in their activities and events can ensure access to up-to-date solutions and best practice examples. These often ask for certain commitments of their members (e.g. of municipalities, giving weight to the targets set). They can also provide motivation and support when an individual (e.g. an environment officer) is facing difficult negotiations and opposition within the municipality or other organisation. They have the advantage of a longer term remit, in contrast to the local platforms mentioned previously.

A very successful example for stakeholder networking is the Covenant of Mayors, initiated by the European Commission, aiming at boosting energy efficiency and the use of renewable energy sources on a local level.

The Covenant of Mayors is a European movement involving local and regional authorities. These voluntarily commit themselves to increasing energy efficiency and use of renewable energy sources on their territories, thus gradually mainstreaming these. By their commitment, Covenant signatories aim to meet and exceed the European Union (EU) 20% CO_2 reduction objective by 2020. The promotion of an innovative district development is part of this project especially concentrating on energy efficiency and the ratio of renewable energy. In order to facilitate the emergence of green district and to strive in the long run, towards Post-Carbon Cities, they offer information and tools.

Image 7.9: **Covenant of Mayors**

Further examples for interesting networks are:

- ICLEI:
  Local Governments for Sustainability, founded in 1990 as the International Council for Local Environmental Initiatives, is an international association of local governments and national and regional local government organisations that have made a commitment to sustainable development.
- SCI-Network:
  The Network for Sustainable Construction and Innovation through Procurement is a growing European network of public authorities working together to: Find new, sustainable construction solutions, and encourage innovation in construction procurement
- Climate Alliance:
  "Climate Alliance of European Cities with Indigenous Rainforest Peoples" is the European network of local authorities committed to the protection of the world's climate. The member cities and municipalities aim to reduce greenhouse gas emissions at their source.
- European Energy Award:
  The European Energy Award is a programme for planning and realising energy and climate protection policy goals and measures in municipalities.
- Smart Cities Stakeholder Platform:

Image 7.10: **Smart Cities Logo**

The Smart Cities Stakeholder Platform (http://eu-smartcities.eu/) was initiated by the European Commission with the dual aim of 1) identifying and spreading relevant information on technology solutions and needs required by practitioners and 2) providing information for policy support to the High Level Group and the European Commission. It is both a web-based and physical Platform open to anyone who registers on it. Backbone is the contributions by stakeholders in a bottom-up way.

In a nutshell:
The coordination of stakeholders creates synergies, enables target-oriented joint action and opens new possibilities.

L

Municipalities are encouraged to join existing international and other municipality networks such as the Covenant of Mayors, Smart Cities Stakeholder Platform, European Innovation Partnership, ICLEI, and Climate Alliance should be tapped into in order to make municipalities communicate with each other and exchange best practice.

7.7. Summary & Recommendations

In summary, the role of social processes in the context of the introduction of technical or organisational measures, as they were realised in CONCERTO, have been analysed. Raising awareness and acceptance e.g. by consistent application of Energy Performance Certificates, have been identified as social success factors. So has the effective diffusion of knowledge via training measures, assurance of quality, creation and support of opportunities for involvement of concerned stakeholders as well as the use of networks for spreading innovative approaches and organising the relation between stakeholders. The necessity and advantages of involving affected individuals and/or groups when undertaking changes to their local environment have been highlighted in particular.

