EUFORIE
European Futures for Energy Efficiency

Consumer and energy efficiency

Stock taking of instruments targeting household energy efficiency

Deliverable 5.1

Version 21.04.2019

This project is supported by the European Commission
Horizon2020 Research and Innovation Programme

www.euforie-h2020.eu

Please cite as:

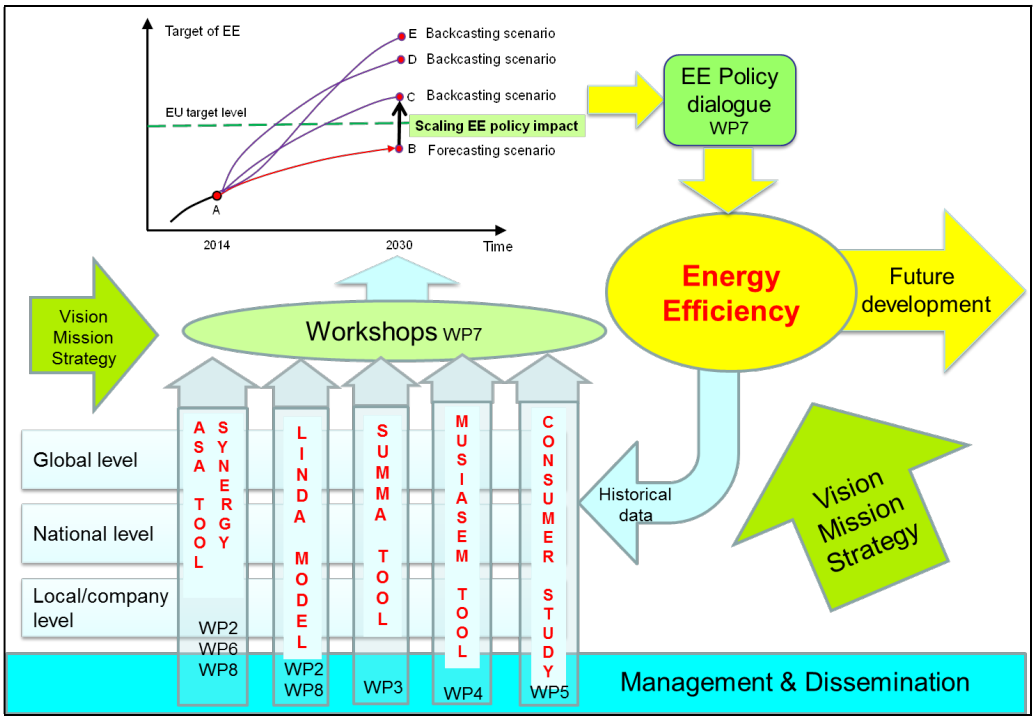
Trotta, Gianluca and Lorek, Sylvia (2019). Consumers and Energy Efficiency – Stock taking of policy instruments targeting household energy efficiency. *EUFORIE – European Futures for Energy Efficiency*

The EUFORIE project

The strategic goal of the EUFORIE project is to provide useful and accurate information and knowledge in the field of energy efficiency for the EU Commission and stakeholders in the Member States. The tangible objectives are the following:

1. To provide energy and energy efficiency trends and their drivers, synergies and trade-offs between energy efficiency related policies, as well as energy efficiency scenarios (WP2).
2. To provide data about implementation of energy efficiency in specific processes, sectors and entire systems, in order to understand bottlenecks/efficiency drops and suggest improvements (WP3).
3. To carry out analyses of efficiency of provision, from making useful energy carriers from primary energy sources, and from conversion of energy carriers to end uses across macro-economic sectors (WP4).
4. To identify policy instruments and other measures leading to significant reduction in the energy consumption of households (WP5).
5. To analyse the relationship between investments and change in energy efficiency, and to develop indicators to describe changing energy efficiency at the company level (WP6).
6. To carry out participatory foresight for European stakeholders of energy efficiency with a target of providing ideas for the energy efficiency vision and strategy in the European Union (WP7).
7. To compare energy efficiency policy instruments and measures and their impacts in China and the European Union (WP8).

The EUFORIE Work Packages relate to each other The project applies different quantitative and qualitative analysis methods to energy efficiency in the EU and its Member States at different levels and from different perspectives. These analyses provide input for foresight activities, which serve European energy efficiency vision and strategy process by generating useful information. Management (WP1) and dissemination (WP9) run in parallel with the research and innovation activities.



BOX 1 – Tasks of WP5 related to Deliverable 5.1

WP5 - Consumers and energy efficiency. The objectives of this work package is to identify policy instruments and other measurements, which are leading to significant reductions in the energy consumption of households (from the proposed project, slightly modified according to later agreements with the Coordinator).

Task 5.1. Stock taking of policy instruments targeting household energy efficiency

The WP starts with stock taking of administrative, economic or informational instruments targeting (1) directly the use phase of energy consumption in households – often described as the behavioural aspect (2) the investment phase but also (3) indirect influences changing the consumption environment (e.g. Odyssee-MURE, SUNSHINE, SCOPE², EPSEI, SPREAD 2050, etc). Attention is given as well to the support coming from the private sector complementing public activities over the whole range of relevant activities from planning (architects, planners), financing (e.g. specific green loans from banks to private owners and other investors), consulting (in particular for modernisation) and implementation as such measures should go hand in hand with existing governmental advisory and subsidy schemes.

Focus of the analysis is the policy impact of single measures but even more the policy outcome as the overall picture of policy interventions which also include unintended effects. The policy outcome here is the long term aggregated result of policies reflecting as well parallel development, changes in the consumption environment and measures from other policy areas promoting or hinder the reduction of energy consumption. Comparison of policy targets will be specified as far as possible regarding to specific appliances (lightening appliances, cooling appliances etc.) and relevant actors e.g. households, producers. Regarding the policy analysis regulations and incentives developed at the EU level will be considered.

Task 5.2. Identification of promising instruments and instrument mixes for energy efficiency

Analysis of social, economic, cultural and educational factors influencing household energy efficiency. Energy consumption in general as well as specific energy efficiency policies are shaped by social, economic, cultural and educational framing conditions and their developments over time. Therefore additional focus of analysis will be on national and local level. According to the composition of the consortium the main countries of analysis will be Germany, Finland, Italy and Spain. They will be accompanied by one further Western country (e.g The Netherlands) and three Eastern European countries (e.g. Hungary, Latvia and Romania). The analysis will result in a deliverable recommending promising strategies for the development of energy efficiency strategies policies and programmes at all levels of governance.

Key findings and summary for stakeholders

1. The issue to be explored

The focus of WP 5 is households as the main final consumer of energy. Reducing final energy consumption has long been advocated as a strategy for minimising primary energy use through consumer information campaigns, promoting more efficient technical appliances, labelling energy efficiency etc. According to the International Energy Agency, household energy efficiency improvements have the potential to support economic growth and social development, to improve occupant health and well-being, and to enhance competitiveness and investment opportunities.

As known the dominating fields of household expenditure affecting energy consumption are mobility and food supply (external) and heating and electricity for operating household appliances (in-house consumption). As mobility and food supply are policy fields distinct from energy policy, we focus on residential energy consumption. Thus analysis undertaken was to identify which tools have been used at the EU level and within selected member states) to improve residential energy efficiency.

2. What was done to investigate it

The report combines overarching European data with information gathered in the case countries. The analysis was focussed on five countries: Finland, Hungary, Italy, Spain, and the UK reflecting North and South Europe, relevant regarding heating, as well as East and West Europe representing a legacy of pre-unification planning and construction. Additional information are available from the country studies covering Germany, Latvia and Romania (all on the project homepage).

The EU Directives (e.g. EED 2012/27/EU) are setting the policy framework for domestic energy policy in the EU and provide the basis for diverging national policies. Consequently, a first research question was the effectiveness of the EU regulatory framework, followed by how they had been implemented and thirdly, which additional measures had been taken on the national level. As the far largest share of energy used in households is on room heating and hot water, building specification, and heating system become immediately relevant. Therefore the possibilities to improve efficient heating take centre stage in this report. A separate section is devoted to electrical appliances.

Analysing how households can contribute to more energy efficiency leads to the questions how households can be supported by other market players and actors. We identified the potentials of traditional stakeholders such as housing companies, banks or research have, plus emerging stakeholders such as Non Governmental Organisations (NGOs), Municipalities' Energy Providers MEPs and Energy Service Companies (ESCOs), and the role new tools such as Energy Performance Contracts (EPCs) might have. In the case of business and civil society initiatives the main objective of the report is to illustrate diversity, not to provide a complete overview of all existing initiatives.

3. The method employed

This stock taking report has been compiled as a result of desktop research regarding the EU regulatory framework, and on the country studies. Promising strategies were selected from the country studies based on assessment if they addressed the key physical, social, and behavioural obstacles to increasing domestic energy consumption. Since this report is based on country data, we

do not discuss which obstacles should have been addressed by what means, but describe which obstacles have been addressed by which measures. Moreover, we analyse the role of the private sector in stimulating the investments in energy efficiency and complementing European and national public policies. In conclusion, we offer some hypotheses explaining obvious policy failures on the national level, indicating where there is room for improvement, and draw some meta-level conclusionsfor EU residential energy policies.

4. The data and sources

The country reports have been compiled with the help of national experts. They had not only the language capabilities to analyse national language information material, but also the knowledge of where to find appropriate information. Additionally, in some cases, the collection of information has been supported by interviewing external stakeholder with expertise in the residential energy sector and energy efficiency. The report analyses the trends available on ODYSSEE/Mure database, Eurostat and National Statistics databases complemented with data on residential building stock taken from national statistics from a legislative and economic perspective. This is because of the strong correlation between dwelling characteristics—age, tenure, type, size—and the energy consumption and thermal efficiency performance of buildings, in addition to household composition, income, and behavioural traits. The collection of information was concluded by end of November 2015.

One of the sources used are the National Energy Efficiency Action Plans (NEEAPs, third version of April 2014). Following European obligations, EU Member States have submitted their plans, and the measures mentioned and the different levels of policy implementations have been analysed and discussed for this report. The in-depth analysis of the third NEEAPs and other national policy documents is supported by additional literature sources. Main EU laws, policies, and related documents were taken from public sources, mainly the EU law database.

5. The results

All European Member States analysed are committed to doing more on energy efficiency at all stages of the energy chain – from the design of houses, cities and grids, to the behaviour of consumers. So far most of the energy efficiency policies have promoted the technical efficiency through technical standards of buildings or incentive for investments in energy efficiency appliances and energy consuming equipment.

Country perspectives

Compared to other analysed countries, the UK government's set of energy efficiency policies lately targeted at the residential sector appears to be more effective. Its more balanced character, together with the participation of and obligations for private actors have been decisive for this relative success. Legal obligations placed on energy suppliers to deliver domestic energy efficiency programmes are part of a holistic policy package with a medium-term framework addressing many aspects of energy efficiency in the residential sector. The motivation for this ambitious approach appears to be a domestic one: the UK residential energy sector is more problematic than the EU average. The prevalence of older dwellings in the national stock, built to lower standards of energy efficiency, combined with a high share house ownership among the less affluent sectors of society and the dominant role of the private sector in the housing rental market leaves larger untapped

potential for improvements than in the other countries under investigation. Due to significant energy efficiency improvements since 2007, the energy use by households in the UK was in line with the EU average in 2015. It is unclear how Brexit will influence energy efficiency policies in the UK.

In Finland, improvements in the residential sector seem not to have been a priority for policymakers, despite its highest energy consumption per capita and the highest space heating demand per dwelling in Europe. Beyond a general tax reduction for any household services, no real economic incentives have been provided to stimulate energy efficiency investments in the last years, and fuel poverty as well as the landlord-tenant problem have not been sufficiently taken into account in the national energy efficiency strategy. Therefore, the residential energy consumption per stock of permanently occupied dwellings did not decrease within the period 1995– 2015. One possible explanation is the policy makers' focus on the energy intensive industries.

Also in Spain, the residential energy sector seems not to have been at the top of the energy saving agenda; instead, the attention has been focused on the transport sector representing about 40% of the energy consumption. But as opposed to Finland, in Spain the residential energy sector is one of the most efficient in Europe, mainly because of the modern building stock and the low level of space heating demand. In addition, with the State Housing Plan 2013–2016 and the PAREER-CRECE Programme, both the national and local governments have recently allocated a significant share of the budget for energy efficiency and saving projects to inhabited residential buildings.

In Hungary, with the Warmth of the Home Programme, the government provided financial incentives to households ranging from the replacement of inefficient appliances or obsolete facade doors and windows, to complex energetic refurbishment of blocks of flats. The funds allocated to this policy measure were rapidly exhausted indicating the programme was underfunded as compared to demand. To increase energy awareness, large-scale educational programmes targeted to specific groups have been provided by both the government and the energy providers E.ON and ELMÜ-ÉMÁSZ. However, there is still room for improvement: implementing policies incentivising energy efficiency investments could reduce domestic energy consumption, alleviate fuel poverty, and improve health and thermal comfort, while reducing the dependence on Russian gas.

Italy offers some interesting policy initiatives in terms of fiscal and financial incentives. The tax deduction scheme (since 2007) has proven to be very effective in attracting more investments than what it actually cost in terms of foregone fiscal revenue. In addition, since 2012, the Thermal Account has provided substantial incentives for energy efficiency investments. Subsidies covering part of the expenses for renovation will be available until 2021. Benefits from these policy measures are partially exploited by ESCOs. These measures and activities may have contributed to curb the negative trend of energy savings. However, these measures have not been developed into a comprehensive policy package addressing all the aspects of the residential energy sector.

European perspectives

Despite a shared ambitious EU residential energy policy adaptation is lacking behind. The different levels of per capita or per dwelling household energy consumption are to a large degree influenced by policies of the last decades, as the housing stock is a lasting legacy. More recent explanations were found in Spain and Finland—in both countries governments focussed their climate mitigation

efforts on other, more dominant sectors, transport in Spain and industry in Finland. Furthermore, economic dynamics play a role: the recent construction boom in Spain led to a significant share of the housing stock built according to advanced energy standards, unlike in the UK or in Finland.

However, whether the common European or the national targets on energy efficiency will be reached is not beyond doubt. What looked well in numbers at the time of taking stock (ending 2015) might just be influenced by reduced economic activities in the aftermath of the Great Recession while not reflecting true efficiency gains. The EU State of the Environment Report due in autumn 2019 will provide the data which emerged after the data collection for the project had ended and which are necessary to distinguish structural reductions from effects of the economic cycle.

6. Their significance for policy-makers, stakeholder, and/or other researchers

Energy efficiency policy design matters, if only in terms of meta-level criteria: an optimal policy strategy for improving energy efficiency in the residential sector should seek to impact different barriers and target segments through a holistic approach pursuing multiple goals coherently, mutually supporting each other. As the barriers are diffuse and policy mechanisms rarely operate effectively in isolation, such an approach must be based on a careful analysis of the local and national situation. Only then synergies, making the combined impact larger than the sum of isolated effects, may be realised. This implies that a comprehensive energy efficiency policy strategy is determined by the degree to which the design of policy mixes address the barriers identified.

The analysis of the different policy instruments indicate the importance of EU initiatives (mainly in form of the directives) to move countries towards energy efficiency. For reaching the emission targets of Paris Accord, adapting the directives will be a key policy tool. The huge variety of approaches that can lead to successful steps. Most effective are policy mixes, combining regulatory approaches with economic incentives and product specific instruments. Amongst the regulatory approaches, legal norms are immediately effective and applicable on a broad scale, while information instruments not necessarily lead to behavioural change on a broader scale. Economic incentives, grants and subsidies, loans, tax and tariffs, all are potentially effective, depending on the context of their application. Product specific instruments from labelling to eco-design can complement legal and economic instruments. Time counts as well: an energy efficiency policy package tends to be more effective if it is maintained over the long-term.

In addition to policy packages, engaging the private sector is acknowledged as being central to ensuring long-lasting impact. As such, private initiatives do not duplicate governmental energy efficiency measures in the residential sector, but rather augment and strengthen them. A long-term policy horizon is a necessary, but not sufficient condition for mobilising private investments in energy efficiency in the residential sector. Rethinking of business models is crucial, and is still challenging. In their current business model, energy providers cannot decouple utility profits from energy volumes and energy service companies do benefit from economies of scale when selling energy efficiency solutions to households. New business models would have to include providing loans, investment and implementing demonstration programs for alternative solutions to low-energy buildings. Mainly practical exchange with citizens leads to the required changes.

Content

Abbreviations

AEEG	Authority for Electricity Gas and Water
AMR	Automated Meter Reading
ANRE	Romanian Energy Regulatory Authority
BPIE	Buildings Performance Institute Europe
CECED	European Committee of Domestic Equipment Manufacturers
CERO	Carbon Emissions Reduction Obligation
CERT	Carbon Emissions Reduction Target
CESP	Community Energy Saving Programme
CIG	Italian Gas Committee
CSCO	Carbon Saving Community Obligation
DECC	Department of Energy and Climate Change
Domestic RHI	Domestic Renewable Heat Incentive
DSOs	Distribution System Operators
EBRD	European Bank for Reconstruction and Development
ECARP	Energy and Climate Awareness Raising Action Plan
ECO	Energy Companies Obligation
EEC	Energy Efficiency Certificates
EED	Energy Efficiency Directive
EEOS	Energy Efficiency Obligation Scheme
ENEA	Agenzia Nazionale per l'Efficienza Energetica
EPBD	Energy Performance of Buildings
EPC	Energy Performance Contract
ERDF	European Regional Development Fund
ESF	European Social Fund
ESCO	Energy Service Company
ESD	Energy Service Directive
EST	Energy Saving Trust
FIDAE	Fund for Investment in Efficiency and Energy Savings
FITs	Feed-in-Tariff scheme
FNEE	Fondo Nacional de Eficiencia Energética
GDHIF	Green Deal Home Improvement Fund
GIB	Green Investment Bank

GDP	Gross Domestic Product
GSE	Energy Service Operator
HHCRO	Home Heating Cost Reduction Obligation
IDEA	Institute for Diversification and Energy Saving
IEA	International Energy Agency
IMF	International Monetary Fund
iPHA	International Passive House Association
KfW	Kreditanstalt für Wiederaufbau
NBEPS	National Building Energy Performance Strategy of Hungary
NEEAP	National Energy Efficiency Action Plan
NREC IS	Information System of the National Real Estate Cadastre
OECD	Organisation for Economic Co-operation and Development
PAREER	Aid Programme for the Energy Renovation of Existing Buildings
PIDEE	Integrated Energy Efficiency Uptake Plan
PPP	Purchasing Power Parity
SMET	Smart Meters Equipment Technical Specification
TBC	Technical Building Code

Unit of measurements

GJ	Gigajoule
Gwh	Gigawatt hour
Ktoe	Kilotonne of oil equivalent
Kwh	Kilowatt hour
Mtoe	Million tons of oil equivalent
PJ	Petajoule
Toe	Tonne of oil equivalent

List of Tables

List of Figures

1. Introduction

Energy is fundamental to the quality of our lives as we know it, and it is a key ingredient in all sectors of modern economies. By now, we are totally dependent on an abundant but limited supply of energy for living and working. In response to climate change, high-energy prices, and growing demand, it is essential to optimise the consumption of energy through a widespread uptake of energy efficient solutions.

Energy efficiency is evolving away from the image of 'switch off your lights' into a more economy-wide perspective. It is widely considered as the most cost effective way to enhance security of energy supply and to reduce emissions of greenhouse gases. In addition, energy efficiency improvements might have the potential to support economic growth and social development, to improve occupant health and well-being, and to enhance competitiveness and investment opportunities (IEA, 2014).

In the last years, the European Commission has acknowledged these benefits in a series of directives and long-term strategy documents - such as the Energy Performance of Buildings Directive 2010/31/EU, the Energy Efficiency Directive 2012/27/EU, the Energy Roadmap 2050, etc. - by establishing a set of measures for improving the existing policy framework of measures and promoting energy efficiency within EU. All European Member States are committed to doing more on energy efficiency at all stages of the energy chain – from the production of energy to final consumption.

The residential sector is responsible for one of the largest share of energy consumption presenting the highest cost-efficient potential for mitigation, and it is consequently vital to meeting the EU objectives toward a low-carbon economy and energy system. Despite the proven cost-effective energy efficiency opportunities for reducing energy consumption in the residential sector, several studies consistently indicate that a large potential for the existing building stock remains untapped (see Gillingham and Palmer 2014 for an overview). In addition, existing conditions, strategies, actions, and political efforts to address residential energy efficiency can vary a lot among countries.

It is in this context that this report evaluates recent policies and private initiatives stimulating energy efficiency improvements in the residential sector of eight selected countries - Finland, Germany, Hungary, Italy, Latvia, Romania, Spain, and United Kingdom - and provides some overarching European data and insights.

The remainder of this report is organized as follows. Section 1 provides the floor and presents relevant socio-economic and energy related data from the selected countries. Section 2 introduces the policy settings in the case countries, mainly as laid out in the National Energy Efficiency Action Plans, and lists and analyses various national measures aimed at improving energy efficiency with a major focus on residential space heating energy consumption. Section 3 examines EU policies and trends concerning energy efficient appliances. Section 4 complements the policy picture by discussing through practical examples the role of the private sector and local actors in stimulating energy efficiency investments.

The report focuses on the use of energy in the household sector for the purposes of heating and the use of hot water, as well as on the use of electricity. Transport-related use of energy was excluded.

The scope of information presented in the report in the case of policies at the national level is mainly on governmental measures in effect. In the case of business and civil society initiatives, the main objective of the report is to illustrate diversity and not to provide a complete overview or an

exhaustive list of all existing initiatives. An attempt was made to introduce the better-known campaigns and programmes as well as to indicate the variety of the actions.

The collection of information was concluded in November 2015. The report has been updated and revised in October 2017.

1.1 Methodological framework and information sources

This report builds on eight European country reports and it covers a wide range of policies and private initiatives addressing energy efficiency in the residential sector.

The report is based on different data and information sources. Main EU laws, policies, and related documents are examined in order to set the framework for the analysis of the policy implemented by the EU member states. An in-depth analysis of the third National Energy Efficiency Action Plans (NEEAPs) and other national policy documents is then provided. More specifically, we focus on how selected countries (Finland, Germany, Hungary, Italy, Latvia, Romania, Spain, and the United Kingdom) translated energy saving objectives and EU requirements (e.g., Energy Efficiency Directive 2012/27/EU) into national policy measures and concrete actions.

In order to find a reasonable level of aggregation and to provide a common basis for comparison between countries, the energy efficiency policies are classified by the type of instrument implemented: regulatory (legislative/normative, legislative/informative), economic (grants and subsidies, loans, tax and tariffs), informational, and cross-cutting. In this regard, we involved national experts who have not only the language capabilities to analyse national language information material, but also the knowledge of where to find the appropriate information. Additionally, in some cases the collection of information has been supported by external stakeholder interviews with expertise in the residential energy sector and energy efficiency.

An extensive use of the Odyssee database that contains detailed data on energy consumption and related CO2 emissions is made. In this report, we illustrate the contribution of the residential energy sector to the final energy consumption and the final residential energy consumption by end-use in the European Union and the selected countries.

Odyssee data on energy consumption are complemented with data on residential building stock taken from national statistics database. This is because there exists a strong correlation between dwelling characteristics – age, tenure, type, size – and its energy consumption and thermal efficiency performance.

The report continues with the analysis of policies and trends in energy efficiency of electrical appliances. Appliances are classified in ‘workhorse’ – such as refrigerators that are typically purchased for a prolonged use and tend to be replaced when they breakdown – and ‘up-to-date’ products – such as TVs that tend to be periodically replaced and upgraded to the latest technology.

Finally, we discuss the role of various private and local actors in stimulating energy efficiency in the residential sector and complementing public activities. Private and local actors included in the report are: municipalities, energy providers, energy service companies (ESCOs), banks, non-governmental organisations (NGOs), research, and housing companies. We conclude by providing implications for energy policy.

Relevant scientific literature and technical reports support the analysis of the energy efficiency measures across various sections of the report. Main issues discussed in the context of energy efficiency and energy behaviour change are (i) the market and behavioural barriers hindering

investments in energy efficiency solutions (for an overview see Ghillingam and Palmer, 2013), (ii) the type of policy instruments driving innovation (e.g., Noailly, 2012), and (iii) the households' determinants and drivers of energy efficiency (e.g., Mills and Schleich, 2010; Brounen et al., 2012; Ameli and Brandt 2015).

This report provides an overview of the major existing policies and initiatives of local and private actors towards energy efficiency in the residential sector. More detailed information can be found in the specific reports of the countries under investigation - Finland, Germany, Hungary, Italy, Latvia, Spain, Romania, and the United Kingdom.

1.2 Main EU directives and policy documents

Energy efficiency is one of the priorities of the European Union, as reflected in the various documents, which place it at the heart of the European corpus on energy and environmental preservation.

An analysis of the numerous documents written over the past ten years on the Union's energy efficiency policy shows a strong coherence between these writings and two broader policy objectives: the fight against climate change and the creation of a common European energy policy. Through the ratification of the Kyoto protocol signed on May 31, 2002, which came into force on February 16, 2005, Member States committed to collectively reduce greenhouse gas emissions by 8% between 2008 and 2012. Most of the texts on energy efficiency adopted by the EU since early 2000 were written in the context of the fight against climate change.