- L — Technical measures should always be combined with awareness and acceptance measures to avoid suboptimal realisation of energy efficiency potentials and rebound effects.
- L — In order to avoid indiscriminate and hence largely ineffective information campaigns, an effort has to be made to identify "windows of opportunity", i.e. target groups and time slots that have a realistic potential for starting an energy project. Awareness measures should be tailored and targeted at a specific audience to avoid information overflow.
- L — Whenever possible, awareness measures should entail face-to-face interactions, as these are more effective than "cold mailing".
- N L — Results from measures implemented should be directly visible and recognised by the local public to motivate follow-on projects.
- L — Promote the voluntary use of Energy Performance Certificates, which should be reissued regularly to show improvements.
- N — Information that appeals to end users should be included in Energy Performance Certificates; for example, actual consumption on the certificate in some way, rather than calculating it or normalising it. This could initially be added as voluntary additional information.
- EU N L — The potential of real world examples should be recognised and exploited – they can create acceptance by proving feasibility and value and to reduce fears and negative myths.
- EU N L — Information standards should be defined in order to ensure correct information is given at the right time, at all times.
- EU N L — Energy efficiency should be tagged onto other topics that people can relate to.
- N — Training contents and training campaigns on up-to-date energy efficiency and renewables solutions for architects, craftsmen, estate agents etc. should be developed and made widely available, e.g. also via road shows.
- L — Pilot sites for practice should be designated on which all stakeholders involved can be trained "hands-on". These should form part of a strategy to roll out skills to other parts of the projects or other future projects.
- L N — Multiplier nodes such as schools, craftsmen and grant providers should be identified and training measures should be targeted at them.
- N L — Dedicated quality control regimes for energy efficiency and renewable energy features should be specified.
- L — Participation and involvement of local stakeholders should start early in the project to foster local integration and acceptance. However, they need to accompany the project throughout its entire duration.
- L — For participation processes, remits and limits and goals should be clearly defined and kept transparent. This will ensure purposeful outcomes and avoid conflicts, frustration and potentially a feeling of not being taken seriously amongst stakeholders.
- L — For participation measures, related existing networks such as 'transition towns' should be tapped into.
- EU N L — Existing networks should be tapped into or new local platforms should be set up in order to bring stakeholders together and make them communicate with each other, to identify synergies and avoid misunderstandings and conflicts within projects.
- L — Municipalities are encouraged to join existing international and other municipality networks such as the Covenant of Mayors, Smart Cities Stakeholder platform, European Innovation Partnership, ICLEI, and Climate Alliance should be tapped into in order to make municipalities communicate with each other and exchange best practice.

7.8. Sources & Further Information

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8. Conclusions and Key Recommendations

8.1. Conclusions

Sustainable energy neighbourhoods, such as those created under CONCERTO, are powerful showcases for demonstrating that an energy transition is an opportunity while making communities less dependent on energy imports and more resilient against energy price increases. Despite the financial crises hitting many of the projects and many having to adapt their original plans quite substantially, the projects succeeded in creating real-life showcases of innovative concepts and low energy buildings and neighbourhoods.

All projects implemented innovative energy efficiency measures and now produce heat and power from renewable energy sources. Many have achieved passive house standard and even energy plus standard could be reached. The projects had to learn to deal with new technologies, that had not been available in some countries beforehand and had to adapt measures and strategies to local conditions – not just on a technical level, but also taking climate and cultural differences or local political aspects into account.

Neighbourhoods and towns are small-scale models for countries and for Europe. They are immediate to people's everyday lives. Real-life, actual projects, that prove to the local community that sustainable energy concepts work in reality, are very effective catalysts for furthering the energy transition, representing a powerful reason to the EU to instigate and fund such projects. The CONCERTO initiative proves that if given the right planning, cities and communities can be transformed into sustainable energy pioneers. Most projects inspired follow-on projects and many policy developments at local, and sometimes even at national, scale, as particularly evident in France. These projects have thus laid an important foundation on which Smart Cities projects can now build.

The analysis of the 58 sites in 23 countries meant that a number of issues relating to calculated and actual energy performance emerged. Many of these relate to the difficulty in comparing the energy performance figures from different countries, due to underlying differences in practices regarding the calculation of it. A selection of these aspects were explored and compared with current thinking outside CONCERTO and recommendations were made to move relevant building regulations forward, in order to meet new challenges and towards better comparability. The need for more and better monitoring of actual performance, in particular at neighbourhood level, was also identified as a key issue.

Retrofitting Europe's largely inefficient building stock is a key challenge in reaching the EU's energy and climate change targets. Due to reduced demand for new-build in the wake of the global financial crisis, many CONCERTO projects shifted emphasis onto retrofitting. Though these projects had to tackle the typical barriers of lack of skills and awareness, split incentives, rebound effects, the difficulties of historic buildings and simple lack of money, these projects now provide an extensive body of experience and real-life examples of successful retrofitting projects, in 23 different countries with varying climates and socio-economic settings.

The projects have demonstrated how the construction of low energy public buildings, energy efficiency retrofits and energy management can reduce emissions directly and lower energy costs for public bodies. These will demonstrate opportunities to act to private and commercial players and encourage them to choose efficient solutions. Low energy public buildings can set incentives for local companies to invest in energy efficiency, low-carbon technologies and related skills.

Many energy technologies are still not sufficiently economically viable, due to their high up-front costs and low profits or low savings achieved. Others are only viable if looking at a long time period. For this reason, financing is a major issue in realising an energy transition. The CONCERTO projects have demonstrated on the one hand that it is necessary to provide

financial support for renewable energy and energy efficiency projects and on the other hand how to mobilise private contributions – often that of private households. Current business models that hold the potential to overcome the barrier of up-front capital cost have been explored. The importance of collaborating with local and municipal energy companies has been highlighted and options of a new role in offering contracting solutions have been explored.
In the projects, a number of different planning tools have to be used. The experiences have shown that well-defined frameworks, tasks, responsibilities for the participants and firmly and universally-agreed energy targets are important for these neighbourhood-scale projects. Additionally, intensive links and interactions between different levels of planning, local and regional as well as energy specific planning, are conducive to project success. Participation in networks to share best practice experiences is also effective.
The role of social processes in the context of the introduction of technical or organisational measures, as they were realised in CONCERTO, have been analysed. Raising awareness and acceptance e.g. by consequent application of Energy Performance Certificates, have been identified as social success factors. So have the effective diffusion of knowledge via training measures, assurance of quality, creation and support of possibilities for involvement of concerned stakeholders as well as the use of networks for spreading innovative approaches and organising the relation between stakeholders. The necessity and advantages of involving affected individuals and/or groups when undertaking changes to their local environment have been highlighted.

The findings summarised above have led to the recommendations for the EU, as well as for national and local governments to support them in their endeavour to reduce their CO_2-emissions reductions in the build environment.

8.2. Key Recommendations

Based on the experiences of the CONCERTO projects, the knowledge from other, similar projects, current scientific debate and literature, a set of core recommendations have been distilled out of the more than 80 recommendations presented in the previous chapters. Some of these have been combined and rephrased, leading to the 18 key recommendations below, which have been divided into those for the EU, for national governments and local governments. The recommendations have been assigned to the political level they were felt to relate to best, even though some recommendations apply to more than one level. No distinction is made between national and subnational/ regional level, because responsibilities between these levels vary between different Member States. In so far the clustering has to be seen as relatively loose.
For more specific information underlying the recommendations, the numbers of the relevant chapters have been given in brackets after the recommendation.

Recommendations for **L local level, N national level, EU EU level.**

8.2.1. Key Recommendations to the EU

EU — Considering the paramount importance of monitoring energy performance, the difficulties and high costs of it have to be addressed. For example, by the EU considering to fund it fully as part of their projects and by supporting research and development of low-cost technical monitoring solutions through grants and other incentives. (2)

EU N — Research and development regarding nearly zero-energy buildings and energy-plus buildings should now shift focus onto nearly zero-energy retrofitting and onto the development of new technical solutions for situations with low PV potential (e.g. larger blocks of flats). (2)

EU — Due to the high multiplier effect as well as associated local economic benefits of measures for public buildings, all public building should be retrofitted to the highest possible technical standard. Relevant requirements at EU-level should be strengthened to exceed those of the Energy Efficiency Directive. (3, 4)

EU — An EU Deep Renovation Fund should be set up to complement national financing schemes. It could be administered by the European Investment Bank. (5)