In 2004, energy efficiency was the key topic of the Cogeneration Directive[1]: it attempted to promote cogeneration through a systematic identification and progressive realization of the national potential for high-efficiency cogeneration by creating a common definition and removing barriers.

The Directive 2006/32/EC on Energy End-Use Efficiency and Energy Services, commonly referred to as the Energy Services Directive (ESD), was the first major wide-reaching piece of legislation on energy efficiency: it was introduced to assist Member States in overcoming market barriers and accelerating the uptake of energy efficiency measures.

The adoption of this directive represents a pivotal point in the evolution of European energy efficiency policy development, as it introduced for the first time national indicative energy savings targets of 9% to be achieved by 2016, and also the requirement for Member States to develop and submit National Energy Efficiency Action Plans (NEEAPs) to the European Commission on a periodic basis. The first NEEAP had to be submitted by 30 June 2007, with the second and third one to follow on 30 June 2011 and 30 April 2014, respectively. The introduction of the NEEAP reporting requirement encouraged Member States to think up new policies and measures to meet the energy savings targets. They are intended to stimulate the translation of energy savings objectives into concrete measures and actions, set implementation milestones at Member State level, and create dialogue between the Commission and Member States.

Member State NEEAPs have adopted very different approaches, resulting in large differences in structure, contents and level of details. Most of the national measures implemented have focused on improving energy performance of buildings (public services, residential), while a lower coverage of measures is in the transport and agricultural sectors[2].

[1] Directive 2004/8/EC of the European Parliament and of the Council of 11 February 2004 on the promotion of cogeneration based on a useful heat demand in the internal energy market.
[2] SEC(2011) 276 final. National Energy Efficiency Action Plans (NEEAPs): update on implementation.

A next relevant EU document was the Eco-Design Directive in 2009[3] followed fairly swiftly by the Directive on the Energy Performance of Buildings[4] (recast EPBD) in 2010. Both looked at energy efficiency beyond the immediate point of consumption, and entered into the design and lifelong energy use of specific products, from the building of new houses or offices, to the production of fridges, computers or industrial machinery. The 2010 recast Directive on Energy Performance of Buildings (recast EPBD) is the main legislative instrument affecting energy use and efficiency in the building sector in the EU. This Directive superseded the first EPBD[5], originally approved in 2002, and pertains to both new buildings and the existing building stock. The objective of EPBD is to promote the cost-effective improvement of the overall energy performance of buildings. The EPBD requires Member States to:

- Introduce minimum energy performance requirements for buildings, building elements and technical building systems.
- Set these requirements based on a cost-optimal methodology taking into account the lifetime costs of the building.
- Build all new buildings at nearly zero-energy standards from the end of 2020.

In addition, the importance of buildings is emphasized in a number of long-term EU strategy documents. These include:

- The EU's Climate Roadmap for 2050[6], which identified the potential to reduce CO2 emissions related to the residential and services sector by 88-91% by 2050 compared to 1990 levels.
- The Energy Roadmap 2050[7], which considered the "higher energy efficiency potential in new and existing buildings" key to reaching a sustainable energy future in the EU, by contributing significantly to the reduction of energy demand, and by increasing security of energy supply and competitiveness.
- The Roadmap for a Resource Efficient Europe[8], which identified buildings among the three key sectors, and estimated that construction and use of buildings in the EU had the potential to influence 42% of final energy consumption, about 35% of CO2 emissions, more than 50% of all extracted materials, and could save up to 30% of water consumption.

Through the recast Energy Labelling Directive of 2010[9], the European energy efficiency strategies entered people's homes by allowing consumers to make informed choices and to be alerted on the consumption/running cost of a product before they make their purchasing decision. According to the new Energy Labelling Directive, the layout of the energy efficiency label gives room to up to three new energy classes to reflect technological progress. The principle of the energy labelling system is that the energy label starts with the classes A to G. The new Energy Labelling Directive introduces

[3] Directive 2009/125/EC of the European Parliament and of the Council of 21 October 2009 establishing a framework for the setting of ecodesign requirements for energy-related products.
[4] Directive 2010/31/EU of the European Parliament and of the Council of 19 May 2010 on the energy performance of building (recast), OJ L153, 18.06.2010.
[5] Directive 2002/91/EC of the European Parliament and of the Council of 16 December 2002 on the energy performance of buildings.
[6] COM, 2011. 112 final. "A Roadmap for moving to a competitive low carbon economy in 2050".
[7] COM, 2011. 855 final. "Energy Roadmap 2050".
[8] COM, 2011. 571 final. "Roadmap to a Resource Efficient Europe".
[9] Directive 2010/30/EU of the European Parliament and of the Council of 19 May 2010 on the indication by labelling and standard product information of the consumption of energy and other resources by energy-related products that substantially replaces the Directive 1992/75/EEC on the indication by labelling and standard product information of the consumption of energy and other resources by household appliances.

new efficiency classes A+, A++ and A+++ on top of the existing A grade for the most energy-efficient household products.

On 8 March 2011, the European Commission undertook a review of Member States progress towards meeting the EU's energy efficiency target. The Communication stated that the Union was not on track to achieve its energy efficiency target: it emerged that they would have just achieved approximately half of targeted savings[10]. On this basis a new legislative initiative, the Energy Efficiency Directive (EED), entered into force on 4 December 2012, which repealed the Cogeneration Directive (2004/8/EC) and most of the Energy End-Use Efficiency and Energy Services Directive (2006/32/EC).

The EED's overarching objective (Art. 1.1) is *"to ensure the achievement of the Union's 2020 20 per cent headline target on energy efficiency and to pave the way for further energy efficiency improvements beyond that date"*. The 20% target is defined in Art. 3.1(a) as a maximum of 1474 Mtoe primary energy or 1078 Mtoe final energy consumption in 2020 (after Croatia joined EU the target was revised to 1483 Mtoe primary energy or no more than 1086 Mtoe of final energy). This target is established only at EU level and does not impose legally binding effort-shared national targets. The most significant binding measures included in the Directive are the following ones:

- Setting indicative national energy efficiency target for 2020 (Art. 3);
- National building renovation strategies and plans (Art. 4);
- 3% renovation of public buildings (Art. 5);
- Purchasing of high energy efficiency products, services and buildings by public bodies (Art.6);
- Energy efficiency obligation schemes (Art. 7);
- Energy audits and energy management systems (Art. 8);
- Metering and informative billing (Arts. 9-12);
- Promotion of Combined Heat & Power (CHP) and District Heating & Cooling (DHC) (Art. 14);
- Efficiencies in energy transmission and distribution (Art. 15);
- Horizontal provisions (Arts. 16-20).

On 26 March 2015, every Member State of the European Union, with the sole exception of Malta, was hit by legal action over failures to fully translate the Energy Efficiency Directive into national legislation by 5 June 2014.

In line with the strategy to drive progress towards a low-carbon economy, on 22 January 2014, EU Member States have agreed on a new 2030 framework for climate and energy[11], including EU-wide targets and policy objectives for the period between 2020 and 2030. The Commission's Green Paper[12] framework follows the 20-20-20 climate and energy package and represents the first phase towards developing policies and a regulatory framework for EU climate change and energy policies up to 2030. It aims at: cutting greenhouse gas emissions by 40% compared to 1990 level, increasing the share of renewable energy to at least 27%, continuing the improvements in energy efficiency (at least 27% energy savings compared with the business-as-usual scenario), reforming the EU emissions trading system, affording competitive and secure energy, promoting new governance system, reporting energy prices and costs.

According to the Energy Efficiency Communication of July 2014, the EU is expected to achieve energy savings of 18%-19% by 2020 – missing the 20% target by 1%-2%. However, if EU countries implement all of the existing legislation on energy efficiency, the 20% target can be reached without additional measures.

[10] European Commission (2011) Proposal for a Directive on Energy Efficiency. COM (2011) 70 final.

[11] 2030 climate and energy goals for a competitive, secure and low-carbon EU economy, Brussels, 22 January 2014.

[12] Green Paper: A 2030 framework for climate and energy policies COM(2013) 169 final.

1.3 Economic and energy situation in the selected countries

Reducing energy consumption without compromising economic growth is the overarching aim of the EU's energy policy. Since the 1990s, the three core pillars of EU energy policy are represented by sustainability, competitiveness and security of supply. Sustainability, to actively combat climate change by promoting renewable energy sources and energy efficiency; competitiveness, to improve the efficiency of the European energy grid by creating a truly competitive internal energy market that can bring substantial economies of scale and welfare benefits; security of supply, to better coordinate the EU's supply of and demand for energy within an international context and to minimize the EU's vulnerability concerning uncertainties with respect to future supply.

Many international institutions (IEA, 2013; European Commission, 2011; OECD, 2011) suggest that energy efficiency is the best tool to keep energy demand under control and transition towards a low-carbon future. This consensus extends to the key role of the residential sector in this strategy, given that it presents the highest cost-efficient potential for mitigation.

Table 1, 2 and 3 give an overview of the economic, energy and environmental situation of the European Union and the selected countries for this report (Finland, Germany, Hungary, Italy, Latvia, Romania, Spain, and the United Kingdom).

Over the period 1995-2013, the European Union economy as a whole grew by 34%; GDP and private consumption at 2005 PPP increased with an average annual rate of 1.88% and 3.67%, respectively.

The contribution of the tertiary sector to the overall GDP increased from 63.2% in 1995 to 66.5% in 2013, while industry decreased by 17.6% in the same period representing the 21.9% in 2013.

Germany is the world's fourth biggest economy and Europe's largest (IMF, 2015). Germany economy grew by 25.5% in the period 1995-2013; GDP and private consumption at 2005 PPP increased with annual average rate of 1.42% and 0.92%, respectively. The tertiary sector contributed for almost 63% of total GDP in 2013, while the industry for the 26.9%.

Germany is a leading exporter of machinery, vehicles, chemicals, and household equipment and benefits from a highly skilled labour force. Almost 10% of Europe's manufacturing companies are German. They generate 30% of the EU's gross value added in manufacturing alone. In fact, they represent more than one fifth of all of Germany's value added – one of the highest shares in Europe.

The population of Germany was estimated at 80.767,5 as of 2013 equivalent to 15.9% of the total European Union population. The population grew slightly from 1995 to 2013 by 1.28%.

Finland is the world's forty-second biggest economy (IMF, 2015). Finland economy grew by 51.2% in the period 1995-2013; GDP and private consumption at 2005 PPP increased with annual average rate of 2.9% and 2.89%, respectively.

Finland has a highly industrialized, largely free-market economy with per capita output almost as high as that of Austria, Belgium, the Netherlands, and Sweden. Trade is important with exports accounting for over one third of GDP in recent years. Finland is strongly competitive in manufacturing - principally the wood, metals, engineering, telecommunications, and electronics industries - and excels in high-tech exports such as mobile phones. Except for timber and several minerals, Finland depends on imports of raw materials, energy, and some components for manufactured goods. Because of the climate, agricultural development is limited to maintaining self-sufficiency in basic products. Forestry, an important export earner, provides a secondary occupation for the rural population.

The population of Finland was estimated at 5.451,27 as of 2013, equivalent to 1% of the total European Union population. The population from 1995 to 2013 increased by the 6.5%.

Hungary is the world's fifty-eight biggest economy (IMF, 2015). Hungary economy grew by 44% in the period 1995-2013; GDP and private consumption at 2005 PPP increased with annual average rate of 2.44% and 1.84%, respectively. The tertiary sector accounted for almost the 58% of total GDP in 2013, while the industry sector for 24.7%.

The service sector accounts for about 60% of GDP and its role in the Hungarian economy is steadily growing due to constant investments into transport and other services in the last 15 years. Located in the heart of Central-Europe, Hungary's geostrategic location plays a significant role in the rise of the service sector as the country's central position makes it suitable and rewarding to invest. The main sectors of the Hungarian industry are heavy industry, energy production, mechanical engineering, chemicals, food industry and automobile production.

The population of Hungary was estimated at 9.903,2 as of 2013 equivalent to 1.9% of the total European Union population. The population decreased from 1995 to 2013 by 4.1%.

Italy is the world's eight biggest economy (IMF, 2015). Italy economy grew by 9.51% in the period 1995-2013; GDP and private consumption at 2005 PPP increased with annual average rate of 0.52% and 0.53%, respectively.

Its economic structure relies mainly on services and manufacturing. The tertiary sector accounted for almost three quarters of total GDP in 2013 (67.9%) and employed around 65% of the country's total employed people. Within the tertiary sector, the most important contributors are the wholesale, retail sales and transportation sectors. Industry accounted for the 21% of Italy's total production and employed around 30% of the total workforce. Manufacturing is the most important sub-sector within the industry sector. The country's manufacturing is specialized in high-quality goods and is mainly run by small- and medium-sized enterprises. Most of them are family-owned enterprises. Agriculture contributed the 2% share of total GDP and it employed around 4.0% of the total workforce.

The population of Italy was estimated at 60.782,67 as of 2013, equivalent to 11.9% of the total European Union population. The population from 1995 to 2013 remained almost stable.

Latvia is the world's ninety-eight biggest economy (IMF, 2015). Latvia economy grew by 116.7% in the period 1995-2013; GDP and private consumption at 2005 PPP increased with annual average rate of 6.48% and 5.8%, respectively.

Latvia is a small, open economy with exports contributing nearly a third of GDP. Due to its geographical location, transit services are highly developed, along with timber and wood processing, agriculture and food products, and manufacturing of machinery and electronics industries.

The population of Latvia was estimated at 2.023,83 as of 2013, equivalent to 0.3% of the total European Union population. The population declined dramatically from 1995 to 2013 by 19%.

Romania is the world's fifty-third biggest economy (IMF, 2015). Romania economy grew by 37.65% in the period 1995-2011; GDP and private consumption at 2005 PPP increased with annual average rate of 2.35% and 3.27%, respectively.

Romania, which joined the European Union on 1 January 2007, began the transition from Communism in 1989 with a largely obsolete industrial base and a pattern of output unsuited to the country's needs. The country emerged in 2000 from a punishing three-year recession thanks to strong demand in EU export markets. Domestic consumption and investment fuelled strong GDP growth, but led to large current account imbalances. Romania's macroeconomic gains have only recently started to spur creation of a middle class and to address Romania's widespread poverty.

The population of Romania was estimated at 20.121,7 as of 2011, equivalent to about 4% of the total European Union population. The population declined from 1995 to 2011 by 11.2%.

Spain is the world's fourteenth biggest economy (IMF, 2015). Spain economy grew by 47.8% in the period 1995-2013; GDP and private consumption at 2005 PPP increased with annual average rate of 2.61% and 2.28%, respectively.

The economic structure is principally dominated by its tertiary sector, which accounted for about 66.5% of its GDP in 2013. Spain's tourism industry is the one of the largest in the world, next only to France and the US. The industry contributed nearly 21% to the nation's GDP, and has been responsible for employment of over 2 million individuals in the Spanish economy. After the tertiary sector, Spain's industry sectors have been the second largest contributor to the economy, employing about a quarter of the nation's total labour force. The industry sector, which comprises of textiles, chemicals, shipbuilding, automobiles, metals and machine tools, was also responsible for a majority of the exports. The contribution of the agricultural sector to the total GDP was of only the 2.5%; despite this, Spain continued to be Europe's biggest cultivator of oranges, strawberries and lemon and the world's largest producer of olive oil.

The population of Spain was estimated at 47.129,780 as of 2013, equivalent to 9.2% of the total European Union population. The population from 1995 to 2013 increased by 19.3%.

The ***United Kingdom*** is the world's fifth biggest economy and the second largest in Europe (IMF, 2015). The United Kingdom economy grew by 44% in the period 1995-2013; GDP and private consumption at 2005 PPP increased with annual average rate of 2.44% and 0.2%, respectively.

The United Kingdom's economic structure is principally dominated by its tertiary sector, which accounted for more than the 70% of its GDP in 2013, followed by the industry (16.4%) and the agriculture sector (0.6%). Within the tertiary sector, the most important contributors are banking, insurance, and business services. Manufacturing of goods is particularly important for UK industries; within manufacturing, the production of automotive or aerospace equipment is a major contributor to UK industries. With regard to the agriculture sector, despite only contributing the 0.6% of UK's GDP in 2012, it is still considered an important part of the UK's economy and society as it produces 60 percent of the UK's food needs. From 1995 to 2012 the tertiary sector increased by 61.5%, while the industry and the agriculture sector decreased by 5.3% and 36.4%, respectively.

The population of United Kingdom was estimated at 64.105,7 as of 2013, equivalent to 12.6% of the total European Union population. The population from 1995 to 2013 increased by the 10.4%.

In 2013, European Union's primary energy consumption amounted to 1.666,32 Mtoe – a 0.29% decrease compared to the level of 1995 (1709 Mtoe) – reaching its peak in 2006, with 1.831,90 Mtoe. However, Belgium, Denmark, Germany, Estonia, France, Poland, Portugal and Slovakia showed an increase in primary energy consumption in 2013 compared to 2012. Final energy consumption amounted to 1.101,63 Mtoe in 2013. Of this, the predominant end-use sector has been transport (31.6%), followed by residential (26.8%), industry (24.8%), tertiary (14.5%) and agriculture (2.1%). Overall, from 1995-2013 the final energy consumption per capita increased by 2.26%. The residential energy consumption increased by 4.3% (even if the residential energy consumption per capita decreased by 0.95%), the tertiary energy consumption increased by 24.6%, the transport energy consumption increased by 13.6%, while the industry and the agriculture sector decreased their consumption of 16.4% and 23.3%, respectively.

Table 1 shows the general socio-economic table 2 shows the main energy-related data (2013) of the European Union and the countries under investigation.

Table 1. General socio-economic data (2013)

SOCIO-ECONOMIC										
Item	**Unit**	**EU 28**	**Finland**	**Germany**	**Hungary**	**Italy**	**Latvia**	**Romania***	**Spain**	**United Kingdom**
GDP at exchange rate	M€2005	11764570,38	170817,61	2553820,04	91020,33	1410876,68	15436,21	88496,11	948219,58	2072796,95
GDP at 2005 PPP	M€2005p	11764570,38	146247,96	2466077,02	146915,89	1362770,87	30025,17	192571,18	1037701,63	1911584,26
Population	k	507162,57	5451,27	80767,5	9903,2	60782,67	2023,83	20121,7	47129,78	64105,7
Number of households	k	216124,42	2599,61	39933	4041,91	24997,79	822	7087	18217,3	26955,81
Private consumption of household at exchange rate	M€2005	7147898,76	90058,73	1404229,25	54536,2	843556,1	9874,27	65925,89	521847,66	1232029,71
Private consumption of household at 2005 PPP	M€2005p	7147898,76	77105,08	1355983,36	88026,87	814793,88	19206,58	143457,44	571093,64	1136208,06
Value added of agriculture at exchange rate	M€2005	176568	4647,87	16228,74	2656,76	30385,03	570,23	4961,22	28813,42	12023,3
Value added of agriculture at 2005 PPP	M€2005p	176568	3979,34	15671,16	4288,27	29349,01	1109,15	10795,81	31532,5	11088,18
Value added of industry at exchange rate	M€2005	2581835	43323,02	687014,15	22557,64	296236,76	2630,58	32662,4	197694,56	337399
Value added of industry at 2005 PPP	M€2005p	2581835	37091,63	663410,02	36410,29	286136,16	5116,77	71074,74	216350,7	311157,64
Value added of tertiary at exchange rate	M€2005	7832542	97823,51	1609570,11	53494,35	959091,06	10162,52	42632,49	631045,02	1459306,06
Value added of tertiary at 2005 PPP	M€2005p	7832542	83753	1554269,21	86345,22	926389,51	19767,25	92770,04	690595,78	1345807,89

Source: Odyssee database

* Data for Romania are of 2011

Table 2. Data related energy consumption (2013)

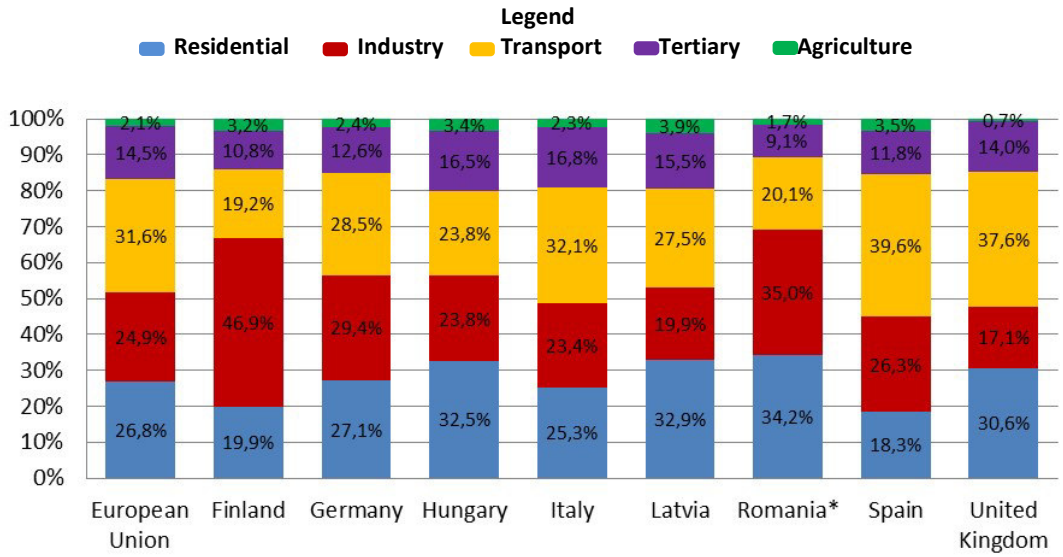
ENERGY										
Item	**Unit**	**EU 28**	**Finland**	**Germany**	**Hungary**	**Italy**	**Latvia**	**Romania***	**Spain**	**United Kingdom**
Total primary consumption with climatic corrections	Mtoe	1672,51	32,01	336,66	23,09	161,07	4,46	34,49	118,32	190,77
Total primary consumption	Mtoe	1666,32	31,6	330,85	22,74	158,1	4,42	34,48	118,5	191,8
Total final consumption with climatic corrections	Mtoe	1107,83	27,04	225,41	15,22	121,86	3,9	24,15	80,61	133,66
Total final consumption	Mtoe	1101,63	26,64	219,6	14,87	118,9	3,86	24,13	80,79	134,69
Final consumption of industry	Mtoe	274,25	12,49	64,54	3,54	27,84	0,77	8,44	20,75	23,03
Final consumption of transport	Mtoe	348,37	5,11	62,48	3,54	38,19	1,06	4,86	31,83	50,63
Final consumption of tertiary	Mtoe	159,82	2,89	27,66	2,46	20,01	0,6	2,2	9,56	18,9
Final consumption of agriculture	Mtoe	23,43	0,85	n.a.	0,51	2,79	0,15	0,4	2,79	0,98
Final consumption of residential (with climate correction)	Mtoe	300,32	5,62	63,81	5,06	32,1	1,3	8,27	14,73	39,32
Final consumption of residential	Mtoe	295,76	5,3	59,54	4,84	30,05	1,27	8,26	14,81	41,17
➢ Coal	Mtoe	10,17	0	0,68	0,13	0	0,01	0,01	0,09	0,66
➢ Oil	Mtoe	38,49	0,39	13,31	0,01	2,57	0,05	0,18	2,76	2,71
➢ Gas	Mtoe	110,5	0,03	23,07	2,51	14,03	0,1	2,29	3,19	26,5
➢ Heat	Mtoe	22,42	1,57	4,41	0,52	0,93	0,37	1,12	0	0,05
➢ Wood	Mtoe	43,18	1,46	6,18	0,74	6,76	0,58	3,66	2,52	1,48
➢ Electricity	Mtoe	70,99	1,85	11,9	0,91	5,76	0,15	1	6,24	9,75
Space heating	Mtoe	200,06	3,73	42,97	n.a.	22,08	0,85	3,98	7,07	31,94
Water heating	Mtoe	37,98	0,78	9,62	n.a.	2,49	0,23	0,96	3,3	7,97
Cooking	Mtoe	13,99	0,05	2	n.a.	1,61	0,09	2,35	1,03	1,17
Air cooling	Mtoe	n.a.	n.a.	n.a.	n.a.	0,67	n.a.	n.a.	0,15	0
Electrical appliances and lighting	Mtoe	42,51	0,73	7,58	n.a.	3,22	0,11	0,94	3,47	6,95
Total stock of dwellings	k	n.a.	2905,73	40995	4402,01	31593,93	1041,49	8459	26112,42	27914
Stock of dwellings permanently occupied	k	211171,02	2599,61	37715,4	3918,63	24603,55	808	7486	18217,3	27151,01
Floor area of dwellings (average)	m^2	89,75	98,23	91,3	77,00	93,65	64,4	39,76	91,44	95,29

Source: Odyssee database

* Data for Romania are of 2011

The predominant end-use sector in Europe (2013) in terms of final energy consumption has been transport (31.6%), followed by residential (26.8%), industry (24.9%), tertiary (14.5%) and agriculture (2.1%). However, there exist significant differences among countries: for example, in Finland, the transport sector has been responsible for 46.9% of the total final energy consumption, while in the United Kingdom it was only the 17.1%. In Spain, the residential sector represented only 18.3% of the total energy consumption, while in Hungary it was 32.5% in 2013. Figure 1 represents the end-use shares of final energy consumption in 2013 of the European Union and the countries under investigation.