EU — Any EU funding for projects, including that under Structural and Regional Development Funds, should define and enforce minimum requirement for cost-optimal energy efficiency measures and renewables. (5)

EU N L — CONCERTO proved yet again how powerful real-life examples are in creating acceptance and by proving feasibility and value and reducing fears and negative myths amongst the local communities. It is of utmost importance to continue funding for such pilot communities and exploiting their potential as a catalyst for change. (7)

8.2.2. Key Recommendations to National Governments

N The split-incentives, also known as landlord-tenant dilemma, need to be addressed, for example:

- by designing and supporting appropriate contracting solutions for energy efficiency measures, that remove the need for up-front capital cost. (2, 3)
- addressing letting legislation, e.g. allowing the increase of rents following energy efficiency measures, to a level that is in line with expected energy cost savings. (3)

EU N L Energy criteria should be included into specifications, tender documents and contracts, as well as service and maintenance agreements for all public buildings. (4)

EU N L Public authorities should display Energy Performance Certificates in all their buildings, regardless of whether they are open to the public or frequented solely by employees and regardless of size. (4, 7)

N Stable, well-calibrated feed-in tariffs, guaranteeing revenues for a long period (20-30 years), have to be provided as these are crucial in bringing about an increased share of renewable energy and important for the viability of business models for renewables. (4, 5)

N L Dedicated quality control regimes for energy efficiency features in buildings have to be developed and formalised, addressing in particular time and human resources requirements as well as training and qualifications. (6, 7)

8.2.3. Key Recommendations to Local Governments

N L Consensus building for the retrofitting of multi-ownership buildings needs to be actively supported at local level – either by:

a) Building contractors including a decision support package in their service offering
b) Municipalities playing a more active facilitating role
c) Caretakers and other building management staff being given support and training on the delivery of consensus on retrofitting (3)

L Municipal energy companies should explore micro-contracting solutions for energy efficiency measures and renewables as new service areas. These would in particular bring contracting solutions into the realm of private households and could extend to include comprehensive retrofitting measures, but also to renewables. (5)

L Technical measures should always be combined with awareness and acceptance measures to avoid suboptimal realisation of energy efficiency potentials and rebound effects. (7)

L Cities should set up a sustainable energy action plan that includes at least the following aspects: energy sustainability indicators, energy efficiency, future energy consumption, energy efficiency potentials, potentials to produce energy from local renewables, storage capacities and a set of firm targets, including a time horizon to reach the target by. Local stakeholders should be involved in the development of the plan. (6)

L Municipalities should employ energy officers for coordination of energy demand, energy efficiency, local energy production, infrastructure and related project funding. They should have an overarching remit for the whole geographic area of the municipality and work closely with planning departments. (5, 6)

L Existing local networks should be tapped into or new platforms should be set up in order to bring stakeholders together and make them communicate with each other, to identify synergies and avoid misunderstandings and conflicts within projects. (6, 7)

L Municipalities are encouraged to join existing international and other municipality networks such as the Covenant of Mayors, Smart Cities Stakeholder platform, European Innovation Partnership, ICLEI, and Climate Alliance should be tapped into in order to make municipalities communicate with each other and exchange best practice. (6, 7)