Figure 1. End-use sector shares of final energy consumption (2013)

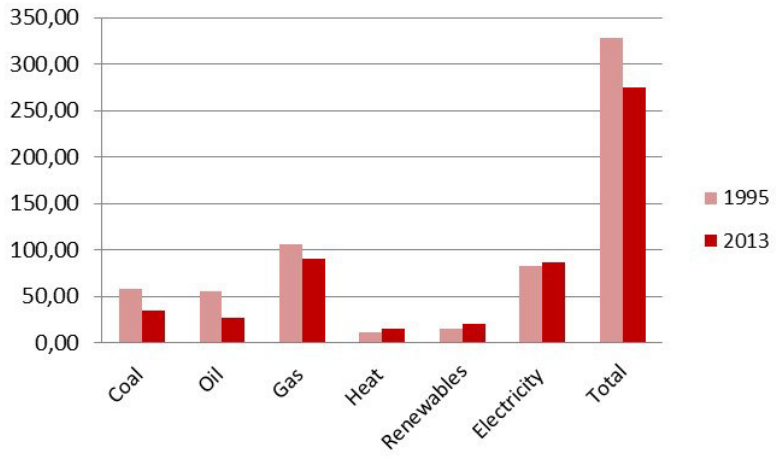


Source: Author's elaboration based on Odyssee database
* Data for Romania are of 2011

In the figures below, it is interesting to note how the contribution of the different energy sources of the industry, transport, tertiary, agriculture, and residential sector changed between 1995 and 2013 in the European Union.

In the industry sector (Figure 2), fossil fuels such as coal, oil and gas, decreased by 39.1%, 50.05%, 14.6%, respectively, from 1995 to 2013. Gas and electricity represented together the 64.5% of the final industry energy consumption in 2013. Renewables increased by 37.3% from 1995-2013, but still representing only the 7.3% of the total consumption in the industry sector (2013).

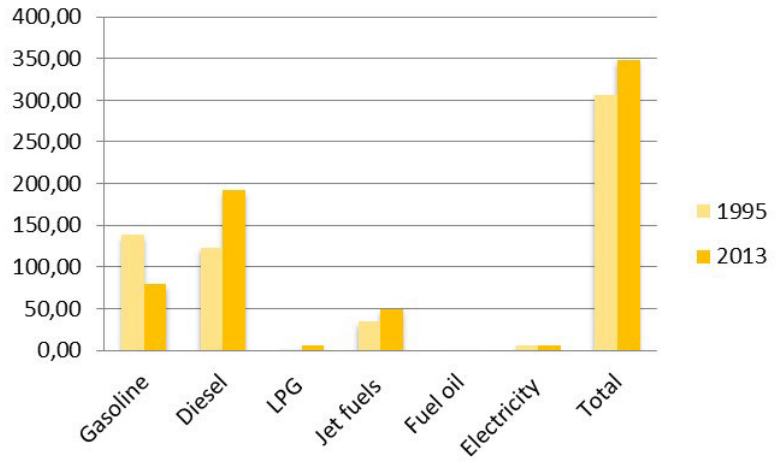
Figure 2. EU industry energy consumption by source (1995-2013)



Source: Author's elaboration based on Odyssee database

In the transport sector (Figure 3), gasoline and diesel represented the predominant sources of energy, being together 77.7% of the final transport energy consumption in 2013; however, gasoline over the period 1995-2013 decreased by 42.57% while diesel increased by 55.4% in the same period. Jet fuels represented 14% of the final transport energy consumption in 2013, while fuel oil (0.2%), electricity (1.5%) and LPG (1.6%) were almost inexistent.

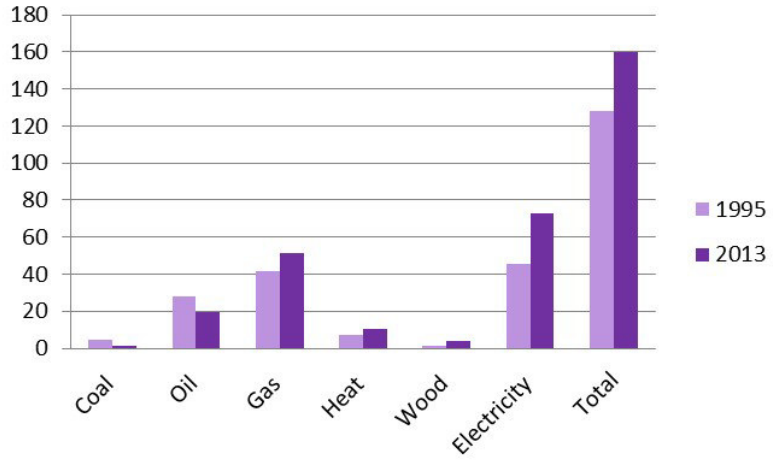
Figure 3. EU transport energy consumption by source (1995-2013)



Source: Author's elaboration based on Odyssee database

In the tertiary sector (Figure 4), electricity was the source of energy more used in 2013, being 45.6% of the final tertiary energy consumption. The electricity consumption grew by 60% from 1995 to 2013, thus reflecting the overall increase of energy consumption in this sector. Gas accounted for 51.68 Mtoe in 2013, followed by oil (19.66 Mtoe), heat (10.4 Mtoe), wood (3.88 Mtoe) and coal (1.17 Mtoe).

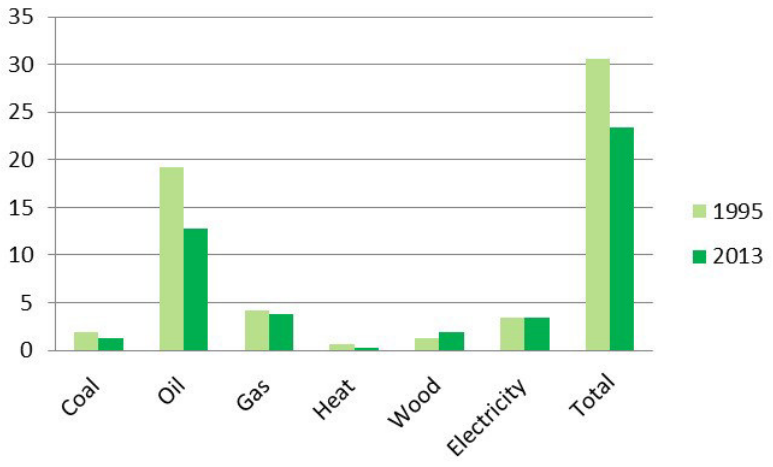
Figure 4. EU tertiary energy consumption by source (1995-2013)



Source: Author's elaboration based on Odyssee database

In the agriculture sector (Figure 5), even though the usage of oil decreased by 33.4% over the period 1995-2013, it still represented the principal source of energy, being 54.5% of the final agriculture energy consumption in 2013. With the exception of oil, electricity and gas were the sources of energy most consumed in 2013 accounting together for the 30.6% of the total energy consumed in the agriculture sector. While coal and heat decreased their consumption, wood increased by 56% (1.95 Mtoe in 2013).

Figure 5. EU agriculture energy consumption by source (1995-2013)

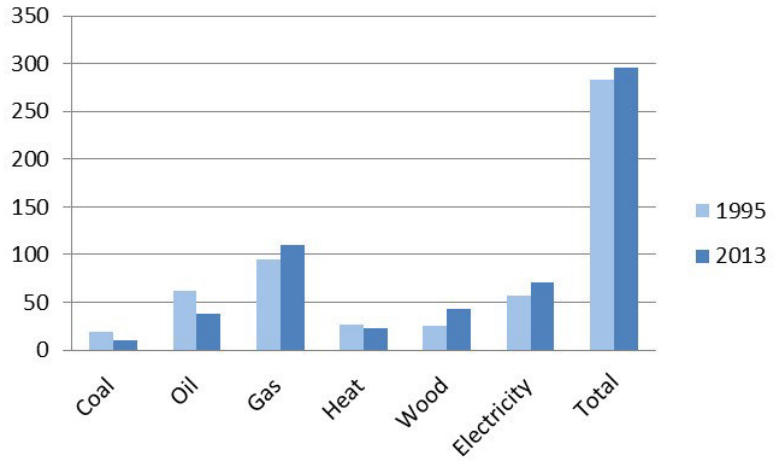


Source: Author's elaboration based on Odyssee database

In the residential sector (Figure 6), gas represented the principal energy source in 2013, accounting for 110.5 Mtoe; it represented 37.2% of the final residential energy consumption, and increased by

16.67% from 1995 to 2013. Electricity was responsible for 24% of the final residential energy consumption in 2013, followed by wood (14.5%), oil (13%), heat (7.5%) and coal (3.4%). While the usage of coal, oil and heat has been reduced, wood increased by 67.4% from 1995-2013.

Figure 6. EU residential energy consumption by source (1995-2013)

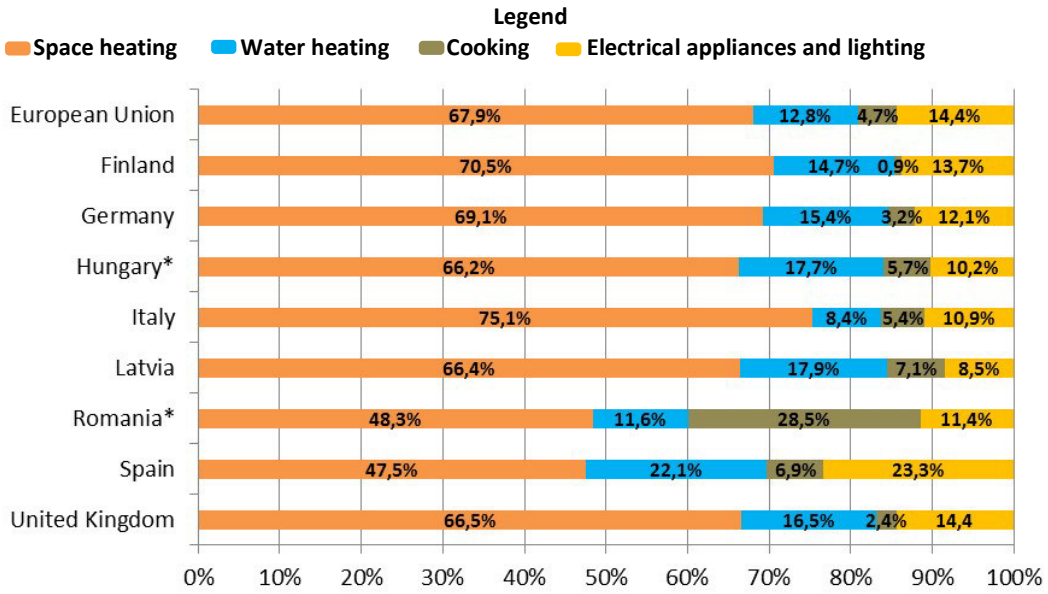


Source: Author's elaboration based on Odyssee database

The residential sector is in the focus in this report. From 1995 to 2013, the final energy residential consumption in Spain decreased by over 48%; in Finland it increased by 23.5%, in Italy 17.2% and in the United Kingdom 2.1%, while in Germany, Hungary, Latvia, Romania the residential energy consumption decreased by 6.12%, 22.5%, 20.6%, 6.3%, respectively.

Figure 7 represents the final residential energy consumption by end-use in 2013. In Europe, space heating holds the largest portion of households energy use representing in 2013 the 67.9%, followed by water heating (12,8%), electrical appliances and lighting (14.4%) and cooking (4.7%).

Figure 7. Final residential energy consumption by end-use 2013 (%)



Source: Author's elaboration based on Odyssee database
* Data for Hungary and Romania are of 2010 and 2011 respectively.
** The energy end-use "air cooling" is not represented in the figure because it is not significant.

In 2013, Finland had the highest final energy residential consumption per capita (Toe per inhabitant, 0.97), followed by Germany (0.73), Latvia (0.62), United Kingdom (0.61), Italy (0.49), Hungary (0.48), Romania (0.41)[13], Spain (0.31).

In ***Finland***, over the period 1995-2013, the sources of energy consumption had different evolutions.

The penetration of electricity has always been significant, being the principal "source" of energy (generated by gas, coal, oil, renewables, etc.). From 1995 to 2013, it increased by 32.1% and represented 34.9% of the total residential energy consumption, followed by heat (29.6%) and wood (27.5%). Fossil fuels such as oil, gas and coal all together accounted for only 7.9% of the total energy used.

In ***Germany***, with the exception of the years 1995, 1997 and 1998 in which oil dominated, gas has always been the principal source of energy accounting for a 38.7% share of the final residential energy consumption in 2013. However, gas increased by 9.44% and oil decreased by 40.1% from 1995 to 2013. The electricity with 11.9 Mtoe was the third "source" of energy, being 19.9% of the final consumption in 2013. While the use of coal has been minimal, the use of both wood and heat represented 17.7%.

In ***Hungary***, gas has always been the principal source of energy, representing 51.8% of the final residential energy consumption in 2013, but it decreased from 1995 to 2013 by 13.1%. Other fossil fuels like coal and oil were almost disappearing, accounting together for only 2.8% of the total energy used in 2013 in the residential sector. While heat decreased by 33.3%, electricity and wood (that were the second and the third source of energy in 2013) increased by 8.3% and 23.3%, respectively, over the period 1995 – 2013.

[13] Data are of 2011.

In ***Italy***, the principal source of energy in the period 1995 – 2013 has been gas, representing 46.7% of the final residential energy consumption in 2013. Oil decreased by 56.9% from 1995 to 2013, while coal from the year 2008 was not used anymore, and the use of heat was only 0.93 Mtoe in 2013. The evolution of wood has been significant: it increased by 619.15% over the period 1995 – 2013, being the second source of energy in 2013 (22.4% of the final energy residential consumption).

In ***Latvia***, even though the contribution of wood to the final energy residential consumption decreased by 19.4% in the period 1995-2013, it was the principal source of energy in 2013 (45.6%). Oil, gas and coal, represented all together a 12.5% share of the total final consumption in 2013, while electricity accounted for 11.8%. Heat declined from 1995 to 2013 by 38.3%, but it still was the second source of energy in 2013 (29.1%).

In ***Romania***, wood represented the main source of energy for the period 1995-2011, and it was 44.3% of the final energy residential consumption in 2011, followed by gas (27.7%). Coal, Oil and heat had a high drop in the period 1995 – 2011. Coal -83.3%, oil -40%, heat -56.4%; their total share of the final energy residential consumption, fell from 33.2% to 15.8%.

In ***Spain***, electricity and gas had a steady growth over the period 1995 – 2013 and they have been the main energy sources in 2013, representing 42.1% and 21.5%, respectively, of the total residential energy consumption. While the use of coal and heat has been insignificant, oil accounted for 18.6% and wood for 17% of the total residential energy consumption in 2013.

In the ***United Kingdom***, the structure of final energy residential consumption did not substantially change in the period 1995-2013. Gas has been the predominant source of energy for the period under consideration with 64.3% of the total final energy residential consumption in 2013. While the use of heat, coal and wood has been insignificant, the use of electricity represented the 23.6% in 2013, followed by oil (6.5%).

Residential buildings are responsible for one-third of global energy-related GHG emissions. Measures for saving energy and enhancing the efficiency of energy consumption contribute towards meeting reduced GHG emissions and so do the increased use of renewable energies.

Energy consumption in residential buildings has considerable effects on climate change. On the other hand, the energy patterns in residential buildings are also influenced by climate change because climate change influences the mean and variance of key climate factors such as solar irradiation, precipitation, wind speed and direction, temperature, and humidity.

The improvement in energy efficiency has been viewed as providing at least two broad benefits in the climate arena:

- Slowing the growth of energy use, to buy time for non-emitting supply technologies to reduce the average emission rates;
- Reducing the cost of meeting CO_2 emission reduction goals.

The residential sector's share of total CO_2 emissions in the European Union from 1995 to 2012 decreased by 11.89%; the CO_2 emissions per dwelling decreased by 29.8% and the CO_2 emissions of space heating per dwelling decreased by 31.6%.

With the exception of Spain and Romania, all the other countries decreased their total CO_2 emissions in the residential sector. In fact, in Spain the total CO_2 emissions of the residential sector increased by 32.9% from 1995 to 2012, and in Romania, from 1995 to 2011 by 2.4%. However, in Germany, the total CO_2 emissions of the residential sector decreased by 19.6%, in Finland by 25.1%, in the United Kingdom 5.14%, in Italy 6.1%, in Latvia f 50.1%, in Hungary by 38.9%.

Below, the Table 3 shows the residential sector's CO_2 emissions in 2012 of the European Union and of the countries object of this study.

Table 3. Environmental aspects of residential energy consumption (2012)

ENVIRONMENT										
Item	**Unit**	**EU 28**	**Finland**	**Germany**	**Hungary**	**Italy**	**Latvia**	**Romania***	**Spain**	**United Kingdom**
CO_2 emissions of households (excluded electricity)	$MtCO_2$	410,35	1,43	93,32	7,35	47,27	0,45	7,1	16,66	72,98
Total CO_2 emissions of households (included electricity)	$MtCO_2$	781,75	6,23	177,34	11,63	75,37	1,06	16,44	44,21	133,5
CO_2 emissions per dwelling	tCO_2/dw	1,95	0,55	2,44	1,87	1,92	0,56	0,95	0,92	2,71
CO_2 emissions per dwelling (with climatic corrections)	tCO_2/dw	1,98	0,56	2,52	1,92	2,01	0,56	0,95	0,92	2,7
CO_2 emissions per dwelling with climatic corrections (included electricity)	tCO_2/dw	3,74	2,42	4,71	3,02	3,16	1,31	2,2	2,44	4,95
CO_2 emissions of space heating per dwelling	tCO_2/dw	1,58	0,44	2,01	n.a.	1,57	0,27	0,26	0,55	2,31
CO_2 emissions of space heating (with climatic corrections)	tCO_2/dw	1,63	0,45	2,08	n.a.	1,44	0,27	0,22	0,54	2,27
CO_2 emissions of space heating with climatic corrections (included electricity)	tCO_2/dw	2,03	1,39	2,3	n.a.	1,67	0,53	0,35	0,91	2,74
Degree-days	degree	2733,08	4423	3573,87	2770,95	1828,97	4357	3061,92	1871,27	3182,72

Source: Odyssee database

* Data for Romania are of 2011

1.4 Specific data on residential building stock and related energy use

The importance of building characteristics for the level of residential energy demand has been determined in diverse studies. Brounen et al. (2012), compared the importance of the physical structure of a home with the demographic characteristics of households in the consumption of energy by Dutch households. Their empirical results showed that the cross-sectional variation in residential energy consumption is a function of both technical characteristics of the dwelling and the composition and background of the household. However, in case of gas consumption, the thermal attributes of the structure are dominant. For example, residents living in a well-maintained and insulated home consume about 12% less natural gas as compared to the same home with a lower level of maintenance and insulation. Per capita gas consumption in dwellings constructed before 1980 is about 50% higher when compared to dwellings constructed during the past decade. With respect to residential electricity demand, they found that household composition is paramount. For instance, families with children consume almost one-fifth more electricity than families without children (even though per capita consumption is lower), and this effect becomes stronger when the age of children increases. Per capita electricity consumption is also more sensitive to changes in income than gas consumption is. Other studies have shown that occupant behaviour might play a prominent role in the variation in energy consumption in different households, but the extent of such influence is as important as the dwelling characteristics (Santin et al., 2009). They found that the occupant characteristics and behaviour significantly affect energy use (4.2% of the variation in energy use for heating), but building characteristics still determine a large part of the energy use in a dwelling (42% of the variation in energy use for heating).

Although building characteristics are known to have a significant effect on energy consumption, their influence in residential buildings has decreased in recent years because governments worldwide have introduced regulations and policies to raise energy performance in the built environment. These regulations are designed first and foremost to increase system efficiency and to improve the thermal properties of new buildings. Meanwhile, renovation programmes are being launched to raise the energy performance of existing buildings.

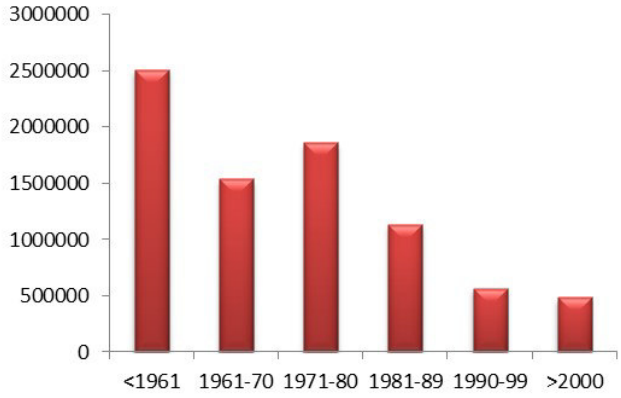
The performance of buildings depends on a number of factors such as the typology, age, typical type of construction, façade types and glazing types, floor area, geometry and number of floors, U-value and thermal characteristic and performance, ownership and tenure i.e. number of social housing, owner occupied, private renting etc., fuel and heating system types, climatic conditions, behaviour characteristics (e.g. typical indoor temperatures) and social conditions. While new buildings can be constructed with high performance levels, older buildings represent the vast majority of the building stock in the European Union, which are predominantly of low energy performance and subsequently in need of renovation work. With their potential to deliver high energy and CO_2 savings as well as many societal benefits, energy efficient buildings can have a pivotal role in a sustainable future.

A substantial share of the stock in Europe is older than 50 years with many buildings in use today that are hundreds of years old. More than 40% of the EU residential buildings have been constructed before the 1960s when energy building regulations were very limited. Countries with the largest components of older buildings include the UK, Denmark, Sweden, France, Czech Republic and Bulgaria (BPIE, 2011).

The UK has around 27 million homes across a wide range of housing types, including a significant proportion of older buildings, as shown in figure 8. The prevalence of older buildings in the national stock built to lower standards of energy efficiency leaves a considerable legacy of non-energy efficient features. Older homes typically have no, or lower quality insulation than more modern

homes and if they have solid walls, they are more difficult to bring up to modern standards of insulation.

Figure 8. Dwelling stock by age (UK)



Source: Housing Survey (2013)

Dwellings are categorised as detached houses, semi-detached houses, terraced houses, flats or bungalows. Terraced house is the most common house type in the UK, representing the 27.8% of homes, followed by semi-detached houses (24.9%), flats (20.6%), detached (17.5%), and bungalows (9.1%).

Regarding the size of the dwellings, 9.3% are smaller than 50 m², 21.6% are between 50-69 m², 28.5% are between 70-89 m², 15.6% between 90-109 m² and the 24.7% are larger than 110 m².

In 2011, around two-thirds (63%) of homes in the UK were owner occupied and recent years have seen a rapid growth in the private rented sector which accounts for 18% of homes in the UK. The level of owner occupation has implications for the policy design to improve the efficiency level. Owner-occupiers benefit directly from energy efficiency upgrades, whereas landlords may pay for improvements while their tenants benefit from lower bills. In the last years, there has been a decline in the number of socially rented homes, which are provided by housing associations or local authorities. However, at 18%, the UK still has some of the highest levels of social housing in Europe.

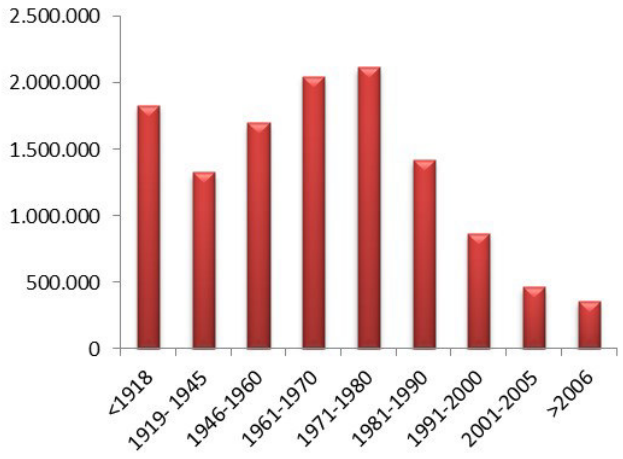
In England, approximately half of the homes have an Energy Performance Certificate rating of D, a further 25% are rated E, and 6% of homes are F or G rated. Scotland has a lower proportion of the least efficient housing with 4% rated F or G. Considering the range of rates from A, the most efficient, to G, least efficient, the picture looks rather concerning.

In ***Italy***, there are about 13.6 million buildings, most of them for residential use; the rest is for non-residential use (hotels, offices, trade, hospitals, churches, etc.). Approximately 5.8 million of the residential buildings are concentrated in just five regions: Sicily, Lombardy, Veneto, Puglia and Piedmont. Alone, Sicily and Lombardy account for 23.9% of the country's residential buildings.

In 2011, buildings for residential use were 12.1 million and comprised more than 29 million dwellings. More than 60% of this building stock is over 45 years old, and more than 25% of total buildings are in the consumption band between 160 kWh/(m²*year) and over 220 kWh/(m²*year).

In Italy, about 72% of the residential building stock existing in 2011 was built after 1976, the year the first thermal regulation came into force (Figure 9).