Abbreviations

ADEME	Agence de l'Environnement et de la Maîtrise de l'Energie (French Environment and Energy Management Agency)
ASIEPI	Assessment and Improvement of the EPBD Impact
BPIE	Buildings Performance Institute Europe
BREEAM	Environmental assessment method of the Building Research Establishment (UK)
CEB	Council of Europe Development Bank
CEN	European Committee for Standardization
CHP	Combined Heat and Power
CLGE	Comité de Liaison des Géomètres Européens
COP	Coefficient of Performance
DG	Directorate-General
DH	District Heating
DHW	Domestic Hot Water
EC	European Commission
EE	Energy Efficiency
EED	Energy Efficiency Directive
EIB	European Investment Bank
ELENA	European Local Energy Assistance
EPB	Electric Power Board
EPC	Energy Performance Certificate
EPBD	Energy Performance of Buildings Directive
ESC	Energy Supply Contracting
ESCO	Energy Service Company
EU	European Union
FIT	Feed In Tariff
FP6	6th Framework Programme
FP7	7th Framework Programme
GBPN	Global Buildings Performance Network
GDP	Gross Domestic Product
GHG	Greenhouse Gas
GIS	Geographic Information Systems
GPR	Ground Penetrating Radar
HCA	Homes and Communities Agency
HDD	Heatind Degree Days
CDD	Cooling Degree Days
ICT	Information and Communication Technologies
IEA	International Energy Agency
IPD	A Property Performance Analysis Provider
ISO	International Organisation for Standardization
JEREMIE	Joint European Resources for Micro to Medium Enterprises
JESSICA	Joint European Support for Sustainable Investment in City Areas
KfW	German Governmental finance institution (Kreditanstalt für Wiederaufbau)
kWp	Kilowatts-Peak
LCA	Life Cycle Assessment
OECD	Organisation for Economic Co-operation and Development
ÖNORM	Austrian National Norms provided by the Austrian Standards Institute
ORC	Organic Rankine Cycle
NEEAP	German National Energy Efficiency Action Plan (Nationaler Energieeffizienz-Aktionsplan)
NREAP	National Renewable Energy Action Plans
NZEB	Nearly Zero-Energy Buildings
PE	Primary Energy
PDA	Project Development Agreement
PPP	Public Private Partnership
PR	Public Relations
PV	Photovoltaic
R&D	Research and Development
RE	Renewable Energy
RECORA	Recognising and Responding to Radicalism
RES	Renewable Energy Sources
SEAI	Sustainable Energy Authority of Ireland
SEAP	Sustainable Energy Action Plans
SET-plan	European Strategic Energy Technology Plan
SME	Small and Medium Enterprise
URBIC	ESCO for Zaragoza
VAT	Value Added Tax

Country Codes Used

AT	Austria
BE	Belgium
BG	Bulgaria
CH	Switzerland
CZ	Czech Republic
DE	Germany
DK	Denmark
ES	Spain
FI	Finland
FR	France
HR	Croatia
HU	Hungary
IE	Ireland
IT	Italy
LT	Lithuania
LU	Luxembourg
NL	Netherlands
NO	Norway
PL	Poland
SE	Sweden
SI	Slovenia
SK	Slovakia
UK	United Kingdom