Figure 9. Residential building stock by construction period (Italy)



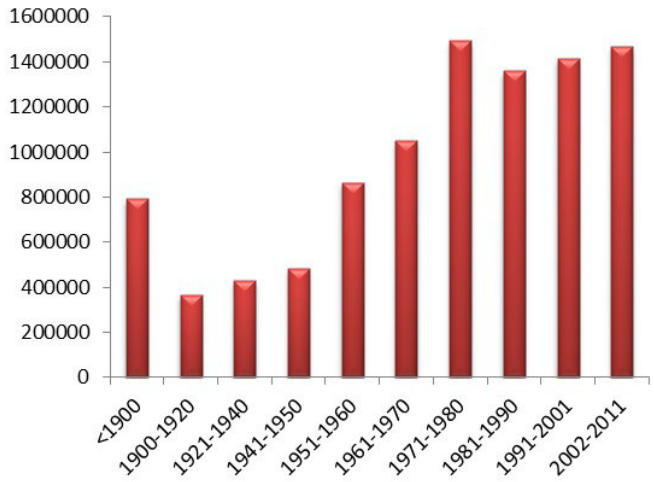
Source: ISTAT (2011)

There are approximately 24 million of dwellings permanently occupied in the national territory. Of this, 73.9% are in multi-family buildings with an average size of 91 m², while the single-family dwellings (26.1% of the total residential stock) have an average size of 110 m².

In ***Spain***, based on information gathered from the latest INE census in 2011 and on data constructed according to the 'main intended use of new buildings' from Ministry of Development statistics, it is estimated that the national stock in 2011 comprise 9.730.99 million buildings, occupying around 2.500 million m² of usable space, 2.100 million m² of which for domestic use and 400 million m² for tertiary or service use.

The breakdown of the building stock by year of construction (Figure 10), indicates that 16.3% of the buildings have been built before the 1940 (tradition buildings), 13.8% between 1940 and 1960 (first cycle of urban expansion with block types), 26.1% between 1960 and 1980 (second cycle of urban expansion with changes in construction systems), and 43.6% between 1980 and 2011 (recognising new technical changes and period of application of NBE-CT/79 that required a minimum of thermal insulation in envelopes; from 2008 onwards, implementation of the Technical Building Code, CTE, which requires energy efficiency conditions for the buildings).

Figure 10. Building stock by construction period (Spain)



Source: INE (2011)

There are 25.2 million existing dwellings in Spain, distributed as follows, according to the 2011 census: 71.5% main dwellings (17.528.518 dwellings), 14.8% secondary dwellings (3.616.695) and 13.8% empty and other dwellings (3.374.291).

Of the more than 18 million Spanish dwellings permanently occupied, nearly half fall between 61 m² and 90 m² in size; of this 29.6% (5.354.920 dwellings) are between 76 m² and 90 m² and 18.6% (3.360.925) are between 61 m² and 75 m².

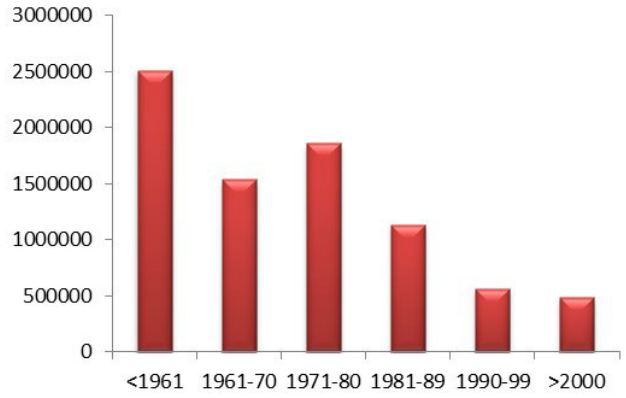
In detail, exploiting the land register information from 2013 makes it possible to differentiate the following dwelling types based on the use of the dwelling: shared (multi-family) in a block or open building, which accounts 24.1% of the total national dwellings, shared (multi-family) in perimeter blocks, which accounts for 46.3% and, within single-family dwellings, detached and semi-detached homes, which account for 10% of the total stock, and terraced single-family dwellings or dwellings in a perimeter block (in a traditional urban area or a recent low-density development), which amount to 19.6% of the total.

In ***Romania***, the total building floor area is 493.000.000 m², 86% of which represents residential buildings. Among the 8.1 million dwellings, single-family homes are dominant, accounting for 61% of the total. The following can be stated with reference to the residential sector:

- 88.5 % of the dwellings are permanently inhabited;
- Almost half of the total number of all homes (47.5%) are located in rural areas, which means that the proportion of rural population in Romania is above the European average;
- In rural areas, 95% of the dwellings are individual (single-family) homes;
- In urban areas, 72 % of the dwellings are located in apartment blocks (which comprise an average of 40 apartments per block);
- Over 60 % of the apartment blocks have four floors, while 16% have ten;
- The dominant form of ownership is private ownership, which represents 84% of the total building stock, 1 % being public property, and the remaining 15% under some form of mixed ownership;
- Homes (apartments) in apartment blocks have an average heated area of 48 m², compared with 73 m² for single-family homes.

In respect of age profile, the majority of residential buildings in Romania were built in the second half of the 20th century, especially during the period 1961–1980, as presented in figure 11. During this period, the vast majority were built without any specific thermal requirements for the building elements that form the building envelope. Thus, from the perspective of energy consumption, the existing residential building stock-still has important potential in terms of raising the standards of energy performance, which highlights, therefore, the importance of developing an ambitious strategy for the renovation of residential buildings in Romania. The analysis of the stock of residential buildings reveals that the energy used for heating represents approximately 55% of the total energy consumption of apartments and up to 80% in the case of individual houses. Depending on the climate zone, a single-family home consumes an average of 24% more energy per m² than a home (apartment) in an apartment block.

Figure 11. Residential building stock by construction period (Romania)



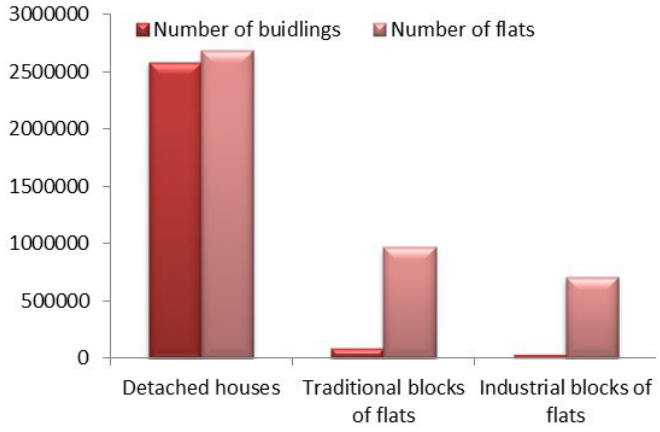
Source: Romanian National Institute of Statistics, INCD URBAN-INCERC

In ***Hungary***, according to the National Building Energy Performance Strategy of Hungary (NBEPS, 2015), the residential building stock is made up of the following three types of buildings in principle:

- Detached houses;
- Blocks of flats built by traditional technologies;
- Blocks of flats built by industrial technologies.

The representation of the different types of buildings in the building stock, in terms of the number of buildings as well as in terms of the number of dwellings, is shown in figure 12, below.

Figure 12. Types of buildings of the residential building stock (Hungary)



Source: NBEPS (2015)

The average age of buildings in the residential sector is about 50 years. Although the number of licenses for new buildings shows a slight increase again, after a downturn and then stagnation period starting about 2003, the rate of replacement of buildings remains low in the country, primarily because of financial reasons (Urbanista, 2015).

The dominating basic type of building in Hungary is a detached house, both in terms of the number of buildings (circa 95%) and the number of flats (circa 60%). Consisting of about 2.5 million flats, around 63 % of the population, equalling about 6.5 million people live in the stock of detached houses in the country (NBEPS, 2015; KSH, 2014).

Within this category, about 25% of the buildings were built before 1945 and at the same time, the representation of buildings built between 1946 and 1980 is close to 50%. Consequently, about 75% of the buildings in this category were built before 1980 and thus generally are without thermal insulation. At the same time, buildings built after year 2001 (and thus with higher thermal efficiency standards) in this category represent only about 8% of the stock (NBEPS, 2015).

So equally to Romania, the stock of detached houses in Hungary embodies the largest energy saving potential in the residential building stock, both in terms of volume and in terms of specific energy consumption values (kWh/m^2) at present.

Concerning the blocks of flats, about 40% of the stock are small-sized buildings (consisting of 1 - 3 flats), built before 2001, by traditional technologies and about 10% of the stock are large-sized buildings (consisting of 10 or more flats), built before 1945.

Furthermore, buildings built by industrial technologies represent a considerable share in the category of blocks of flats in the country: in terms of the number of buildings, their representation is slightly above 25% and in terms of the number of flats it is about 42%. Consisting of about 0.75 million flats, about 20% of the population, equalling almost 2 million people, live in the stock of buildings built by industrial technologies in Hungary.

According to the estimates of the NBEPS, about 70% of residential homes in the country are in need of energetic refurbishment and in certain proportion of these buildings, it is likely that such refurbishments are economically not viable anymore and thus it will be necessary to replace the whole building.

The private ownership of residential properties (meaning less professional owners in general) is relatively high in the country, in a comparison to other EU countries: slightly above 90% of the private homes are owned by the inhabitants, compared to the EU average of about 65% (€OSTAT, 2012).

The considerable share of condominiums[14] in the stock of blocks of flats is also an important factor in Hungary in the context of energy efficiency refurbishments, since common property many times is a hindering factor in refurbishment decisions.

According to a biannual survey into the stocks of household appliances in the country initiated by the Hungarian affiliate of the European committee of domestic equipment manufacturers (CECED Hungary), at the turn of 2012/13 in the category of large household appliances already 46% of the stock was older than 8 years old in the country and this share has grown further to 59% by 2015. Respectively, in the category of washing machines, the stock of relatively old and thus inefficient equipment has grown from circa 43% further to about 49% by 2015.

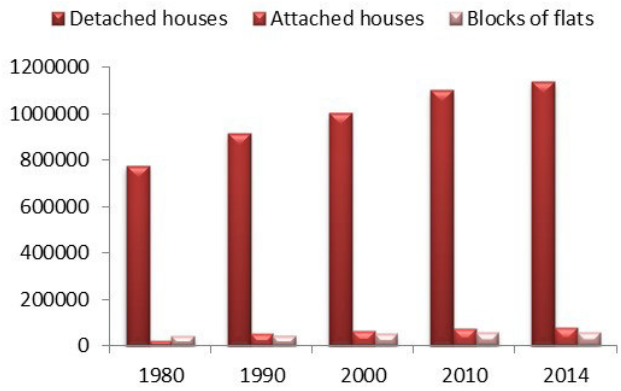
This trend is likely to be related to the economic crisis and thus the lack of capital on the part of households to invest into newer and more efficient equipment.

In ***Finland***, at the end of 2014 there were 1.277.699 residential buildings and 2.918.000 dwellings, of which 300.000 were without permanent occupants. The dwelling stock went up by 12,000 dwellings from the previous year. From 1990, the building stock has decreased by 708,000 dwellings, or by about 30,000 dwellings per year. Compared to 1990, 121,000 more dwellings were without permanent occupants. The growth in the building stock has been slowing down from the preceding decade. Most dwellings have been built in the 1970s- and 1980`s. Residential building construction has centered in urban municipalities. In all, 76 per cent of the dwellings completed in the 1995 to 2014 period are located in urban areas. Until 1990, the numbers of dwellings in detached houses and blocks of flats were still almost equal. At that time, dwellings in blocks of flats numbered 939.000 and those in detached houses only 4.000 fewer. The share of dwellings in blocks of flats grew during the 1990s, however. At the end of 2014, 45% of all dwellings were in blocks of flats, i.e. 1.311.000 which is 160.000 more dwellings in blocks of flats than in detached houses. The number of terraced houses has grown over tenfold since 1970. In 1970 they numbered only 30.000 but since then the figure had gone up to 399.000 by the end of 2014 (Statistics Finland's data).

Figure 13 shows the composition of the types of buildings of the residential building stock.

[14] Condominium: housing blocks, where the flats are owned privately, while the public rooms and other infrastructures of the building, such as the heating system, elevators, etc. are owned jointly.

Figure 13. Types of buildings of the residential building stock (Finland)



Source: Statistics Finland

In 2014, the average floor area of a dwelling was 80 m². The average floor area of the dwelling stock has grown by about 20 m² since 1970. The average floor area of a one-room unit was 34 m², that of a two-room unit 55 m², and that of a three-room unit and a kitchen 79 m². Despite the growth in the average size of dwellings, there were about 119.000 dwellings of under 30 m². In contrast, only 27 per cent of dwellings have a floor area of over 100 m². There are 426.000 one-room units with a kitchen or kitchenette, i.e. 15 per cent of the dwelling stock. The most common type of dwelling is a two-room unit. There are 872.000 two-room units with a kitchen or kitchenette, i.e. 30 per cent of the dwelling stock. The average floor area of an owner-occupied dwelling was 96 m² and most of them are in detached houses. The average floor area of a rental dwelling was 53 m² and most of them are in blocks of flats. In the dwelling stock statistics, the tenure status is mainly defined for permanently occupied dwellings. The tenure status is also defined for a dwelling not permanently occupied when a dwelling is located in a rented dwelling subsidised by the state or a dwelling is temporarily occupied. Of all dwellings, the number of rented dwellings was around 905.000 at the end of 2014 and 824.000 of them were permanently occupied dwellings. The number of rented dwellings has grown by 359.000 since 1990 (Statistics Finland's data).

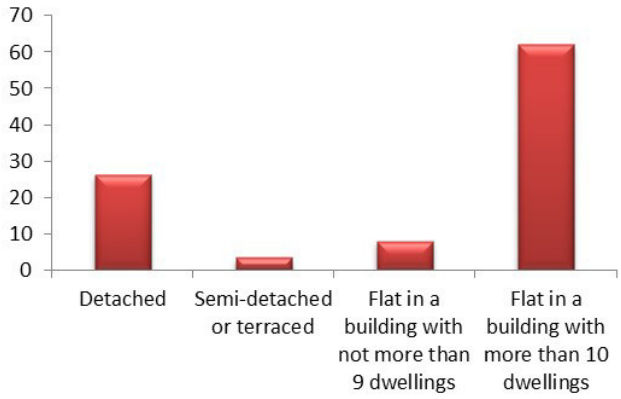
In ***Latvia***, 1.35 million buildings are registered in the Information System of the National Real Estate Cadastre (NREC IS), with a total area of 198 million m² , including various auxiliary buildings. From the total number of buildings, in approximately 400 thousand buildings energy is used to adjust the microclimate of interior (heating), and from these 352.4 buildings with a total area of 86.9 million square meters are residential buildings. The largest number and share (85%) is formed by single-dwelling buildings (300.7 thousand), however, in terms of area, the share of single-dwelling buildings is only 39%, and the largest share (58%) is formed by multi-dwelling (three and more dwellings) buildings (50.4 million m²), while by number their share is only 11 % (38.6 thousand). In accordance with the data of population census 2011, there are 988 thousand dwellings in Latvia, of which 680 thousand (68.8 %) are multi-dwelling buildings, 285 thousand (28.9 %) are individual houses and 16 thousand are semi-detached or row houses (Long-Term Strategy for Building Renovation, 2014).

The age of residential buildings can be divided in periods in accordance with their thermal characteristics:

- Until 1940: Pre-war constructions, mainly wooden in rural areas and brick wall in cities. Most of the buildings have up to two floors.
- 1941–1960: Post-war constructions, period characterised by good quality, mainly brick buildings, residential sector characterised by brick buildings of standard design of Stalin's time.
- 1961–1979: Extensive construction of standard design buildings; for external walls, clay bricks, aerated concrete and ceramsite concrete were commonly used.
- 1980–1991: New requirements for design were stipulated by the USSR construction standard "Thermal Engineering of Building Envelopes".
- 1992-2002: Construction of standard design buildings practically stopped. With Order No. 68 of the Ministry of Architecture and Construction of the Republic of Latvia 12 September 1991, requirements for building envelopes were significantly increased.
- Since 2003: LBN 002-2001 "Thermal Engineering of Building Envelopes" comes into force stipulating thermal engineering requirements for building envelopes. In this period, buildings with large glass surfaces emerged; therefore, the respective buildings usually do not meet the requirements of the LBN. However, in the residential buildings sector, use of dominating glass surfaces in building's design is not typical.

The largest number of multi-dwelling buildings has been built in the period until 1940 (38%), which, in terms of area, is the second category (26%), whereas the largest number of multi-dwelling buildings, in terms of area, has been built over the period from 1961 to 1979, i.e. 30%, which, in terms of number, forms only 17% of all the multi-dwelling buildings built. The share of new buildings built after 2003 in terms of both number and area is the smallest, i.e. only 3% of the number and 5% of the area of the multi-dwelling buildings built. Figure 14 shows how the dwelling stock in 2014 was composed.

Figure 14. Type of dwellings %, 2014 (Latvia)



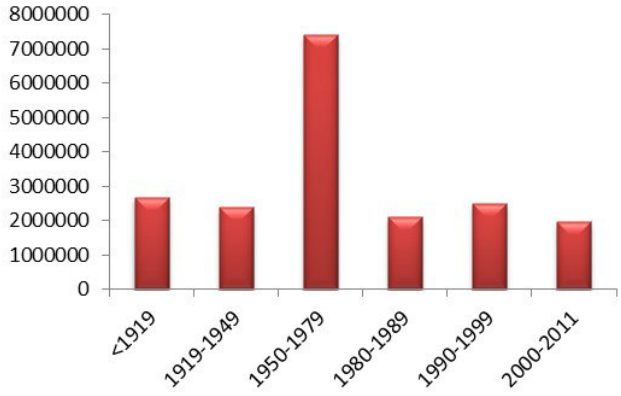
Source: Central Statistical Bureau

The breakdown of residential buildings by ownership shows that, in accordance with NREC IS data, the largest proportion of buildings – 303 thousand (86.1%) – are owned by natural persons, 25.6 thousand (7.2%) residential buildings are owned by owners with various statuses (mixed ownership),

7.7 thousand are owned by legal entities, 5.4 thousand (1.5%) are owned by local governments and 0.37 thousand (0.1%) are owned by the State.

In Germany, about 34% of the dwelling stock existing in 2011 was built after 1977, date of the first thermal regulation. The rooms per flat show with 4.4, average rather high but stable average over the last years, however the average size in m² is raising (91,4 in 2011) as well as the m² per person (46,5). Here the increasing number of senior single households raise the average (78,4 m²). Also the number of flats per 1000 inhabitants is constantly going up. Central heating is the major way of heating with nearly 70%. The smaller shares are on district heating, floor heating or room based heating systems (in this order). Renting a flat or house is still the dominant way of living but ownership is catching up (43% in 2013). A shrinking share can be recognised regarding the costs for a flat/house from available income. It decreased from 31,8% in 2008 to 27,3% in 2014. The energy consumption per household however dropped by 12,1% from 2005 to 2014. While heating energy holds the major share (-12,4%) only household appliances demanded more energy (1,7%).

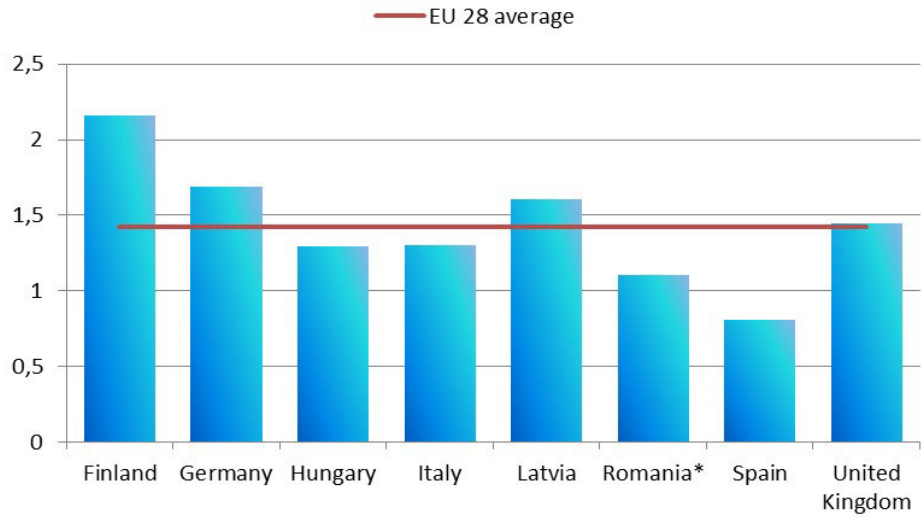
Figure 15. Residential buildings by year of construction (Germany)



Source: Federal Statistical Office

In order to compare the residential energy building performance of the European countries under investigation we use the final energy consumption per dwelling (toe/dwellings) as indicator. Figure 16 shows the household consumption at normal climate per dwelling of Finland, Germany, Hungary, Italy, Latvia, Romania, Spain, United Kingdom compared to the average of the European Member States in 2013 (1.42 toe/dwellings). Finland had the highest household consumption (at normal climate) per dwelling in 2013 followed by Germany, Latvia and the United Kingdom. Spain had the lowest toe/dwellings value (0.8) in 2013 and it was below the EU average.

Figure 16. Final energy consumption per dwelling of 2013 (toe/dwellings)



Source: Author's elaboration based on Odyssee database
* Data for Romania are of 2011

2 Policy instruments addressing energy efficiency in the residential sector

Energy efficiency in the context of housing and households is evolving away from the image of "switch off your lights" into a more economy-wide perspective. All European Member States are committed to doing more on energy efficiency at all stages of the energy chain – from the production of energy and generation of electricity, through the design of cities, grids, and houses, to the use of energy meters and the behaviour of consumers.

Policies to improve end-use energy efficiency have invoked great interest over the past several decades because they help to achieve all the objectives of energy policy – competitiveness, sustainability and security of supply. This, in a nutshell, is where energy efficiency fits into energy policy: not just as a means of saving energy or reducing waste, but as a way of delivering other objectives as well: environmental, social, economic and geopolitical (Dennis, 2006).

This section first generally gives an overview about policies taken under the guidance of the Energy Efficiency Directive as e.g. highlighted in the National Energy Efficiency Action Plans (NEAAPs) and lists the national efficiency targets. It then takes a closer look at specific kinds of policy instruments, namely regulatory, economic and informational. The general description of these instruments is followed by examples how the case countries apply such instruments in their policies.

2.1 General level of policy implementation

Under the Energy Efficiency Directive 2012/27/EU, Member States are obligated to draw up a National Energy Efficiency Action Plan (NEAAP) every three years in which they estimate energy consumption, planned energy efficiency measures and the expected improvements in terms of energy efficiency.

Almost all European Member States updated existing NEEAPs in compliance with the European Directive 2012/27/EU. However, there is considerable disparity in terms of content, level of detail in describing, and the level of ambition about the energy efficiency instruments in place and planned for the next years.

Especially the latter is of interest because the NEEAP is not merely a reporting tool, but is a strategic document; Member States are required to take appropriate measures to ensure the achieving of the energy efficiency target. On the 18th of November 2015, the European Commission published a report on the assessment of the progress made by Member States towards the national energy efficiency targets for 2020 and towards the implementation of the Energy Efficiency Directive 2012/27/EU as required by Article 24 (3) of Energy Efficiency Directive 2012/27/EU which included some recommendations for Member States how to improve energy efficiency policies.

Since the implementation of the NEEAPs, Member States identified national indicative targets for energy efficiency under Article 3 of the Energy Efficiency Directive 2012/27/EU. Of the European countries under investigation in this report only ***Hungary***, ***Italy*** and ***Spain*** have set more ambitious targets in their 2014 National Energy Efficiency Action Plans for final energy consumption, focusing on a larger decrease of demand in the residential, services, industrial and transport sectors.

In particular, the residential energy efficiency target set by the ***Italian*** Government in the latest NEEAP (2014) for the period 2011-2020 is 5.14 Mtoe of primary energy, equivalent to 3.67 Mtoe of final energy. The new energy consumption reduction target for 2020 is based on strengthening of the measures and instruments already in place – such as the energy efficiency certificates scheme

("white certificates"), tax deductions (55%/65%), regulatory standards (Leg. Decr. 192/05, etc.) - and on the introduction of new mechanisms - such as the Renewable Energy for Heating & Cooling Supporting Scheme ("thermal account").

In the new 2014–2020 NEEAP, ***Spain*** notified to the European Commission an energy consumption target expressed in terms of an absolute level of primary energy consumption (119.893 ktoe) and final energy consumption (80.1 Mtoe) in 2020 in accordance with Article 3(1) of the Directive. According to the latest Spanish NEEAP 2014, the 15.3% (87.1 ktoe/year) of the final energy savings target (571 ktoe/year) will be achieved through measures in the building and equipment sector. The main policy instruments to improve the energy efficiency in the residential sector with the aim of achieving the European energy savings target and as part of the "Spanish Strategy for Energy Renovation in the Building Sector" are the Technical Building Code, the BIOMCASA, SOLCASA, GEOTCASA, GIT, the State Plan for promotion of rental housing, building rehabilitation and urban regeneration and renewal, 2013-2016, the "Aid Programme for the Energy Renovation of Existing Buildings" (PAREER).

Hungary set the final energy efficiency target of the residential sector at 40 PJ in 2020, representing the 54.7% of the total energy efficiency target. In fact, final energy savings targets from the Government's energy consumption forecasts, approved by Government Resolution No 1160/2015 of 20 March 2015, are about 73 PJ, while the expected total final energy consumption in 2020 is about 603 PJ (207 PJ the residential sector). According to the third NEEAP and the latest decisions of the Hungarian Government, this target will be achieved through the implementation of the relevant EU directives for the building sector, the Warmth of the Home Programme, a green soft loan aimed at promoting energy efficiency investments provided directly to the households and a soft loans made available to energy utility companies for financing their ESCO-related activities in the households sector (under construction). However, the overarching objective of the energy policy of the Hungarian government is to guarantee the all-time security of energy supply, with respect to maintaining the competitiveness of the economy, environmental sustainability, as well as the capacity of consumers/households to be able to pay for energy services, hand in hand with the necessary restructuring of the energy sector. The considerable fall in the prices of energy hampered the price incentive for energy efficiency incentives in the household sector. Furthermore, it is alleged, and in some cases proved, that the market has not been able to compensate for the lower prices: for example, for the providers of district heat, it was necessary to request continued financial state support in order to be able to maintain their operation.

According to the European Commission, since the objective of energy efficiency is to decouple energy consumption from economic growth due to efficiency gains, the level of the indicative targets set by ***Finland***, ***Italy***, ***Romania*** (and also, Croatia, Cyprus, Greece, Portugal) are not ambitious enough as final energy consumption is projected to be higher than the forecast GDP development from 2014 to 2020.

In ***Finland,*** the primary objective of energy efficiency is the cost effective reduction of greenhouse gas emissions, with securing of energy supply, decreased the need for imported energy, reduced energy costs, environmental protection and air pollution control as secondary goals. With beginning of 2014 the practical implementation of measures to improve energy efficiency were transferred to the Energy Authority (Finish Ministry of Employment and the Economy, 2015). In particular, voluntary energy efficiency agreements and audits have a long history and have produced good experiences. Finland's energy efficiency activities have been praised in international assessments by the EU and IEA for their diversity and market orientation. Households seem to be a kind of missing factor in Finnish energy strategies so far. This indicates that in fact energy efficiency measures directly related to households play a rather marginal role of about 1% of expected savings.

The Energy Strategy of ***Romania*** is under the general objective to cover the present and future energy demand at the least price, under the conditions of a modern market economy and civilized standard of living, ensuring quality and security of supply and observing the principles of sustainable development. Energy politics in Romania is focussed on efforts to keep energy prices low, for the benefit of household consumers but also for industry. This indicates that energy policy in the Romanian context is dominated by approaches to reduce energy costs not necessarily to reduce energy consumption. Nevertheless, Romania's indicative national energy efficiency target is to achieve primary energy savings of 10 million toe by 2020, which would mean a reduction in forecasted primary energy consumption (52.99 million toe) through the PRIMES 2007 model for a realistic scenario of 19%. Reaching this target means that in 2020 primary energy consumption and final energy consumption will reach 42.99 million toe and 30.32 million toe, respectively. According to the latest NEEAP, part of the energy efficiency target (around 10%) will be achieved through measures in the residential sector such as the thermal rehabilitation of apartment blocks, the thermal rehabilitation of single-family residences and the purchase of high performance electric equipments.

In ***Latvia***, energy efficiency has a very high national security issue aspect, and it takes a priority place in Latvian Energy Policy. The Energy Strategy 2030 sets the objectives of a competitive economy, sustainable energy and secure supply. Latvia's Second Energy Efficiency Action Plan considers the household sector (among others) as a main priority. Based on the requirements of Article 3 of Directive 2012/27/EU, the indicative national energy efficiency target set for Latvia based on primary energy savings in 2020 is 0.670 Mtoe (28 PJ), which is equivalent to final energy savings of 0.457 Mtoe (19 PJ). Latvia has opted to combine the energy efficiency obligation scheme (article 7) with alternative measures, which involve allocations by EU funds. Nearly all new measures focus on the building sector. Roughly, half of all savings from alternative measures (1,690 GWh) will come from building renovation measures covering residential, central government and municipal buildings, as well as those of small and medium enterprises.

In the ***United Kingdom,*** the energy target was set at the level of 129.2 Mtoe for final energy consumption on a net calorific value basis and 177.6 Mtoe for primary energy consumption. This represents an 18% reduction in final energy consumption (equivalent to a 20% reduction in primary energy consumption), relative to the 2007 business-as-usual projection. Over the period 2010-2023, the residential sector is expected to be the major contributor to energy saving with 312 TWh, corresponding to the 66.8% of the total energy savings. Various policy measures have been identified to contribute towards the energy efficiency target in the residential sector (including three Energy Efficiency Obligations - the Carbon Emissions Reduction Target, the Community Energy Saving Programme, and the Energy Company Obligation): Building Regulations, the Energy Companies Obligation (ECO), the Domestic Renewable Heat Incentive (Domestic RHI), the Warm Home Discount scheme, the Feed-in-Tariff scheme (FITs).

In ***Germany***, the national energy efficiency target was set at 276.6 Mtoe of primary energy consumption in 2020, corresponding to 194.3 Mtoe of final energy consumption. Energy efficiency represents a key pillar of the 'energy transition' (Energiewende): accordingly, it applies a wide range of instruments for increasing energy efficiency, and is one of the few industrialised countries to have managed a visible decoupling of energy consumption from economic growth. Assuming an average annual increase of 2.1 % in energy productivity from 2008 to 2020 the target for reduction in the energy-related share of primary energy consumption is to come from 314.3 Mtoe in 2008 to 276.6 Mtoe in 2020. This does not fully satisfy the explicit target to reduce primary energy consumption by 20 % by 2020 and 50 % by 2050 compared to 2008. It is therefore a major effort to create the right incentives for citizens to save energy and through this way to open up new markets and business areas for efficiency technologies and services.

Looking from the overarching, EU level, again, it can be summarised, that collectively, Member States have failed to set national energy efficiency targets ambitious enough to add up to the 20% EU level target. The sum of the national indicative targets corresponds to 17.6 % primary energy savings compared to projections for 2020. While this represents a welcome improvement compared to the first set of notified targets, it still falls short of the EU target to save 20 % of primary energy compared to projections in 2020 (EC, 2015).

Considering the problems meeting the required reductions, it does not come as a surprise that most countries follow EU regulation only. On the contrary it can be recognised that in some countries only the force of the directives induce activities at all. As a weakness appears, that energy efficiency targets (and their measurements for fulfilment) are oriented on scenarios (e.g. based on the PRIMES model) calculating energy consumption considering efficiency measures compared to a development without further efficiency efforts. On such a basis GDP growth rates less than expected can have a higher influence on reaching the envisioned consumption target than the efficiency gains.

Anyway, many scholars like Spaargaren (2003), Putman (2006) and Vringers (2007), claim that a policy approach that is only based on efficiency will most likely not be enough to meet the ambitious long-term environmental targets that are put forward nowadays, like the ambition of the EU to reduce greenhouse gas emissions by 80 to 95% by 2050. Some authors even request the belief in the energy-saving potential of technological measures. York et al. (2005) refer to the “Jevons Paradox”: because of the energy efficiency gains, energy becomes more affordable, leading to greater use (Clark and Foster, 2001; Polimeni et al., 2007). This view is also supported by Herring (2006) and several other economists, especially ecological economists. These authors’ views are supported by the empirical evolution of energy use on the macro-level: despite continuous improvements in efficiency in the past fifty years, the total energy use has not fallen but has risen continuously. Starting from this Jevons Paradox and the empirical observations, some authors, and other actors, like NGOs, have become adherents to the “sufficiency theory”, claiming that energy conservation (energy saving by behaviour change) should be pursued. From this viewpoint, energy conservation also becomes a moral issue: according to Rudin (1999) “efficiency tells us what to buy, conservation tells us how to behave”.

The following tables (4) show the national approach of the relevant provision for the residential sector of the Energy Efficiency Directive 2012/27/EU as notified in the NEEAPs 2014 or in a separate notification to the European Commission in 2015. In particular, the articles 3, 4, 7, 9, 10, 11, 12, 17, 19, 20 of the EED are analysed.

Energy Efficiency Directive 2012/27/EU:

- **Article 3. Energy efficiency targets (2020):**

"Each Member State shall set an indicative national energy efficiency target, based on either primary or final energy consumption…"

- **Article 4. Building renovation:**

"Member States shall establish a long-term strategy for mobilizing investment in the renovation of the national stock of residential and commercial buildings…"

- **Article 7. Energy efficiency obligation schemes:**

"Each Member State shall set up an energy efficiency obligation scheme. That scheme shall ensure that energy distributors and/or retail energy sales companies that are designated as obligated parties under paragraph 4 operating in each Member State's territory achieve a cumulative end-use energy savings target by 31 December 2020, without prejudice to paragraph 2…"

- **Articles 9-11. Metering and informative billing:**

"Member States shall ensure that, in so far as it is technically possible, financially reasonable and proportionate in relation to the potential energy savings, final customers for electricity, natural gas, district heating, district cooling and domestic hot water are provided with competitively priced individual meters that accurately reflect the final customer's actual energy consumption and that provide information on actual time of use…"

"Where final customers do not have smart meters as referred to in Directives 2009/72/EC and 2009/73/EC, Member States shall ensure, by 31 December 2014, that billing information is accurate and based on actual consumption…"

"Member States shall ensure that final customers receive all their bills and billing information for energy consumption free of charge and that final customers also have access to their consumption data in an appropriate way and free of charge…"

- **Article 12. Consumer information and empowering programme:**

"Member States shall take appropriate measures to promote and facilitate an efficient use of energy by small energy customers, including domestic customers. These measures may be part of a national strategy. For the purposes of paragraph 1, these measures shall include one or more of the elements listed under point (a) or (b): (a) a range of instruments and policies to promote behavioural change… (b) ways and means to engage consumers and consumer organisations during the possible roll-out of smart meters…"

- **Article 17. Information and training:**

"Member States shall ensure that information on available energy efficiency mechanisms and financial and legal frameworks is transparent and widely disseminated to all relevant market actors…"

- **Article 19. Other measures to promote energy efficiency:**

"Member States shall evaluate and if necessary take appropriate measures to remove regulatory and non-regulatory barriers to energy efficiency, without prejudice to the basic principles of the property and tenancy law of the Member States, in particular as regards: (a) the split of incentives between the owner and the tenant of a building… legal and regulatory provisions, and administrative practices, regarding public purchasing and annual budgeting…"

- **Article 20. Energy Efficiency National Fund, Financing and Technical Support:**

"Without prejudice to Articles 107 and 108 of the Treaty on the Functioning of the European Union, Member States shall facilitate the establishment of financing facilities, or use of existing ones, for energy efficiency improvement measures to maximise the benefits of multiple streams of financing…"

Tables 4. An overview of the countries approach to promote energy efficiency in the residential sector in terms of the relevant provisions of the EED.

Energy Efficiency Directive 2012/27/EU	Finland
Article 3. Energy efficiency targets (2020).	Primary: Mtoe 35.9 - Final: Mtoe 26.7
Article 4. Building renovation.	The Decree No 4/13 of the Finnish Ministry of the Environment, passed in 2013, obligates all individuals undertaking a renovation, alteration or system modernisation project that requires permission to also incorporate measures to improve energy efficiency into the project. The regulation introduces cost-optimal levels of minimum energy performance requirements for individual building components and for total energy consumption. The levels laid down in the regulation also double as Finland's deep renovation levels. The regulation includes guidelines for both one-off deep renovations and staged deep renovations.
Article 7. Energy efficiency obligation schemes.	➢ Energy efficiency agreements / Energy Services Action Plan and Höylä III with regard to customers; ➢ Heat pumps for detached and terraced houses; ➢ Energy efficiency regulations for renovations and subsidies to incentivise renovations; ➢ Energy efficiency regulations for new development
Articles. 9-11. Metering and informative billing.	More than 95% of all electricity usage points already have an hourly electricity meter that can be read remotely. Remote reading is also already in use for more than 80% of district heating customers. ➢ The Finnish Act on energy efficiency services of companies operating in the energy market (1211/2009); ➢ The Government Decree on electricity supply statements and metering (66/2009).
Article 12. Consumer information and empowering programme. **Article 17. Information and training.**	In addition to the renovation consultancy provided by the Finnish Ministry of the Environment, the Ministry has commissioned Motiva to disseminate information about the energy performance of buildings and energy certificates. Advice on themes such as property management and maintenance, material efficiency, damp and mould problems and accessibility is also provided nationwide. Responsibility for advising consumers on ecodesign and energy labelling requirements lies with Motiva. Communications are financed by the Finnish Ministry of Employment and the Economy and the Finnish Ministry of the Environment. Motiva and lighting companies have set up a joint website containing information about lighting products for households. The website has information about choosing the right kinds of light bulbs and locations where light bulbs can be taken for recycling. An online training course about light bulbs has also been developed for retailers. Also, sustainable development and energy efficiency are featured at all levels of education from comprehensive schools to universities.
Article 19. Other measures to promote energy efficiency.	No legislative barriers are found that prevent landlords and tenants from agreeing to implement energy efficiency measures and to split any energy savings thus achieved.
Article 20. Energy Efficiency National Fund, Financing and Technical Support	Finland has no plans to establish a national energy efficiency fund.

Energy Efficiency Directive 2012/27/EU	Germany
Article 3. Energy efficiency targets (2020).	Primary: Mtoe 276.6 - Final: Mtoe 194.3
Article 4. Building renovation.	For years already, efforts are being made in Germany to modernise the building stock. There have been numerous state, regional and municipal funding programmes in place for many years already making – according to IEA - Germany one of the world leaders in energy efficiency in the construction sector. The Federal 'CO2 building renovation programme', together with the KfW 'programmes for energy-efficient building and renovation', provides loans and grants in the residential area. Within this framework, the KfW e.g. initiated investments running to just under € 162 billion on behalf of the Government between 2006 and the end of March 2014. These funds were used to renovate more than 3.5 million homes or to build particularly energy-efficient new homes and to renovate over 1 940 buildings for municipal or social bodies.
Article 7. Energy efficiency obligation schemes.	Standard-setting measures such as the 'Renewable Thermal Energy Act, promote investment in the construction sector (such as renewable heat energy) through the aid programmes of the Kreditanstalt für Wiederaufbau (KfW) for energy-efficient building and renovation. So do as well various programmes to promote investment in energy-efficient technologies by undertakings and measures to increase energy efficiency through information and advice, Including the various programmes run by the Federal Government in the field of energy consulting. Based on current estimates, these strategic measures should produce cumulative final energy savings of 459 PJ in the period 2014–2020 and at least 1 121 PJ from 'early action' in the period 2009–2013.
Articles. 9-11. Metering and informative billing.	Individual metering is common in Germany, A diverse market in measurement and metering services is developed, covering a range of services such as local and remote meter reading, testing and replacement of meters and more far-reaching services such as account management, energy data management and energy controlling for larger customers.
Article 12. Consumer information and empowering programme. **Article 17. Information and training.**	Consumer information is available through a broad range of organisations, from the German Energy Agency, via KfW for energy-efficiency building, renovation, and the Federal Agency for Energy Efficiency (BfEE) to the Federal Environment Agency (UBA) various programmes run by the Federal Government in the field of energy consulting. In addition the regional consumer consultancy organisations play an important and trustworthy role.
Article 19. Other measures to promote energy efficiency.	The promotion of cogeneration (combined heat and power – CHP) is another package of measures to increase energy efficiency. A differentiated system of measures addresses CHP at various levels. Further, on, ways of addressing distribution losses in the energy grids through state regulation is the fee structure laid down in the Electricity Network Fees Regulation. It stipulates that distribution losses should be posted to a separate cost item. This makes the costs of distribution losses visible to all, so there is an incentive to reduce this cost item further.
Article 20. Energy Efficiency National Fund, Financing and Technical Support.	The subsidies applied in Germany for energy-efficient refurbishment programmes are manifold. Most programs are carried out through the state owned KfW.

Energy Efficiency Directive 2012/27/EU	Hungary
Article 3. Energy efficiency targets (2020).	Primary: Mtoe 24.1- Final: Mtoe 14.4
Article 4. Building renovation.	The National Building Energy Performance Strategy ("NABEPS") pinpoints the targets and main directions for modernizing the domestic building stock and achieving a significant decrease in the energy demand of buildings over the period until 2020, with projections until 2030, by defining a conceptual framework for the building energy action plans as well as the specific programmes and actions to be devised at a later date. Within the category of residential buildings, priority will be given to the modernisation of family houses, in particular to single-family houses built between 1946 and 1980, which are the most common based on the typology.
Article 7. Energy efficiency obligation schemes.	Hungary intends to draw up a financial package by way of an alternative policy measure. On the basis of the financial package, it is intended to provide attractive loans with a view to encouraging the Hungarian business and residential sectors to carry out investments in order to reduce their energy consumption and environmental impacts. The financial package would include the following: energy audit mentor services, providing a green loan programme or other financial instruments suitable for the financing of residential energy efficiency projects, providing low-interest financing to residential energy providers for their ESCO financing activities.
Articles. 9-11. Metering and informative billing.	Related to these provisions only some smaller additions/modification were necessary in the transposition of the EED, as most of the stipulated conditions have already been established earlier (by the relevant national act on electricity and respectively by the act on the supply of natural gas and the act on district heating). Concerning the roll-out of smart metering systems, relevant pilot projects are on-going.
Article 12. Consumer information and empowering programme. **Article 17. Information and training.**	The main programming instrument in this regard is the Energy- and Climate Awareness Raising Action Plan (ECARP). Among the many fields of action in the ECARAP the ones with the most relevance to the household sector are: the promotion of energy efficiency and energy conservation; the realisation of new social and economic structures according to the principles of resource efficiency and low carbon-intensity. The most important informational measures put forward by the ECARAP are: "the price of energy" – awareness raising campaign; energy and climate-awareness webpage aimed at energy consumers; energy efficiency web portal of the Government; tender framework for projects aimed at raising awareness about the rational use of energy; primary research into values, attitudes and consumption behaviour related to the use of energy; secondary education and adult education in the topic of building energetics.
Article 19. Other measures to promote energy efficiency.	The legal conditions concerning the co-ownership of dwellings and housing communities are already enabling for decisions to be made for energy efficient investments and no further legal action is considered necessary.
Article 20. Energy Efficiency National Fund, Financing and Technical Support.	There is no Energy Efficiency National Fund in place and there are no related plans to establish one either.

Energy Efficiency Directive 2012/27/EU	Italy
Article 3. Energy efficiency targets (2020).	Primary: Mtoe 158.0 - Final: Mtoe 124.0
Article 4. Building renovation.	Potential consumption reduction was estimated taking into account performance standards in force, the applicability of energy efficiency schemes, the cost-benefit ratio and the feasibility of the following type of works: thermal insulation of the building envelope; replacement of windows and doors; upgrading of the heating/cooling system controls; replacement of the heat generator; installation of an home automation system; replacement/redoing of the lighting system; use of renewable sources. The types of actions considered are: complete renovation or partial renovation.
Article 7. Energy efficiency obligation schemes.	Italy complies with Article 7 of the EED through the white certificate scheme also known as Energy Efficiency Certificates – EEC (Ministerial Decrees of 20 July 2004 and of the Ministerial Decree of 28 December 2012), regulatory standards (Leg. Decr. No 192/05), tax deductions (55%/65%) for improving the energy efficiency of buildings (Budget Law 2007), and the Thermal Account (Renewable Energy for Heating & Cooling Supporting Scheme) introduced by the Ministerial Decree of 28 December 2012 (Leg. Decr. No 28/2011).
Articles. 9-11. Metering and informative billing.	In Italy, the replacement of the traditional electricity meters with a smart metering infrastructure started between 2001 and 2002. Initially, the adoption of smart metering in the electricity sector was on a voluntary basis, driven by the initiative of DSOs, in particular ENEL Distribuzione; this later became a mandatory roll-out under a Decision of the Electricity, Gas and Water Authority (Decision No 292/06). Gas meters are also smartening up. In fact, Italy is ahead of the other Member States also as to the regulatory framework for gas meters
Article 12. Consumer information and empowering programme. **Article 17. Information and training.**	In order to disseminate at national, regional and local level transparent information on energy efficiency and to transpose Article 12, 16 and 17 of Directive 2012/27/EU, an Integrated Energy Efficiency Uptake Plan will be designed. The Plan addresses the provision of information and training on energy efficiency; in detail, it sets out targets, beneficiaries, strategies and contents of the information and training actions, budget, implementing agencies and provisions for post hoc assessment of the activities. Mainly, the energy efficiency uptake strategy includes the following actions: 1. Strengthening of communication on energy efficiency to improve the user-friendliness and transparency of information; 2. Initiatives promoting energy-awareness in daily behaviours targeting specific groups (e.g. home-makers' associations, high school students, universities); 3. Design, implementation and testing of instruments to ensure the dissemination to all relevant market players of information on energy efficiency schemes and the financial frameworks via direct/indirect means.
Article 19. Other measures to promote energy efficiency.	An analysis of the economic and financial barriers to improve the energy performance of buildings is provided without proposing solutions to overcome these limits to the deployment of energy efficiency technologies.
Article 20. Energy Efficiency National Fund, Financing and Technical Support.	The Legislative Decree No 102/2014 provides for the creation of the National Energy Efficiency Fund at the Ministry of Economic Development amounting to € 800 million for the period 2014-2020. Part of this fund will be allocated to improve the energy efficiency of entire buildings including social housing buildings.

Energy Efficiency Directive 2012/27/EU	Latvia
Article 3. Energy efficiency targets (2020).	Primary: Mtoe 5.4 - Final: Mtoe 4.5
Article 4. Building renovation.	The indicative financial allocations under the Cohesion Policy to improve national and housing energy efficiency in the following 2014 – 2020 programming period are € 247.86 million. Projects will be financed on the basis of activity implementation regulations that are currently in the development phase. Grants ranging from 50% to 60% were available to citizens in the 2007 – 2013 programming period. Meanwhile, in the 2014 – 2020 programming period, low-interest loans for renovations and principal repayment up to 35% are planned for inhabitants of multi-apartment residential buildings subject to the achievement of a certain energy efficiency level. As a result, financing required for project implementation will be guaranteed, while at present quite a number of houses cannot obtain financing from commercial banks to implement their renovation projects.
Article 7. Energy efficiency obligation schemes.	Contrary to many other countries, Latvia has no experience in the implementation of the EEOS or its elements. Based on the experience of other countries, the preconditions for the successful fulfilment of the binding target include cooperation between energy companies and final customers, analysis of final customers' consumption pattern, implementation of cost-effective and innovative energy efficiency measures, etc. These preconditions have not been fulfilled in Latvia yet. However, Latvia has opted to combine the EEOS with alternative measures, which involve allocations by EU funds. A decision on the establishment of the EEOS was approved by Paragraph 1, Sub-paragraph 1.2 of Cabinet Order No 587 of 2 December 2013.
Articles. 9-11. Metering and informative billing.	According to the current practice, smart electricity meters allowing for remote meter reading are provided to large electricity consumers above 100 kW (above 200 A). Such meters are being gradually installed by AS Sadales tīkls in households whose electricity consumption reaches 2.500 kWh per year. Starting from 2015, the extensive replacement of customer meters must be performed, and for this reason the installation of smart meters will be continued. AS Latvenergo is implementing a project named "Promoting Energy Efficiency in Households Using Smart Technologies". This five-year project is aimed at providing households with detailed information about their individual energy consumption and CO2 emissions, as well as achieving a 10% reduction in energy consumption.
Article 12. Consumer information and empowering programme. **Article 17. Information and training.**	Several information campaigns and studies have been conducted in Latvia in the fields of energy efficiency in the residential sector. For example, the campaign Let's Live Warmer" ("Dzīvo siltāk!") introduced in 2010, is an integrated, multimedia communication campaign that promotes the availability of information on housing insulation issues.
Article 19. Other measures to promote energy efficiency.	No evaluation and proposed solutions to overcame the barrier of the split of incentives between the owner and the tenant of a building or among owners is provided.
Article 20. Energy Efficiency National Fund, Financing and Technical Support.	The Ministry of Economics is planning to set up Latvian Energy Efficiency Fund, which will managed by the state joint-stock company ALTUM. It will combine EU funds in order to introduce as many energy efficiency measures as possible.