Glossary

Bio-Climatic Design	This term refers to the relationship between climate and architecture. It has a long pedigree going back to the work of Le Corbusier with his use in hot climates of ventilating atria, solar screening and thermal mass
Box Plot Graph	A graphic representation of a distribution by a rectangle, the ends of which mark the maximum and minimum values
Building Services	The common term for all technical installations relating to heating, water, lighting, drainage and if applicable ventilation, cooling
Capital Cost	Total upfront cost for labour and materials etc. to complete a project
Cost of Capital	Same as "investment cost – costs associated with securing capital
Marginal Abatement Costs	Is the expense associated with eliminating a unit of pollution. As the amount of pollution produced approaches zero, the marginal abatement cost tends to rise, because it becomes more and more expensive to prevent the pollution.
Cost Optimal/Cost Optimality	Is the energy performance level which leads to the lowest cost during the estimated economic lifecycle
Data Logger	A data logger is an electronic device that records data over time or in relation to location. It can record a wide variety of energy and environmental measurements such as temperature, relative humidity or light intensity.
EPCs	Energy Performance Certificate. This is the general term used at EU level used for any type of certificate regarding the energy performance standard of a building be it new or existing, residential non-residential be it for display or documentation
Feed-In Tariff	remuneration set for feeding renewable energy (mostly electricity) into the national grid or gas network.
Final Energy	Sometimes also referred to as "delivered energy" – the energy delivered and metered at point of entry into a property/ the final energy includes the share of primary energy for direct use and the secondary energy (primary energy that went through a transformation process)
Investment Cost	Costs such as interest – sometimes confused with capital cost
Low Carbon	A commonly used term meaning "low in greenhouse gas emissions"
Multiplier	In the context of this study an information multiplier is a person or media whose function is the goal oriented diffusion of information among certain target groups (e.g teacher, journalist)
Mixed Ownership	Is a mixture of government and private ownership, including both not-for-profit and for-profit firms
Multiple Ownership	A multiple ownership describes a situation where real properties are owned by several players (individuals or parties) jointly.
Prebound Effect	A variation of the rebound effect. The difference is the effect occurs previously to a planned intervention
Principal Agent Dilemma	Economical issue concerning the difficulties in motivating one party (the "agent", e.g. a landlord), to act in the best interests of another (the "principal", e.g. the tenant) rather than in his or her own interests. It develops when a principal creates an environment in which an agent has incentives to align its interests with those of the principal, typically through incentives.
Primary Energy	Primary energy is energy that has not been subjected to any conversion or transformation process (e.g. oil, coal, wind, solar). This energy can be renewable as well as non- renewable.
Prosumer	Or produser describes consumers that are simultaneously producers
Public Building	A facility used by public administration
Rebound Effect	The effect of less reduced or even increased ("Backfire effect") resource usage due to efficiency measures. Direct rebound effects are caused by the reduced costs of a more efficient service resulting in more intensive use. The indirect effect consists in the shift of purchasing power formerly needed for the now more efficient service towards other resource consumptive goods & services.
Renewables	A term synonym to „renewable energy sources" as well as for „renewable energy installations"
Refurbishment	servicing or renovation of older or damaged equipment to bring it to a workable or better looking condition
Retrofitting	To furnish existing buildings with new or modified parts or equipment not available or considered necessary at the time of manufacture
Shale Gas	Is natural gas that is found trapped within shaleformations

Soft Loan	Or "cheap loan". A loan with no interest or a below-market rate of interest, typically with long repayment terms than conventional bank loans. Soft loans are usually provided by governments to projects they think are important.
Split Incentives	Depending on the type of lease, either tenants or landlords (but not necessarily both) will obtain the rewards of efficiency upgrades
Subsidiarity Principle	Is the principle of devolving decisions to the lowest practical level of state or Union
Sustainable Energy	In accordance with common use: energy efficiency + RES
Useful Energy	By some EU-documents referred to as "energy need" the energy actually delivered in the form of heat or light, i.e. final energy minus transformation losses/ Useful energy is energy that goes into work, as opposed to being lost as heat etc/ portion of final energy which is actually available after final conversion for the respective use. In final conversion, electricity becomes for instance light, mechanical energy or heat
U-Value	a measure of heat loss in a building element such as a wall, floor or roof. It can also be referred to as an 'overall heat transfer co-efficient' and measures how well parts of a building transfer heat.

List of Figures and Images

The abbreviations used below refer to the following departments within the Karlsruhe Institute of Technology, which produced the relevant figures:

DFIU: Deutsch-Französisches Institut für Umweltforschung (French-German Institute for Environmental Research)
EE: Erneuerbare Energien (Renewable Energy)
ITAS: Institut für Technikfolgenabschätzung und Systemanalyse (Institute for Technology Assessment and Systems Analysis)
OEW: Lehrstuhl Ökonomie und Ökologie des Wohnungsbaus (Chair for Sustainable Management of Housing and Real Estate)

Figures

Images

Biodruckfarbe
Auf Basis nachwachsender Rohstoffe, mineralölfrei

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Papier aus verantwortungsvollen Quellen
FSC® C106007
www.fsc.org

Print CO2 kompensiert
Id-Nr. 1325692
www.bvdm-online.de

MJ-01-13-669-EN-C

ISBN 978-92-79-33693-5

9 789279 336935

doi: 10.2833/17772

Publications Office