Energy Efficiency Directive 2012/27/EU	Romania
Article 3. Energy efficiency targets (2020).	Primary: Mtoe 43 - Final: Mtoe 30.3
Article 4. Building renovation.	Measures aimed at mobilising investments in the renovation of residential and commercial buildings, are identified and presented in the "BPIE guide to developing strategies for energy renovation of buildings". It distinguishes between three phases. PHASE 1 – Establishing conditions based on which deep renovations may become a goal within five years; PHASE 2 – Technological development in the renovation of buildings, which can provide the means for achieving a substantial reduction in energy consumption and attaining a level where buildings have a nearly-zero dependence on traditional energy within approximately 15 years; PHASE 3 – Deep renovation of buildings within 15 years.
Article 7. Energy efficiency obligation schemes.	In order to achieve the committed target of the EEOS the aggregate energy savings for the period 2014 – 2020 is 5,817.1 thousand toe. The Ministry of European Funds intends to achieve the thematic objectives related to energy efficiency improvement in the 2014-2020 period, under the Large Infrastructure Operational Programme and the Regional Operational Programme. Also, in order to improve the energy efficiency performance of buildings and to finance investment projects, the Law No 238/2013 and the Romania Energy Efficiency Fund have been established.
Articles. 9-11. Metering and informative billing.	Smart energy distribution has become a priority of Romanian Energy Regulatory Authority (ANRE), which, starting from Law No 123/2012 on electricity and gas, issued Order No 91/2013 that provides as national target implementation of smart metering systems for electricity to approx. 80 % of final consumers number by 2020. However, it is estimated that in 2012 only 1% of electricity consumers and 0.1% of gas consumers benefited from smart metering.
Article 12. Consumer information and empowering programme. **Article 17. Information and training.**	The Romanian Energy Regulatory Authority (ANRE) has an important role in informing consumers and stimulating training. ANRE is concerned with raising energy consumers' awareness of the needs and possibilities to reduce energy consumption, highlighting the benefits of energy audits. Thus, the IEE project "Residential Monitoring to Decrease Energy Use and Carbon Emissions in Europe – REMODECE" aimed to monitor energy consumption and carbon emissions in the residential sector and an assessment was made of energy savings that could be achieved with the existing means through efficient use of appliances or by removing/reducing standby consumption. To improve energy efficiency in low-income households and communities in Romania, a project funded by the United Nations Development Programme - Global Environment Fund provides specialisation of architects, building engineers, qualified auditors through training courses and postgraduate courses in energy efficiency of buildings.
Article 19. Other measures to promote energy efficiency.	Developing promotional and dissemination activities that sensitise building owners to opportunities for deep renovation and that provide step-by-step support throughout the renovation process is an objective of the Building Renovation Strategy. However, the barrier regarding the split of incentives between the owner and the tenant is not discussed.
Article 20. Energy Efficiency National Fund, Financing and Technical Support.	Romania makes use of EU funds to finance energy efficiency, but no National Energy Efficiency Fund exists or it is planned. The Romanian Energy Efficiency Fund is financed through the Global environment Facility.

Energy Efficiency Directive 2012/27/EU	Spain
Article 3. Energy efficiency targets (2020).	Primary: Mtoe 119.8 - Final: Mtoe 80.1
Article 4. Building renovation.	The "Spanish Strategy for Energy Renovation in the Building Sector" contains a set of measures designed to encourage significant investments to facilitate in-depth building renovation projects. It provides a comprehensive and detailed technical appraisal of the building stock and energy saving opportunities. It also recognise the strategic importance of building renovation, including the link to wider urban regeneration, and broader social and economic benefits. Specific actions reducing the barriers, and help the financing of renovation measures, have been identified and described. Further policies are in place and planned to reach the energy efficiency target.
Article 7. Energy efficiency obligation schemes.	According to the savings target 87.1 ktoe/year must be achieved through measures in the building and equipment sector. These savings shall derive from the energy renovation of the thermal envelope of existing buildings, improvement in the energy efficiency of heating, cooling and domestic hot water systems, lighting, lifts and other transport systems and electrical installations. Further savings shall come from the restoration of existing buildings to a high rating. Finally, the implementation of smart systems (home and building automation) and renovation of the stock of electrical appliances shall contribute as well.
Articles. 9-11. Metering and informative billing.	The draft Royal Decree transposing Articles 9, 10 and 11, states that in existing buildings which have a central heating, cooling or domestic hot water system serving more than one user or in buildings supplied by a district heating network serving multiple buildings, individual consumption meters shall be installed to measure the consumption of heat or cooling or hot water for each unit or final customer. The law regulates billing content and the obligation for all sellers to offer their customers free online billing and complementary information on historical consumption.
Article 12. Consumer information and empowering programme. **Article 17. Information and training.**	The communication, information and training in energy saving and efficiency programmes provided by the Institute for Diversification and Energy Saving (IDAE) and designed for the transposition of Articles 12 and 17 are grouped into seven parts: 1. Institutional advertising and communication campaigns; 2. Internet: IDAE website; 3. Period communications: IDAE online newsletter; 4. Internal audio-visual productions; 5. Citizen information service on energy efficiency and renewable energies (SICER); 6. E-learning.
Article 19. Other measures to promote energy efficiency.	In a view to eliminating the regulatory barriers which impede investment decisions regarding energy saving and efficiency, concerning decision-making in multi-property assets, Law 19/2009 of 23 November 2009 on measures to promote and speed up building rental proceedings and energy efficiency introduced several changes to the wording of the Horizontal Property Act 49/1960 of 21 July 1960. Article 17(3) of the Act states that the installation or removal of equipment or systems, which improve the energy efficiency of a property, shall require a vote in favour from three fifths of the owners who, in turn, represent three fifths of the shares in the building. This new draft facilitates the adoption of agreements, where previously adopted in unanimity.
Article 20. Energy Efficiency National Fund, Financing and Technical Support.	Planned. To support its obligation scheme, Spain, using the right it is granted in Article 20(4), shall set up an Energy Efficiency National Fund to guarantee fulfilment of its energy efficiency targets.

Energy Efficiency Directive 2012/27/EU	United Kingdom
Article 3. Energy efficiency targets (2020).	Primary: Mtoe 177.6 - Final: Mtoe 129.2
Article 4. Building renovation.	The UK strategy for building renovation builds on existing strategy documents; in particular the Energy Efficiency Strategy, the Carbon Plan, and The Future of Heating. The objectives of the building renovation strategy are: to make buildings more thermally efficient through better insulation and improved airtightness; to improve the efficiency of heating systems through the use of more efficient boilers; to reduce electricity use through improved energy management systems and technologies, enabled by the introduction of smart meters and more efficient energy services within buildings.
Article 7. Energy efficiency obligation schemes.	A total of 19 policy measures have been identified to contribute towards the target including three Energy Efficiency Obligations: the Carbon Emissions Reduction Target (CERT); the Community Energy Saving Programme (CESP); and the Energy Company Obligation (ECO). Foremost amongst these measures are the UK's stringent Building Regulations
Articles. 9-11. Metering and informative billing.	Between 2015 and 2020, energy suppliers will be responsible for replacing over 53 million gas and electricity meters; this will involve visits to 30 million homes and small businesses. In line with art. 9(2) of the Directive 2012/27/EU, the UK Government put in place a Data Access and Privacy Framework that gives consumers control over who sees their energy consumption data, and implemented the second Smart Meters Equipment Technical Specification (SMETS 2) for ensuring meters are capable of providing customers with near real-time information on their energy usage and storing up to 24 months of consumption data as well as up to 3 months of half hourly export data.
Article 12. Consumer information and empowering programme. **Article 17. Information and training.**	Information about existing energy efficiency mechanisms, financial and legal frameworks is widely available through an easy online access. The UK Government also commissions research and evaluation projects to better understand how behavioural change can lead to savings in energy use for domestic consumers. In 2013, the Government began a Heating Controls Trial to study the impact of trusted advice on managing heating controls in homes. The Energy Saving Trust (EST) is the UK's leading independent organisation helping people to save energy and to reduce carbon emissions. EST provides energy saving advice with the information householders need to make informed decisions about managing the energy consumption of their homes: Renewables; Home Insulation; Heating and hot water; Home appliances.
Article 19. Other measures to promote energy efficiency.	The UK Government has taken action to encourage the installation of energy efficient measures in rented properties. The Green Deal helps to overcome the landlord-tenant where the former invests while the other saves money. Additionally, the Landlords Energy Saving Allowance, a financial incentive, allows landlords of domestic rented property to claim tax relief of up to £1,500 per property for the costs of buying and installing energy-saving products. The Energy Act 2011 contains provisions for regulation to drive the take-up of energy efficiency improvements in the domestic and non-domestic private rented sectors. The use of these regulation-making powers is conditional on there being no net or up-front costs to landlords.
Article 20. Energy Efficiency National Fund, Financing and Technical Support.	The UK has established a number of financing facilities and does not deem an Energy Efficiency National Fund to be necessary.

2.2 Stocktaking of specific policy instruments

The type of policy instrument suitable for driving energy efficiency depends on many country and sector specifics, but there are circumstances in which certain policy instruments are more appropriate than others. In fact, in an existing context, a certain type of instrument can be more suitable than others, depending on the market barriers, target groups and country-specific factors. However, the achievable impact of energy efficiency policies depends more on the design of the instrument and the way in which it is implemented than on the type of instrument itself. A distinction can be made between general success factors and instrument-specific success factors, which together can help to shape the policy implementation framework, like stakeholder participation in design and implementation, continuous revision and improvement of an instrument during the implementation phase, smart integration of policy instruments into effective policy packages, etc.

Large reductions in household energy use are unlikely to be achieved from interventions designed to change habitual behaviour or to finance building retrofitting alone. In fact, there is evidence that suggests that there is potential for larger energy savings if technical/infrastructural and behavioural interventions are applied in combination because they mutually reinforce each other, having the same goal.

Both in the literature and in the EU policy strategy documents (e.g. Commission's Energy Roadmap 2050), there is broad agreement that energy efficiency is a "no regrets" option; no matter which other policies are followed, focused efforts on energy efficiency have a positive outcome in terms of lowering emissions, increasing security of supply and sealing competitiveness.

The stimulation of energy efficiency improvement can be undertaken using a broad range of policy instruments (Tukker et al, 2008), including regulatory instruments (standards, obligations), financial incentives (subsidies, tax incentives, loan facilities), fiscal instruments (tax exemption, tariffs) as well as information-based instruments (raising awareness, training, capacity building), co-operative (voluntary agreements) and cross-cutting measures (eco-tax); moreover, gathering information about such policy metrics across countries can also help to increase the understanding about policy effectiveness that can be obtained from cross-country comparisons of energy efficiency indicators.

The different types of policy measures described in the next paragraphs are as follows:

- Regulatory: Legislative/Normative, Legislative/Informative
- Economic: Financial, Fiscal/Tariffs
- Informational: Information/Education
- Cross-cutting

This report takes a closer look at how energy efficiency policy instruments in the residential sector are currently carried out in the selected European countries. It builds on the country reports conducted in preparation of this report. This report intends to gives some first indications on their effectiveness, gathers key facts from the use of a specific instrument and the way it is implemented, and – where already possible – provides insight for innovative policy interventions to stimulate energy efficiency.

2.2.1 Regulatory

Regulatory instruments, and especially regulatory standards are the most common form of energy efficiency measures in the residential sector used in the European Union, and they cover a wide variety of approaches. A regulatory instrument specifies with a certain degree of precision the actions that an individual (or a company) must undertake to achieve environmental objectives and

energy savings: these can consist on the adoption of a specific technology or product to use or not use and on more general standards of performance as well as. Regulatory mechanisms need to be monitored, evaluated and updated regularly to remain in touch with technological developments and market trends. There are national product standards for nearly all major appliances, and they are easier to enforce with respect to new rather than existing buildings.

Estimates of the energy savings resulting from appliance standards typically are based on ex-ante engineering models and do not account for effects on consumer surplus from limiting choices (Gillingham, Newell, and Palmer 2006); when there is heterogeneity in consumer needs for energy services, a single standard would not be optimal for everyone. These ex-ante studies typically fail to capture rebound in energy use, although studies suggest that these effects may be small in many contexts (Dumagan and Mount, 1993; Davis, 2008). Other empirical studies explore the effects of building codes on energy consumption. In their analysis using cross-sectional data, Jaffe and Stavins (1995) find no significant effect of building codes on energy demand, while Aroonruengsawat, Auffhammer, and Sanstad (2012) find that building codes decreased per capita residential electricity consumption by 3 to 5 percent, and Jacobsen and Kotchen (2012) find electricity savings of about 4 percent. In Saussay et al. (2012) building energy codes are established to have a significant effect on the improvement of residential space heating energy efficiency in selected EU countries. Recently, O' Broin et al. (2015) by using a panel of 14 EU countries to estimate the impact of efficiency policies affecting space heating demand in the residential sector have found that regulatory policies had a greater success than financial or informative in the period 1990-2010.

Regulatory instruments can be classified in Legislative/Normative and Legislative/Informative measures.

2.2.1.1 Legislative/Normative

Buildings and equipment standards are a key instrument influencing energy efficiency performance of building systems. Standards set a minimum level of energy efficiency that products must meet to save energy and to achieve environmental objectives. Standards ensure that the desirable energy performance of e.g. building components and (especially) heating equipment is achieved even when its purchaser does not show interest in obtaining more efficient products due to either behavioural failure or lack of incentives (IEA, 2011).

Recent reviews of the literature on standards shows that instruments such as energy efficiency standards (e.g. Energy Performance of Buildings Directive) have been one of the main drivers of innovation (Noailly, 2012), and the preferred policy option in the European Union to address barriers to energy efficiency (Bleischwitz et al., 2009). Expert opinion here is that regulation has proved to have the best impact on efficiency measures. In fact, the regulations are getting stronger all the time so new houses are heading towards zero energy. However, there is no indication that they go beyond the EU requirements. Compared what would be necessary from an environmental perspective efficiency standards are still rather weak.

However, these legislative measures are characterized by their low flexibility, which in some cases can generate considerably high implementation costs (Galvin, 2010).

Legislative/Normative instruments typically applied in EU countries are:

1. Mandatory Standards for Buildings

- Energy Performance Standards
- Minimum thermal insulation standards

2. Regulation for Heating Systems and hot water systems

- Minimum efficiency standards for boilers
- Compulsory replacement of old boilers above a certain age
- Periodic mandatory inspection of boilers
- Thermostatic zone control
- Control systems for heating
- Periodic mandatory inspection of Heating/Ventilation/AC (HVAC)
- Mandatory heating pipe insulation
- Mandatory use of solar thermal energy in buildings

3. Building energy codes

4. Other Regulation in the Field of Buildings

- Individual billing (multi-family houses)
- Maximum indoor temperature limit(s)/limitation heating period

5. Mandatory Standards for Electrical Appliances

- Minimum efficiency standards for electrical appliances
- Maximum indoor temperature limit(s)/limitation heating period

The regulatory principles and the methods to improve the energy efficiency in the ***Italian*** residential sector e.g. have been mainly settled in various decrees aim at promoting the improvement of the energy performance of buildings through cost-effective measures.

New rules concerning the operation, management, control, maintenance and inspection of heating, cooling and hot water systems in buildings have been established. These set of obligations and criteria are applicable to public and private buildings.

Subsequently, the Italian Decree Law No 63/2013 (converted by Law No 90/2013), transposed the Energy Performance of Buildings Directive Recast (2010/31/EU) in order to strengthen the energy performance requirements of buildings.

In the ***United Kingdom***, there have been many changes to the legislation and the supporting guidance of the building regulation regime over the last years.

Building Regulations set minimum energy efficiency standards whenever certain types of building work are carried out on new and existing buildings. Energy standards have been in place since the 1970s and have been steadily tightened, leading to increasingly better standards for insulation, glazing, airtightness and the efficiency of fixed building services such as heating, lighting and controls. The Building Regulations, was first introduced in April 2006, and then amended in 2010 and 2013, addresses the conservation of fuel and power and sets out energy efficiency standards that apply to renovations.

Closely linked to the Building Regulations is the Code for Sustainable Homes, which is designed to be a step-change in sustainable home building practice (Communities and Local Government, 2006). It is a national standard for the sustainable design and construction of new homes. It was part of the package of measures towards a zero carbon development in the UK. The Code lays the ground for higher sustainability performance across a range of criteria, especially energy, water and waste.

The assessment measures performance against nine criteria: Energy/CO_2, Water, Materials, Surface Water Runoff (flooding and flood prevention), Waste, Pollution, Health and Well-being, Management and Ecology. It then combines these scores into an overall sustainability rating measured from 1 to 6. One star is entry level above building regulations, with six stars being the highest performance, reflecting exemplary development in terms of sustainability.

Initially, the Code was compulsory where public sector funding were involved, but voluntary in the private sector. However, since May 2008, there has been a mandatory requirement for all new homes including private sector to be rated against the Code so that new home owners know whether their home is built to higher standards than Building Regulations. Minimum standards for Code compliance have been set above the requirements of Building Regulations. It was intended that the Code would have signalled the future direction of Building Regulations in relation to carbon emissions from, and energy use in homes, providing greater regulatory certainty for the homebuilding industry.

However, in March 2015, the Code for Sustainable Homes has been withdrawn and has been replaced by new national technical standards, which comprise new additional optional Building Regulations regarding water and access as well as a new national space standard (this is in addition to the existing mandatory Building Regulations).

The new approach introduces optional building regulations requirements for access and water efficiency , which provide a higher standard than the minimum national building regulations. Powers to introduce these optional requirements are now included in the Building Act. As a result, since March 2015, Local Plans, Neighbourhood Plans, supplementary planning documents and local validation lists should not include any additional local technical standards or requirements relating to the construction, internal layout or performance of new dwellings. This includes also policy requiring any level of the Code for Sustainable Homes as the Government withdrew the code, aside from the management of legacy cases.

In ***Spain***, the Technical Building Code (TBC 2006) is the regulatory framework governing the basic quality requirements of health, sustainability, energy saving and comfort that must be met by buildings, in order to comply with the basic safety and habitability regulations.

The Technical Building Code applies to new construction, except for technically simple structures of negligible constructional consequence not designated for residential or public use. It also applies to the extension, modification, alteration or renovation works that are carried out on existing buildings.

Part of the TBC is the Basic Energy Saving Document with the principal objectives: to obtain a rational use of the energy required for buildings, to reduce their consumption to sustainable limits, and thereby ensuring that a portion of this consumption comes from renewable sources of energy. It comprises the following sections:

- Limiting energy demand (heating and air conditioning).
- Efficiency of heating/air-conditioning systems.
- Energy efficiency of lighting systems.
- Minimum solar contribution to the hot water supply.
- Minimum photovoltaic contribution to the electrical power supply.

In addition to the TBC, Spain has adopted the Regulation of Thermal Installations in Buildings (2007, revised in 2013). The objective is to lay down the energy efficiency and safety requirements of heating and cooling systems in buildings which are intended to meet the thermal comfort and hygiene demands of people. The RITE has to be applies also during design and sizing, construction, maintenance and use, and specifies the procedures allowing to prove that the requirements have been met.

A further decree from 2013 implements the basic procedure to be followed in calculating energy efficiency ratings, considering factors that have the most influence in terms of energy consumption, as well as technical and administrative conditions for building energy efficiency certifications. The competent bodies of the autonomous communities must create a statistical inventory of measures related to certificates registered by them, which will serve as a crucial mechanism for planning

measures to improve the energy efficiency of the existing stock of buildings and for monitoring compliance with the rule.

In ***Latvia***, the Law on the Energy Performance of Buildings came into force on in 2013. It introduced new provisions regarding increased requirements for energy efficiency energy certification of state-owned buildings and certain parts of buildings, rights and obligations of building owners, and task to promote construction of near zero-energy buildings. Related Cabinet regulations consider the methodology for calculating the energy performance of buildings, the energy certification, and the criteria for independent experts in the field of energy performance.

Together with the Law the Parliament adopted, the requirements regarding energy certification of buildings and "nearly zero-energy buildings". The latter is defined as 'a building with a very high energy performance, using high efficiency systems for the energy supply thereof' and stipulates the classification system for energy certification of buildings and requirements for nearly zero-energy buildings:

- Class A — conforms to the requirements for nearly zero-energy buildings;
- Class B — energy efficiency index for heating does not exceed 40 kWh/m2 per year;
- Class C — energy efficiency index for heating does not exceed 50 kWh/m2 per year;
- Class D — energy efficiency index for heating does not exceed 60 kWh/m2 per year;
- Class E — conforms to the average consumption of buildings of the particular type;
- Class F — conforms to the permissible level of energy consumption set in national legislation regarding management of residential buildings.

The actual regulation relating to energy efficiency the Energy End-use Efficiency Law does not include all the provisions required by the EED so far. Therefore, a new Energy Efficiency Law is under development. In addition, amendments in other regulations are in process, for example, amendments of Law on Energy, Electricity market Law and Law on Public Procurement.

Latvian experts however recognize as obstacle to achieving improved energy efficiency in the residential sector that house owners experience excessive administration and procurement procedures.

Finland has introduced minimum energy performance requirements for renovations that require planning permission mainly from the perspective of cost-optimal levels. The relevant decree entered into force in 2013. The Finnish Ministry of the Environment also promotes the objectives of the Renewable Energy Sources Directive with regard to buildings undergoing thorough renovation.

Finnish legislation is following the targets set by the EPBD to achieve nearly zero energy buildings from beginning of 2019. Regulations for the renovation of buildings are considered as important as well. The regulations are getting stronger all the time so new houses are heading towards zero energy.

The mandatory standards for electrical appliances is in line with the requirements of the EPBD but no especially ambiguous above this.

In order to improve the energy efficiency of buildings and to fulfil the Energy Efficiency Directive, ***Romania*** adopted the Law on Energy Efficiency (2014). The main purpose to establish a coherent legislative framework for the development and implementation of national energy efficiency policy in order to achieve the national target for energy efficiency. The National Regulatory Authority for Energy (ANRE) was established and is responsible for transposing the provisions of this law into secondary legislation.

These secondary legislations on energy efficiency, among others, regulate the procedure regarding the change of electricity supplier by the end-customer, the modalities of information of end-

customers by gas suppliers regarding the commercial conditions, or the certification of energy managers and energy service companies and energy auditors' authorization regulation for the industry.

Concerning the economy-wide promotion of energy efficiency in ***Hungary***, and in order to transpose the EED into national law, Hungary has adopted in 2015 an Act on Energy Efficiency and issued a relevant governmental decree. The new act makes explicit reference to the III. National Energy Efficiency Action Plan and the National Building Energy Performance Strategy, as the two main programming policy instruments aimed at supporting implementation.

Legislative-normative, or legislative-informative policies in place in the country are limited to measures resulting from the transposition and implementation of relevant EU Directives (e.g. the eco-design directive, buildings performance directive, energy labelling, etc.). These relevant EU Directives have all been already transposed into national law and implemented, and, accordingly, they have been/are being implemented by the direct effect of EU law.

In the context and connected to the reduction of energy prices for the household sector, the Hungarian government has decided to establish a *National Public Utility Company* (NPUC) in order to provide electricity, natural gas and district heating on the national energy markets.

This new energy utility company is 100% state-owned and its goal is to ensure the security of energy supply and at the same time to provide cheap energy to the Hungarian economy, by re-investing all surplus income into the development of the infrastructure and services. The infrastructure of the NPUC has been established and it is under continued expansion by the gradual buying out of the shares of the large private utility companies currently present on the markets.

2.2.1.2 Legislative/Informative

Legislative-informative measures on the residential sector are

- Mandatory energy labelling of heating equipment or electrical appliances
- Mandatory energy efficiency certificates for existing or new buildings
- Mandatory audits in large or small residential buildings

The mandatory requirements to display energy efficiency classes on products proved to be useful while the ranking was on a scale from A-G. The newer regulation including A+ to A+++ appeared to be more irritating for consumers as they hardly distinguish between A+ and A++ as they do between B and C, for example.

The mandatory information for buildings have mainly focused on new buildings. Only a more recent trend is to extend regulations to existing buildings, by imposing minimum standards in the case of renovation and energy-efficiency labels for existing buildings (often called energy certificates); such certificates are mandatory in EU countries each time there is a change of occupant or a sale. These certificates enable consumers to obtain information about the energy consumption of the dwelling they are going to buy or rent and are differently implemented within the boundaries set by the EBPD. Most countries have chosen to include an energy-efficiency class system in their certificates (as for appliances), which makes the information more transparent to end users.

Some concerns are raised whether energy classes for buildings respectively flats for sale are much of a help for providing information to consumers. Despite the various other aspects which influences a decision on housing the 'energy certificates' do not necessarily cover the true picture if it is based on (a timeline of) consumption data of previous owners/tenants only.

2.2.2 Economic incentives

Economic incentives are an important instrument especially for spurring investment in energy efficient technologies and services. The incorporation of a financial or fiscal incentive can make energy efficiency investments more alluring for households, as it either is lowering upfront costs or is reducing tax. Economic incentives also complement other efficiency policies such as appliance standards and energy codes, overcoming market barriers for cost-effective technologies. Financial measures are net savings for the "end-user" which take into account the required investment as well as the financial revenues from saved energy. Financing the initial investment in energy-efficient equipment requires easy access to credit with appropriate finance conditions. Overcoming any initial cost barriers is achieved by making grants, subsidies or soft loans available to consumers who invest in energy-efficient technologies and equipment.

The Financial instruments are:

1. Grants / Subsidies
   - Investments in new buildings exceeding building regulation
   - Investments in energy efficient building renovation
   - Investment in renewables
   - CHP investments
   - The purchase of highly efficient electrical appliances and more efficient boilers
   - Energy audits

2. Loans/Others
   - Reduced interest rates (soft loans)
   - Leasing of energy efficient equipment

3. Tariffs

Recent studies (e.g. Filippini et al., 2013) have found that improved energy efficiency in the residential sector can be linked to the introduced financial incentives and energy performance standards, while informative measures such as labelling and educational campaigns do not show to have significant effect in fostering energy efficiency improvements. Another study conducted in Switzerland (Amstalden et al., 2007) analysed the effect of policy instruments such as subsidies, income tax deduction and carbon tax on investment decisions. The study showed that all instruments had a significant effect on the net present value, although no policy instrument alone could make energy-efficiency measures profitable. Yet, the combination of all policy instruments in that study made even the most advanced retrofit package gainful.

However, like for any other type of economic incentive, free ridership is a clear concern for these measures. It occurs when consumers take the incentives of an energy efficiency policy, but would have done the home renovations or appliance replacements anyway. Blumstein (2010) and Vine et al. (2001) discuss the difficulty of recognizing free riders, and other studies have used a variety of approaches to estimate the shares of free riders in incentive-based programs (Joskow and Marron, 1992; Malm, 1996; Grosche and Vance, 2009; Boomhower and Davis, 2013).

Working in the opposite direction are consumers, sometimes called free drivers, who purchase the efficient product because their awareness was raised by the existence of the rebate (Blumstein and Harris 1993; Eto et al. 1996; Geller and Attali 2005). Gillingham and Palmer (2013) and Blumstein (2010) discuss free drivers, namely persons who do not avail themselves of the incentives offered by

a program, but choose to make energy-efficiency purchases because their awareness has been raised by the existence of the program.

The following takes a closer look on subsidies, loans and various forms of tariffs and taxes.

2.2.2.1 Grants and Subsidies

Many governments provide grants to facilitate access to capital and encourage energy saving measures, and they have developed various ambitious schemes, mainly to retrofit existing buildings or dwellings. In principle, these incentives apply to actions that are cost effective from the collective point of view, but which would not otherwise be undertaken by consumers. For example, ***Germany***'s government-owned Bank for Reconstruction (Kreditanstalt für Wiederaufbau, KfW) provides financing (€ 162 billion between 2006 and 2014) in low-interest loans and grants for innovative energy efficiency investments in residential buildings and local infrastructure. In the ***United Kingdom,*** the government announced £ 50 million of investment in the Warm Front programme in 2009-2010, which supplied insulation and heating measures to benefit vulnerable households.

Grants usually cover a percentage of the total investments for the energy savings measures. The percentages vary between 15 to 80% among different countries. There are programs that require implementation of certain technical measures in order to qualify for a grant of a certain percentage. Grants and subsidies present the advantage of filling an immediate financial gap, thereby allowing for a temporary shift in the market, at a minimum. By targeting very specific measures or appliances, they also send clear messages to customers.

A general major drawback of the use of grants is their low sustainability. In most instances, once a grant programme is finished, there is no sustained change in the market and customers revert to previous behaviours. Longer implementation of grant programmes, on the other hand, can make these costly, and do not result in a real market transformation. However, training and information programmes operating alongside grants programmes can make up for this limitation.

The European Union and national funds also contributes to close the energy efficiency gap in the residential sector; energy efficiency funds offer more flexibility in promoting innovative technologies and solutions than other financing sources. The preamble of the EED says that "Member States should encourage the use of financing facilities to further the objectives of this Directive" and that "the financing facilities could in particular use those contributions, resources and revenues to enable and encourage private capital investment, in particular drawing on institutional investors, while using criteria ensuring the achievement of both environmental and social objectives for the granting of funds; make use of innovative financing mechanisms (e.g. loan guarantees for private capital, loan guarantees to foster energy performance contracting, grants, subsidised loans and dedicated credit lines, third party financing systems) that reduce the risks of energy efficiency projects and allow for cost-effective renovations even among low and medium revenue households."

One program in ***Romanian*** for private households (and others) is the ‚Casa Verde' or ‚Green House' Program. It was launched in 2010 to promote the use of alternative heating energy systems replacing or supplementing traditional heating system with installations of solar, wood waste and geothermal energy sources. Grants are provided by the Environmental Fund and varied according to the chosen heating system, up to € 1400 e.g. for solar panels, gas based thermal energy pellets, briquettes, wood chips, and any plant debris and waste from agriculture and forestry respectively up to € 1800 for heat pumps. The overall budget in 2010 was about € 27 million. Beneficiary should receive up to 80% of the eligible expenses of the project. The applicant had to fulfil some conditions in order to be eligible to get financing: have residence in Romania; be the owner or co-owner of the

building in which the project is implemented; have no debts to public authorities; and have not violated laws on environmental protection. The program was promoted via mass media and internet, and some meaningful symbols easy to remind have been used to help the program to gain a positive image in the public. The budget was distributed to development regions depending on the number of inhabitants per region. The grants were not meant to cover the full cost but should help homeowners intending to reduce their fuel bill as well as smoke from heating. The average costs of an energy system based on renewable sources for individual housing about 4,000 €. In 2010, the Green House program had over 18,000 requests for funding and in 2011, 24,000 applications were submitted.

However, already in its first year the program had to face a range of problems. On one hand it could started in June 2011 only because budget approval of AFM occurred late. In addition, the program was interrupted already in 2012 due to lack of money. For the beneficiaries a further burden appeared because according to funding guidelines, homeowners can settle their expenses only after the work is finished. Due to the hindrances there were still 13,000 applications pending from 2011 in 2014 but a high share were accepted finally in August 2014. In addition, political debates and changes in the Ministry of Environment played a role for the delays.

In ***Hungary***, the main financial instrument managed by the central government to promote investments on energy efficiency in households the "Warmth of the Home Programme". This grant scheme was launched in September 2014 and until date, there have been five sub-programmes implemented focusing on the different aspects of energy efficiency in households, e.g. household appliances, facade doors and windows, heating and hot water boilers and insulation. Further sub-programmes are under preparation.

The sources of the programme funds have been the Green Economy Financing Mechanism revenues from the sale of Kyoto units and the Specific Appropriation for Building Energetics and Energy efficiency of the central state budget. Due to overwhelming interest on the part of households, all sub-programme funds have been sourced out fully after announcement, either within hours, or after a few days the latest.

The sub-program *replacement of large household appliances in the categories of refrigerators and freezers resulting in energy savings* aimed to raise the energy efficiency of households by supporting the replacement of inefficient refrigerators and freezers to new, energy-efficient ones. The tender was targeted primarily at pensioners as well as large families and provided 50% co-financing for the purchase of new appliances, up to maximum HUF 25,000 in the case of A+ category units and respectively HUF 35,000 in the case of A++ and A+++ units. The criterion for the co-financing was to achieve energy savings of at least 10% per annum, or to save, at the minimum, 20 kg/year CO_2 emissions. The total available fund was HUF 500,000,000.

The sub-program *modernisation of heating systems (replacement of inefficient heating boilers)* aimed at households equipped by individual boiler units in blocks of flats including not more than four independent dwellings by providing 40% co-financing to the maximum amount of HUF 650,000. The total available fund was HUF 1,000,000,000. Target group were owners of (any type of) households by providing 40% co-financing to the maximum amount of HUF 450,000 and respectively, in the case of shading integrated new installations HUF 520,000. The available programme fund was HUF 1,100,000,000.

Co-financing up to maximum of 50% of the total costs was provided for complex energy refurbishment programmes, including the replacement of facade doors and windows of the common areas of the buildings, the thermal insulation of the building facade, the modernisation of energy infrastructure, including the improvement of the efficiency of heating and/or hot water systems as well as the utilisation/integration of renewable energies. The available programme fund was HUF

10,000,000.000. The tender provided 50% co-financing for the purchase of a new appliance, up to maximum HUF 25,000 in the case of A+ category units and respectively HUF 40,000 and HUF 45,000 in the cases of A++ and A+++ units. The criterion for the co-financing was to achieve energy savings of at least 10% per annum, or to save, at the minimum, 20 kg/year CO_2 emissions. The estimated monetary savings per households (combined energy and water savings) were up to HUF 12,000 per year.

Due to overwhelming interest on the part of households, all sub-programme funds have been sourced out fully after announcement, either within hours, or after a few days the latest.

A second grand scheme currently in effect is a social support scheme, with integrated energy efficiency criteria, under which families are eligible for a governmental grant to establish their first home (flat or house). Since 2013, the size of the grant is differentiated according to the energy efficiency category of the property to be purchased, or to be built. Properties falling into the A, A+ or "passive house" categories receive 10%, respectively 20% and 30% higher grant. The grant, in general, is available for properties to be purchased/built fulfilling the B category at the minimum.

A second grand scheme currently in effect is a social support scheme, with integrated energy efficiency criteria, under which families are eligible for a governmental grant to establish their first home (flat or house).

In parallel, however, there are also plans that the financials that had originally been dedicated to the household sector in the EEOP are going to be reoriented towards the financing the necessary energetic refurbishment of public buildings. This plan is actually contrary to the fact that for the purpose of the energetic refurbishment of public buildings there have been funding secured from other sources already and that the volumes of the estimated energy saving potential in public buildings although is high, it remains only a fraction of that in the household sector.

In **Finland**, the Ministry of Employment and Economy offers about 40 Mio € annually for energy issues and of this about 10-15 Mio € for efficiency measures. They are used for e.g. heat recovery units, a switch to LED lighting etc.

The role of small-scale investment, in particular by households or small businesses, has not been particularly prominent in Finnish energy policy. Some interest in households' investment is visible in the National Renewable Energy Action Plan (NREAP) through its expectations of a sharp increase in ambient energy produced by heat pumps. However, this is mainly left to the market, because the small government grant (15% of investment cost of ground source heat pumps, bioenergy boilers and solar heat) was only available for homeowners during 2010-2012.

Different from many other countries Finland has no national energy efficiency fund or plans to establish one. As the Parliament of Finland has no control over state funds that are not part of the state budget, a restriction on founding extra-budgetary funds is provided in the Constitution of Finland.

In ***Italy***, the Thermal Account (2013) "Renewable Energy for Heating & Cooling Supporting Scheme", is the first nationwide and the youngest direct incentive scheme for the generation of renewable thermal energy, as well as being the first scheme encouraging public authorities to implement energy efficiency actions in buildings and technical installations. The scheme is addressed to public administrations and private parties (i.e. individuals, apartment block owners, and parties with business or agricultural income). These beneficiaries ("responsible party") may implement the actions via an ESCO, by means of a third-party financing contract, an energy service contract or an energy performance contract.

The GSE (Gestore dei Servizi Energetici) is in charge of implementing and managing the scheme. It also awards, disburses and revokes incentives and it is in charge of monitoring and checks. ENEA assists GSE in preparing the technical rules for implementing the decree and takes part in the verifications and checks.

The Thermal Account supports the following energy efficiency projects for private parties:

- Replacement of existing systems for winter heating with more efficient ones (condensing boilers) – Category B.
- Replacement and, in some cases, construction of new renewable-energy systems (heat pumps, biomass boilers, heaters and fireplaces, solar thermal systems, including those based on the solar cooling technology) – Category B.

This support is granted on the basis of the type of project. The incentive covers part of the costs incurred and is paid out in annual instalments for a period from 2 to 5 years according to the actions implemented. The incentives may be granted only for projects that do not benefit from other forms of government support, except for guarantee funds, revolving funds and loans.

Since its implementation in July 2013 until November 2014, eligible beneficiaries submitted around 9.000 applications, among which more than 6.000 in 2014.

The European Structural Funds programme, and in particular the European Regional Development Fund (ERDF) and the European Social Fund (ESF), earmarked under the 2014-2020 programming period almost € 32 billion in Italy. Of these, € 23 billion will go to the less developed Regions (Campania, Puglia, Calabria, Sicily and Basilicata), 1.1 to transition Regions (Abruzzo, Molise and Sardinia) and the remaining 7.8 to the more developed Regions. Even though funds for the overall cohesion policies have been significantly reduced as a whole, those intended to finance projects related to renewable energy, and especially those related to the energy efficiency improvements of buildings, have increased. Also, the Kyoto fund established with the Law No 296/2006 (it entered into force only the 16th of February 2012), is a revolving fund for the subsidised financing of GHG emission reduction projects, set up at the Cassa Depositi e Prestiti (Deposit and Loan Fund) having a total budget of some € 600 million, to be paid out in three one-year cycles of € 200 million each. The actions funded under the first programming cycle concerned 7 national or regional measures, but only three actions are referred to energy efficiency. The subsidised projects obtained loans with a duration of 3 to 6 years (3 to 15 for Public authorities) with six-monthly instalments at a fixed annual interest rate of 0.5%. The fund covers the 70% of the total investment for private individuals, while the 90% for public bodies. The overall interest on the Kyoto fund has mainly been on renewable energies, while requests for energy efficiency funding have been scarce.

The Domestic Renewable Heat Incentive (Domestic RHI) launched by the ***UK*** Government in 2014, is a Government financial incentive to promote the use of renewable heating system. The domestic RHI is targeted at, but not limited to, homes off the gas grid. Those without mains gas have the most potential to save on fuel bills and decrease carbon emissions.

The scheme covers single domestic dwellings and it is open to homeowners, private landlords, social landlords and self-builders. It is not open to new build properties other than self-build.

The domestic RHI pays the following tariffs per unit of heat generated for seven years (Table 5).

Table 5. The domestic RHI tariffs per unit of heat generated

Technology	Tariff
Air-source heat pumps	7.3p/kWh
Ground and water-source heat pumps	18.8p/kWh
Biomass-only boilers and biomass pellet stoves with integrated boilers	12.2p/kWh
Solar thermal panels (flat plate and evacuated tube for hot water only)	19.2 p/kWh

Source: UK Government website

The tariffs have been set at a level that reflects the expected cost of renewable heat generation over 20 years. Payments are made on a quarterly basis.

All installations must be certified under the Microgeneration Certification Scheme and meet relevant required standards for each technology, including limits on harmful emissions for biomass systems.

The renewable heat generated will be estimated in most cases for payment purposes. For biomass and heat pumps, it will be based on an estimated figure of heat demand from an Energy Performance Certificate. For heat pumps, this will be combined with an estimate of the heat pump's efficiency to determine the renewable proportion of the heat. For solar thermal systems, the payments will be based on the estimate of system performance completed as part of an MCS installation. Those applying for a space heating system who have a backup heating system, such as an oil boiler, or people applying for a second home, will need to install metering equipment on which the RHI payments can be based.

To help improve performance of renewable heating systems, there will be an extra incentive for applicants who install metering and monitoring service packages, of £230 per year for heat pumps and £200 per year for biomass boilers. This scheme is administered by Ofgem (Office of Gas and Electricity Markets).

In ***Latvia*** most of the funding so far has come from the EU Structural funds and revenue generated by sales of Kyoto quota to support energy efficiency. During the new funding period from 2014 to 2020, the total budget will be over € 300 million. In this programme, private households will receive more than 40% of the funding available.

Activities supported were energy audits of multi-apartment buildings, technical inspections, preparation of project documentation (80% co-funding rate) and renovation of multi-apartment buildings (20% co-funding rate). Relevant for households were the project "Improvement of Heat Insulation of Multi-apartment Residential Buildings" implemented within the 2007–2013 grant program. Here individual flat owners could become beneficiaries. The total volume of the measure was € 89 million (ERDF 78 million + state budget 11 million). More than 1400 project applications were handed in (demand for ERDF – € 128 million), and more than 635 projects were accomplished by October, 2015.

The most relevant national instrument, administrated by the Latvian Ministry of Environment and Regional Development, the 'Climate Change Financial Instrument (CCFI)' is available for municipalities only. However, the Ministry of Economics is planning to set up a Latvian Energy Efficiency Fund, which will managed by the state joint-stock company ALTUM. It will combine EU funds in order to introduce as many energy efficiency measures as possible. The main difference for beneficiaries who are used to at least a 50% grant is that now they will receive a loan of 100% of the amount required for construction and supervision costs as mentioned above. This loan will have a

low interest rate (EURIBOR + 2%) but if the project will achieve high energy efficiency, it will be possible to receive a grant of up to 35% of the loan. The idea of the loan is to ensure high investment efficiency and insulate as many buildings as possible.

The ***Spanish*** 'State Plan for promotion of rental housing, building rehabilitation and urban regeneration and renewal', 2013-2016 promotes – among others – the 'Programme of Building Rehabilitation'. It is meant to finance the renovation and maintenance in fixed installations and equipment, as well as in common private areas and elements in buildings with at least a built-up surface area of 70% for residential use built before 1981. To qualify for subsidies, the building's total annual energy demand in terms of heating and cooling must be reduced by at least 30% compared to the levels taken before implementation of the measures, as demonstrated by the energy certificate. The maximum amount of the subsidies to be granted per building is not to exceed the amount resulting from multiplying €11.000 by each house and by every 100 m² of the premises useful surface. The expected beneficiaries of the aids from this programme are property owners, associations of property owners or sole owners of blocks of houses.

In addition, the ***Spanish*** Ministry of Industry, Energy and Tourism through the Institute for Energy Diversification and Saving (IDAE) launched the PAREER-CRECE Programme "Aid programme for integral energy efficiency and saving projects in residential buildings" (2015). It is a specific aid and financing programme amounting to € 207 million to encourage and promote the implementation of integral energy efficiency saving and improvement actions, as well as the use of renewable energy sources, such as the renovation of windows, roofs, boilers, air conditioning equipment, the incorporation of equipment to individually measure heating and domestic hot water consumption, replacing conventional energy with biomass or geothermal energy, etc. The actions are to fit one or more of the following typologies:

1. Improving a building's thermal insulation.
2. Improvement of energy efficiency in thermal and lighting installations (including solar thermal).
3. Replacement of conventional energy for biomass in thermal installations.
4. Replacement of conventional energy with geothermal energy in thermal installations.

Eligible beneficiaries of the aids from this Programme are:

- Natural and legal persons, owners of residential and hotel buildings.
- Associations of property owners or Associations of residential-building property owners.
- Owners of single-family houses or sole owners of residential buildings.
- Energy service companies.

All types and beneficiaries can receive a money allowance without consideration, supplemented with a refundable loan. The amount of the direct aid is a sum of a Base Aid and an Extra Aid. The additional aid up to the top amount to be received depends on the following criteria:

a) Social criteria: actions to carried out by the relevant body in the Regional Government in buildings classified as public housing and subsidized housing under the Special Scheme; or actions taken in residential buildings located in areas of buildings Urban regeneration and renewal, in compliance with the State Plan for Development of Rental Housing, the Rehabilitation in Buildings and Urban Renewal and Regeneration 2013-2016.
b) Energy efficiency: actions to upgrade the energy rating of the building to achieve "A" or "B" energy rating in the CO2 emission scale, or else, actions to upgrade the initial energy rating by two letters.
c) Comprehensive Performance: simultaneous actions combining two or more action types.

Table 6. PAREER-CRECE Programme

Type of action	Building use	Money allowance without consideration					
		Base aid	% Additional Aid				
			Social criteria	Compreh. performance	Energy efficiency		
					"A" Final Rating	"B" Final Rating	Two-letter upgrade or higher
Upgrade of the energy efficiency in the thermal envelope	Households	30% (limit 6 000 €/ household)	15%	20%	15%	10%	5%
	Other uses		0%	20%	15%	10%	5%
Upgrade of energy efficiency in thermal & lighting installations	Households	20%	0%	0%	10%	5%	0%
	Other uses		0%	0%	10%	5%	0%
Replacement of conventional energy by thermal biomass in building thermal installations	Households	25%	5%	10%	0%	0%	0%
	Other uses		0%	10%	10%	5%	0%
Replacement of conventional energy by geothermal energy in building thermal installations	Households	30%	10%	15%	0%	0%	0%
	Other uses		0%	15%	10%	5%	0%

Source: ODYSEE-MURE

Aid can be requested from the 5th of May 2015 to the 31st of December 2016.

In June 2014, the Spanish government has adopted a National Energy Efficiency Fund (Fondo Nacional de Eficiencia Energética, FNEE). The new fund will be managed by the Institute for Diversification and Saving of Energy (IDAE) and will be partly financed (35%) by the central government from EU structural funds. The FNEE intends to allocate most of the funds to co-finance energy-efficiency actions in residential and commercial buildings (hotels, National Health System centres, retail trade, etc.). It announced to focus on building renovation, heating systems, and boiler efficiency, among others, and will co-finance energy efficiency investments in buildings, industry, transportation, and agriculture. In the building sector, the FNEE will participate to energy-efficiency investments worth about €892m/year. It will be completed by the "Plan de Vivienda 2013-2016" (€ 200 million) for building renovation.

Finally, the European Investment Bank (EIB) and the Spanish Energy Saving and Diversification Institute (IDAE) the 1st July of 2011 concluded a finance agreement to launch a JESSICA holding fund (FIDAE) designed to finance energy efficiency and renewable energy projects. The Fund for Investment in Efficiency and Energy Savings (FIDAE) was initially endowed with € 127.6 million (€ 87.8 million are financed by the ERDF). The fund is managed by the European Investment Bank (EIB) and is available for 10 Spanish regions: Andalusia, the Canaries, Castilla y León, Castilla-La Mancha, Ceuta, the Valencia Region, Extremadura, Galicia, Melilla and the Murcia Region. In addition, the 11th of June 2014, the Spanish government has adopted a National Energy Efficiency Fund (Fondo Nacional de Eficiencia Energética, FNEE). The new fund will be managed by IDAE and will be partly

financed (35%) by the central government from EU structural funds. The FNEE will allocate most of the funds to co-finance energy-efficiency actions in residential and commercial buildings (hotels, National Health System centres, retail trade, etc.). It will focus on building renovation, heating systems, and boiler efficiency, among others, and will co-finance energy efficiency investments in buildings, industry, transportation, and agriculture. In the building sector, the FNEE will participate to energy-efficiency investments worth about €892m/year. It will be completed by the "Plan de Vivienda 2013-2016" (€ 200 million) for building renovation.

The subsidies applied in ***Germany*** for energy-efficient refurbishment programmes are manifold. They can be grouped to

- Passive houses, and energy saving houses,
- Isolation measures for existing buildings
- Energy saving heating and airing systems
- Co-generation
- Renewable energies

Builders and Renovators benefit from financing for grant and loan variants. Most programs are carried out through the state owned KfW. Their 2013 programmes e.g. increased

- the investment grants for individual measures from 7.5% to 10% of the eligible costs, maximum grant amount of EUR 5,000 per housing unit
- the investment grants for the KfW Efficiency House 70 from 17.5% to 20% of the eligible costs, maximum grant amount of EUR 15,000 per housing unit
- the investment grants for the KfW Efficiency House 55 from 20% to 25% of the eligible costs, maximum grant amount of EUR 18,750 per housing unit

However, to receive the support the funds demand high technological requirements and the involvement of an energy consultant.

2.2.2.2 Loans

Soft loans on average are less popular than subsidies. But they are the main istrument targeted at consumers with the advantage of being easily implemented by banking institutions. Soft loans in the context of this report are loans offered at subsidised interest rates (i.e. lower than the market rate) to consumers who invest in energy efficient technologies and equipment. In some cases, they are given directly to installers, a promising approach, if well managed. This removes one important barrier for consumers, the access to information. As the installers may have a commercial approach to promoting energy efficiency gathering information for them is less a hindering effort. Loans usually are applied in cooperation with the business sector.

The ***UK*** Government has recently committed to additional spending of £ 320 million on the 'Warm Home Discount' scheme in 2015/16. The Warm Home Discount scheme is a five-year scheme that was introduced in 2011. Though it the Government and electricity suppliers are working together to offer extra support to people struggling to afford their energy. The Warm Home Discount is a one-off discount of £ 140 on the electricity bill, usually between September and March. Some consumers of a so called "core group" automatically qualify for the Warm Home Discount. Beyond that, some suppliers also offer the discount to a "broader group" of customers who are under risk to falling into fuel poverty, such as low-income households and here especially those with a small child.

Another ***UK*** programme in this context is the 'Green Deal Home Improvement Fund (GDHIF)'. With it, the government established a framework to enable private firms to offer consumers energy efficiency improvements to their homes, community spaces and businesses at no upfront cost, and get back payments through instalments on the energy bill. This way, consumers can see the Green

Deal charge alongside the reductions in energy use, which generate savings on their bill. An important side effect of this model is that if tenants or homeowners had moved out and cease to be the bill-payer at that property, the financial obligation did not move with them but moved to the next bill payer. In this way, the Green Deal differed from existing lending – it was not a conventional loan since the bill-payer was not liable for the full capital cost of the measures, but only for the charges on the energy bill.

The original GDHI Fund ran out in July 2014, and the scheme was relaunched in December 2014. However, the Government stopped the Green Deal in July 2015, as the number of households taking out the loans with just over 15.000 was much lower than had been hoped by the Government.

This decision had no impact on existing Green Deal Finance Plans or existing Green Deal Home Improvement Fund applications and vouchers.

With the support *European Bank for Reconstruction and Development* (EBRD) in context of their *Sustainable Energy Financing Facility* (SEFF) the ***Romanian*** government established the *RoSEFF.* It is partnering with financial institutions such as the Romanian Commercial Bank, Raiffeisen Bank, Transilvania Bank, and the Development Bank. Finance for sustainable energy projects is provided for two key areas: energy efficiency and small-scale renewable energy.

The national financial institutions on-lend the funds which they have received from the EBRD to their clients, which include small and medium-sized businesses, corporate and residential borrowers, and renewable energy project developers. Residential loans cover a few thousand to a few hundred thousand €os, most often to support improvements on the building envelope. Various groups have benefited from SEFF loans including individual owners, groups of homeowners and multi-apartment associations with individuals representing a very small share only.

Latvia, in turn, rotation funds - long-term investment funds. Advantage of these funds is that payback for the loan only starts after the renovation project is completed. Thus, it can easier afforded from the energy savings. Such rotation funds already exist in Estonia and Lithuania since 2009. In Estonia, the fund offers loans for 10 years with the fixed interest rate of 3%.

In addition, ***Hungary*** considered a green loan (soft loan) promoting energy efficiency investments provided directly to the households; and soft loans made available to energy utility companies for financing their ESCO-related activities in the households sector. According to the latest policy developments, however, the government modified this original idea and decided that the household sector will be provided support for the energetic refurbishment of buildings in the format of returnable funding (i.e. soft loans) only.

2.2.2.3 Tax and Tariffs

Fiscal policies aim at reducing capital costs to make energy-efficient investments more attractive. They are widely used across the European Member states but not to the extent of financial instruments as grants. Fiscal incentives for the energy efficiency in buildings include several measures to lower the taxes paid by consumers investing in the energy efficiency of buildings. In particular, measures include VAT reduction on retrofitting investment and equipment, income tax credit, income tax reduction, and linear tariff electricity (constant-price).

Tax/Tariffs instruments include:

1. Tax Exemption / Reduction
    - VAT reduction on retrofitting investment
    - VAT reduction on equipment
    - Income tax reduction

- Income tax credit

2. Tariffs
   - Linear electricity tariffs

Member States differ in their approach towards fiscal instruments as a tool for energy efficiency. For example, tax reductions have been traditionally common in ***Italy*** and ***Finland***.

Tax deductions for the energy upgrading of buildings were introduced in ***Italy*** by the Budget Law 2007 and are still in force. These deductions have been key drivers of energy efficiency improvements in the housing sector. The total numbers of actions implemented have helped to generate final energy savings currently in excess of at least 2 $MtCO_2$ emissions avoided.

Tax deductions can be claimed by all taxpayers, including natural persons, professionals, companies and undertakings incurring costs for implementing the actions in existing buildings. The deduction can also be claimed by the family members living with the owner or possessor of the property and tenants holding a regular letting agreement.

Italian tax deductions (which are granted for both residential and commercial buildings) consist of reductions of personal income tax (or corporate income tax) in respect of actions to improve the energy efficiency of existing buildings, in particular for expenses incurred to:

- Reduce heating demand by means of overall upgrading of the building's energy performance;
- Improve the building's thermal insulation (replacement of windows, including blinds or shutters, and insulation of roofs, walls and floors);
- Install solar thermal panels;
- Replace winter heating systems (with condensing boilers or heat pumps);
- Replace electrical water heaters with heat pump water heaters.

Government and Parliament have extended the action through 2015 (up to June 2016 for actions on the common parts of buildings) and have raised the tax deduction rate to 65% but have already decided to revise the scheme, with a view to rationalizing expenditure, so as to transform the scheme into a structural incentive.

IEA recently mentioned this measure as a best practice at international level (Energy Policy Highlights), with specific reference to its role in the spreading of an energy efficiency culture at local level. The 356.000 requests for tax deductions made in 2013 showed a 1/3 increase compared to the number of 2012. This phenomenon is certainly attributable to the increased tax deductions rate of 65%. These conditions have stimulated private owners to bring forward to 2013 the realization of those energy improvements that would otherwise have made in subsequent years.

Finland applies a general tax reduction for any household service. It can be used e.g. for the service component of the installation, and totals 1900 €/taxpayer. The positive aspect is it can be used for drilling the ground source heat well. With two taxpayers in a family, it pays a large part of that investment, which can be almost have of the total investment (about 18 000 € for a medium-size house in total) about half of that is the drilling (Lorek, 2015).

Household service tax deductions are regarded as a significant incentive for energy efficiency improvements in detached houses. Taxpayers can currently deduct from their taxes 45% of the value of household service or maintenance work conducted at the taxpayer's or his/her parent's home, up to a maximum value of €2,000 per year (€4,000 for a couple). Vendors of energy technology have utilised this incentive by pricing their work high and equipment low.

Actually, due to the quite good achievements of energy reductions in industry in Finland there are production over capacities now. This also includes overcapacities in electricity provision. This results in the problem that energy is offered at a very cheap rate. It concerns electricity even if the electricity price for private use is more expensive than for industry. This holds especially true for heating energy. District heating holds a high share in apartment blocks and it is argued, that the heat is available anyway as a co-product from electricity production. Actual political debates are between the interest for cheap and the demand for wise energy provision.

To support at least demand response measures Finland has implemented a) time-of-use tariffs and b) real-time pricing.

In ***Spain***, in order to reduce the deviation between costs and revenue within the Electricity Sector, the Government applied in the recent years a package of measures to split the burden of the corrective action between energy consumers, renewable energy producers and the other actors in the energy sector. The reason behind is that Spain has the highest electricity tariff deficit among Member States (€ 30 billion, 3% of GDP, at the end of 2013). Regulation from 2012 established permanent tax mechanisms on energy prices in order to promote a rational and efficient use of energy by the end user.

The following tax measures came into force on January 1, 2013. All their revenues will be used to finance certain costs within the Electricity Sector, and thus are planned to help to reduce the current deviation between costs and revenue within the Electricity Sector (the "tariff deficit"):

- Tax on Production Value: the taxable basis will amount to all revenues derived from the production/injection of energy into the electrical system. Tax rate of 7%.
- Levy on the Use of Fresh Water Resources: the taxable basis is the value of the hydroelectric energy produced, measured at the power plant busbar. Tax rate of 22%.
- Green Cent: the law creates 3 new special taxes applicable to the use of gas (general use: 1,15 €/gigajoule; energy production: 0,65 €/gigajoule; other professional uses: 0,15 €/gigajoule), coal (0,65 €/gigajoule) and fuel-oil (29.15 €/1,000 litres diesel; 12.00 €/ton fuel-oil).
- Tax on the production of radioactive waste as a consequence of the energy generating activity, and the tax on radioactive waste storage.

A relevant tax in ***Latvia*** is real estate tax. According to the law, municipalities can apply 50% tax discount for the buildings, which have implemented energy efficiency projects, which have been funded via EU or national funds or has ensured 20% energy savings. OECD and EU Semester recommendation asked to increase property taxes in Latvia. Such increase in combination with the tax break would even more stimulate energy efficiency.

Additionally there are also energy and transport taxes, which has an impact on household energy use. Excise duty on energy resources in Latvia apply to mineral oils and natural gas used for both transport and heat and power. All excise duty rates in Latvia are above the minimum set out in the EU Energy Taxation Directive; however, almost all of excise duty tax rates are also below the EU-28 average, putting Latvia towards the lower end of OECD Member States in terms of energy taxation. However, if comparing tax burden by purchasing power, the situation is vice versa – then Latvia has the higher excise tax burden than OECD average by purchasing power. Furthermore, the government in preparation for the national budget 2016 is planning to increase the excise duty rates for fossil fuels using the current market situation with low energy prices. Therefore, it will be additional pressure to the cost of consumers and will make even higher energy taxation.

Latvia also applied several taxes on electricity. Electricity tax was introduced in 2003 in order to promote electricity production from renewable resources. It is levied on electricity supplied to the

final consumers or consumed by suppliers. Tax exemption have both social and environmental aim, as tax should not be paid for electricity generated using renewable energy and high efficiency CHP plants, but also households and transport sector are exempt from the tax.

Furthermore, tax for subsidized electricity producers was introduced in January 2014. The tax is paid by the companies receiving financial support for power generation from renewable energy sources (feed-in tariff) or from CHP plants (including those running on fossil fuels) and is differentiated according to the energy source (15% rate for fossil fuels and 5% for renewables and high efficiency CHP). If energy supplier is providing heat for district heating tax rate is also fixed at 5%, to minimalize an impact on district heating prices. Aim of this tax is to compensate households and Latvian companies increase in electricity prices due to the introduction of feed in tariff called the mandatory procurement component, which has been added to electricity bills since 2013. This happens via the state budget program Electricity Customer Support.

2.2.3 Informational

Citizens and relevant stakeholders need relevant information and motivation for taking action and to be able to make informed decisions and choices towards energy efficiency measures. The challenge is to provide the right information when decisions and choices are made, in a format that the citizens find interesting, useful and trustworthy.

Information and educational programs typically aim to induce change of the consumer's behaviour by providing information about potential energy savings from energy efficient product or investments and by including programs to give feedback to consumers about their energy consumption. The intention is that through the provision of greater and more reliable information, issues of uncertain future returns and asymmetric information may be lessened.

These programmes intend to guide consumers toward better decisions, because often there is a lack of information about the difference in future operating cost between more-efficient and less-efficient goods necessary to make proper investment decisions (Howart and Sanstad, 1995).

There are many different national and European programs among the Member States, which aim to change the consumer's behaviour regarding his/her energy consumption and to be more concerned of energy efficiency in purchasing decisions. Governments and energy agencies have introduced a number of different mechanisms to provide customers with direct, cheap and reliable information about the energy performance of their energy services and products. These programs follow many different concepts ranging from a pure publication of information in brochures or booklets to mass media campaigns via internet and TV for monitoring and consulting consumers by experts or smart metering and billing. The most common way for informational and educational measures is promoting energy efficient usage through campaigns via print, internet and TV.

When a change in user behaviour is identified and quantified, it is hard to determine its origin. In doing so, some studies focus on the socio-economic and demographic characteristic of the households, while others on personality traits and social norms.

Ameli et al. (2014) through an empirical analysis of the OECD Survey on Household Environmental Behaviour and Attitudes, confirms the assumption that renters have much weaker incentives than owners to invest in energy efficient and clean technologies, and in addition demonstrates that the technology adoption is strongly influenced by household's social context and energy practice; targeted policies are required to address specific barriers for different groups of consumers.

Other studies focus their attention on the personality traits that affect the propensity of the individuals to save energy in their daily activities. In fact, for all the technological advancements in

building energy efficiency, technology alone cannot obtain the full potential of energy savings because psychological factors are robustly associated with people's energy saving behaviours; for example, being opened to new experience, curious and creative, can help people in overcoming the obstacles which prevent them from obtaining pro-environment behaviours (Lourdel et al., 2006; He et al., 2010; Markowitz et al., 2012).

There is also a large body of existing work on how normative feedback can induce households to conserve energy. Giving consumers feedback on their consumption, providing information on the potential of energy savings opportunities, and comparing their use to their neighbourhood, have caused households to reduce energy consumption (mainly electricity) by 5-12% (Fischer, 2008), but also undesirable boomerang effects[15], observed in many normative feedback experiments (e.g., Schultz et al., 2007; Fischer, 2008; Ayres et al., 2012; Sælen and Westskog, 2013). However, the boomerang effects are generally overwhelmed by enhanced energy conservation behaviours.

Typical informational instruments are as follows:

- Voluntary labelling of buildings/components (existent and new) (see 2.2.1.2)
- Information campaigns (by energy agencies, energy suppliers etc.)
- Detailed energy/electrical bill aiming at EE improvements
- Regional and local information centre on energy efficiency (see 4.1)

Information initiatives on the national level

In order to disseminate at national, regional and local level transparent information on energy efficiency ***Italy*** developed the 'Integrated Energy Efficiency Uptake Plan'. It addresses the provision of information and training on energy efficiency; in detail, it sets out targets, beneficiaries, strategies and contents of the information and training actions, budget, implementing agencies and provisions for post hoc assessment of the activities. The target groups of information and training actions include: public sector employees, banks and financial institutes, SMEs and the general public. It includes the following actions:

- Strengthening of communication on energy efficiency to improve the user-friendliness and transparency of information;
- Initiatives promoting energy-awareness in daily behaviours targeting specific groups (e.g. home-makers' associations, high school students, universities);
- Design, implementation and testing of instruments to ensure the dissemination to all relevant market players of information on energy efficiency schemes and the financial frameworks via direct means (information from computers or smart meters combined with home-installed displays) and indirect means (smart bills containing historical and comparative energy consumption data).
- Promotion of energy audits as a useful instrument to provide the information needed to take energy efficiency measures, and impact assessment of the communication campaign.
- Awareness-raising in the building trade, with a focus on the real estate market; cooperation on actions to raise end-users' awareness of the energy performance of buildings.
- Cooperation with research institutes, universities and companies to assess the costs of EE systems and components, compare the different technologies available for a given energy service and examine the applicability of innovative technologies in the home;

[15] The "descriptive norm" element of the Home Energy Report treatment, in which a household's energy use is compared to that of its neighbors, would cause households that previously used more than the norm to decrease usage, but would cause households that used less than the norm to use more (Allcott, 2011).

- Planning and delivery of awareness-raising initiatives on the workplace and training of the Energy Manager within public authorities.

Different type of dissemination methods to influence energy consumption behaviours are considered, such as traditional communication actions, a mix of direct and indirect feedback from energy suppliers, and training on energy issues. Most pilot studies have proven that even small information actions can bring about measurable reductions in energy consumption. The energy savings achievable via individual or combined actions are: feedback (5-15%), direct feedback (smart meter, 5-15%), indirect feedback (enhanced billing, 2-10%), energy audits (5-20%), EU-based measure (5-20%), and combined measures (5-20%).

The main informational policy instrument in ***Hungary*** is the *Energy and Climate Awareness-Raising Action Plan* (ECARAP) endorsed by the government in September 2015. It is an action plan of cross-sectorial nature, identifies as target audience the entire Hungarian society, including the civil-, business-, household- and public sectors, with the overall objective (with reference to the relevant objectives of the NEEAP and other related national policy documents, etc.) to propagate energy and climate awareness.

The plan identifies the main areas of action for the government in the short term (in the majority of the cases till 2020) to foster a major change in the awareness, attitudes and values of stakeholders concerning the use of energy and related to climate change, as well as towards the necessary change of related consumption patterns. The ones with the most relevance to the household sector are:

- The promotion of energy efficiency and energy conservation;
- The realisation of new social and economic structures according to the principles of resource efficiency and low carbon-intensity [16]

Special attention is paid to children and young people (as a targeted sub-group), because of their particular importance in inducing the necessary sift in the awareness, values and attitudes of society.

Other identified target groups with high relevance to the household sector include the media, energy utility- and other related companies, as well as the civil sector, with emphasis on the importance of the coordination of related activities and messages to the different target groups.

The intended main "messages" of the ECARAP are differentiated according to also of age groups, e.g. within the group of children and young people age-groups of 3 to 6 years old and 6 to 18 years old are defined, while in the group of adults, the age-groups of 18 to 39 years of and 39+ years old are, differentiated. Furthermore, low-income households suffering from/endangered by energy poverty are identified as a target group on their own.

Measures put forward in the action plan are grouped into the following main areas:

- Informational and communication campaigns/measures;
- Educational and pedagogical measures;
- Financial support for the implementation;
- Other measures aimed at supporting the implementation (e.g. research, coordination etc.).

For the monitoring of the implementation of the ECARAP an awareness-raising working group was announced to be established by end of 2015 and in a next step an indicator system to evaluate the effectiveness of the implementation of the action plan will be worked out by mid-2016.

Within the 2013 ***Romanian*** campaign to inform the population and businesses on the importance of improving energy efficiency, ANRE organised 8 seminars in 6 cities attended by approximately 370

[16] In addition to and hand in hand with the fields of action: *promotion and use of renewable energies*; *energy savings and the reduction of emissions in the transport sector*; and *climate adaptation*.

trainees. ANRE presented the EU regulation, the general objectives of the energy efficiency policy in Romania, energy efficiency issues in public and residential buildings, issues related to funding facilities, issues concerning the thermal rehabilitation of buildings, etc.

A high amount of information is available on the Internet about energy efficiency, energy business, ESCOs, etc. The way it is presented, however, does not meet the knowledge level of average citizen. In order to become useful these information would have to be 'translated'. In addition, the conferences organized took place in luxury conference hotels based on a high participation fee, which is not affordable for interested consumers or even engaged NGO representatives.

Finland has a long history of investing in the dissemination of information, advice and training relating to energy efficiency. One of the most important organisations in this respect is Motiva Ltd, a state owned company operating as an affiliated Government agency.

Consumer advice on the efficient use of energy and energy saving, as well as advice on promoting the use of renewable energy, is seen as an important topic which and must be increased. There is a need to develop tools, online services and other services for comparing the impacts of one's own choices and for finding solutions tailored to one's own situation and household. Adequate attention is given to this in the NEAAP.

Nevertheless, the financial support for regional energy advisors was cut for budget reasons. This appears as an unfortunate situation as personal exchange with experts would be beneficial in various settings. E.g. public authorities normally know quite well which houses require renovation in the next future. A timely proactive exchange with the house owners (whether private ones or companies) could help to pave the floor, raise awareness, and increase willingness to go through the 'suffering' which come with major renovations. Neutral experts have been proven to achieve more and trustful attention from tenants, which lead to better solutions regarding energy efficiency.

Another example is that based on experiences in the 1970s people are often concerned about bad air and mold resulting from isolated flats. So they contradict the benefits of isolation though exaggerated airing or resistance to renovation. While the problem generally is solved through technology, informational policies have not managed so far to prove the argument as outdated.

In ***Latvia*** the campaign "Let's Live Warmer" is an integrated, multimedia communication campaign that promotes the energy-efficiency of Latvian buildings. This campaign was introduce in February 2010 to stimulate use of the funding provided by European Regional Development Fund. The campaign was response of the government to the low demand for the available funding for energy efficiency in buildings. The campaign was based on the cooperation memorandum aiming to ensure the availability of information on housing insulation issues.

The Ministry of Economics during five years of the campaign-organized seminars, conferences and different discussions, participated in trade fairs and exhibitions**.** Two-way communication was established through social networking, engaging in direct communication with citizens. Total number of events from 2010 until 2014 – 198; more than 6390 participants in person and more than 2740 participants through online channels. Success of the campaign can be measured with the steady increase in number of submitted project applications for funding increasing from 117 in 2009 (when the campaign did not yet exist), to 170 in 2010 (when the campaign was started), to 470 in 2011 (highly attributable to the campaign, as taking the decision about renovation and preparation of project application can take up to 6 months), to 435 in 2012 (continuing results of the campaign) and 248 in 2013 (in 2013 project applications were submitted only till 31 of July). There has been also the much higher density of discussions about the necessity and benefits of energy efficiency in the media and general public. According to the assessment done by Latvian Green Movement campaign

has stimulated positive effect as investment (national and ERDF) in the housing energy efficiency which was increased fourfold – from € 20 to 89 million.

Within the campaign the contest "The Best Energy Efficiency Building" has been regularly organized since 2011, assessing buildings renovated in the previous year. It promotes good practice in the field of energy efficiency, as well as raising public awareness of the heat resistance of buildings and the role and opportunities for greenhouse gas emissions to create high quality living space and expressive architecture.

Through communication campaigns and information and training programmes for consumers and all other actors on the energy efficiency market the ***Spanish*** Energy Diversification and Saving (IDEA) aims at promoting and facilitating an efficient use of energy by SMEs and households. Many developments have been posted on the institute's website specialising in energy efficiency (www.idae.es), including publications, online classes and an array of audiovisual content. The awareness-raising campaigns carried out over more than ten years have helped to track the evolution of the Spanish consumer profile and to better direct actions aimed at achieving quantifiable energy saving results. A recent study (Labanderia et al., 2015) suggests that energy efficiency-driven public campaigns may increase their effectiveness if they focus on the adoption of pro-environmental behaviours rather than on trying to raise environmental attitudes.

Examples of efficiency programmes are:

The first institutional advertising and communication campaign on energy saving and energy efficiency under the latest NEEAP with a national coverage, has been implemented in June 2014. The campaign has a budget of € 4 million, a savings target of 6 ktoe/year and is aimed at the 26 million holders of domestic energy agreements. The campaign is structured into three stages: permanent online presence through the creation of a citizen information site (search engine placement and social networks), mass media campaign (television, radio, press, etc.) accompanied by measures such as the distribution of 26 million leaflets with electricity bills, and the production and broadcasting of informative content on Spanish public television.

Since 2004, IDAE has been running radio (“consume” campaign), radio and television, press, outdoors and online campaigns, as well as periodic campaigns focusing on the efficient use of energy for heating (in winter) and air conditioning (in summer), aimed at the southern half of the peninsula and the Mediterranean basin as the areas which use the most energy for air conditioning. On occasions, players from the Spanish national football team have been used to endorse energy saving (2009 and 2010 campaigns) and the wide distribution of the Vuelta Ciclista a España cycling race has been used to maximise the impact of communication.

To support the new electricity billing and energy saving system the Spanish Ministry of Industry, Energy and Tourism and IDAE carried out an institutional communication and publicity campaign during the second half of 2014. This campaign was primarily aimed at informing the public in a clear and simple manner about the changes that have taken place in the electricity price calculation system and the rights of consumers with regard to power supplied to homes. To this end, a comprehensive campaign has been developed using the creative concept of “Now, you control your energy”.

The citizen information service is to be expanded through the creation of an online national citizen information platform on energy saving and energy efficiency, which contains the practical energy guide and will be integrated into the existing citizen information service (SICER), offering online and telephone support.

Finally, a website offers free e-learning courses and provides tips on how to save energy at home and at work, as well as how to make a home energy certified. These courses last around two hours

and have been taught to more than 12.000 students already.

Raising awareness about cautions energy consumption and energy efficiency in the first and secondary education in ***Hungary*** is an integrated part of the curricula (from 1st to 12th class).

The main policy instrument in Hungary in the area of informational measures is the *Energy and Climate Awareness-Raising Action Plan* (ECARAP) endorsed by the government in September 2015.

The ECARAP identifies as target audience the entire Hungarian society, including the civil-, business-, household- and public sectors, with the overall objective (to propagate energy and climate awareness. Target group of the ECARAP, in all fields of action in its focus, is the whole population. Nevertheless, special attention is paid to children and young people (as a targeted sub-group), because of their particular importance in inducing the necessary sift in the awareness, values and attitudes of society.

Other identified target groups with high relevance to the household sector include the media, energy utility- and other related companies, as well as the civil sector, with emphasis on the importance of the coordination of related activities and messages to the different target groups.

For the monitoring of the implementation of the ECARAP an awareness-raising working group was announced to be established by end of 2015 and in a next step an indicator system to evaluate the effectiveness of the implementation of the action plan will be worked out by mid-2016.

The *Hungarian Energy and Public Utility Regulatory Authority* is in charge to initiate and then to operate of a web portal, aimed at informing the different groups of energy consumers about relevant legal and economic measures to promote energy efficiency, as well as to provide information about relevant awareness raising and educational programmes, consumption behaviour patterns, and practical methods aimed at promoting energy efficiency.

The aim of this intended project is to harmonise the communication by energy utility companies towards energy consumers, amongst them households, about potential measures to improve energy efficiency both concerning their own related activities, as well as related programmes, measures and tenders by the government.

In ***Germany***, several programmes (especially online platforms) have promoted the dissemination of relevant information about energy efficiency in the residential sector over the last years. For example, the *Zukunft Haus platform*, funded and implemented by the German Energy Agency (dena), offers a wide array of information, including step-by-step guidelines for construction and refurbishment projects, energy saving tips, examples of energy efficient buildings, and also all the relevant regulations and laws supporting EE in buildings in Germany.

The web portal *Heizspiegel* that is funded by the Federal Ministry for the Environment, Nature Conservation, Building and Nuclear Safety, is a campaign towards lowering heating costs for tenants and building owners. The aim of the campaign has been informing end-users about the energy saving potentials with regards to heating since 2004. In particular, the main activities of the campaign are: (1) to provide heat audits for residents; (2) to offer benchmarks of consumption patterns for different regions of Germany; (3) to advise on energy saving potentials, environmentally friendly heating sources, and energy efficient heating system options available.

Despite various efforts at different levels and among various players to provide information and raise awareness of energy efficiency, there is still a lack of knowledge among end-consumers of the (economic) potential for energy savings available to them, of possible improvements to their processes and procedures and of the many options and products available to exploit this potential. Because they lack information on their energy consumption and the complex relationships involved, many players find it difficult to recognise opportunities for energy savings or the need to increase

energy efficiency at all. Cost-effective measuring and metering systems for energy consumption may be helpful here, or specialised staff who concern themselves with energy savings in the undertaking or organisation. Once the basic awareness is there, the second step is to provide targeted information on potential energy efficiency measures. A qualified energy consultation may be the answer here. Concrete advice on implementing the measures is then needed.

Smart Metering

Smart meters is the principal informational instrument employed by Member States that facilitates real time and tailored monitoring and feedback and provides many advantages for end users, energy companies and Distribution System Operators (DSOs). The roll-out of smart meters for electricity and gas is making progress in the EU mainly due to various Directives, and it is mandatory, meaning that at least 80% of consumers must be equipped with intelligent metering systems by 2020 (full coverage by 2022), unless a cost benefit analysis proves that the business case is negative for a specific Member State.

In some countries, e.g. ***Finland*** and ***Germany***, there is quite some resistance to individual metering. Typical counter-arguments are: it is too expensive to establish such metering and it would be unjust because central flats as a matter of fact have a lower energy demand than flats e.g. on the top level of a house. Also, (data) security issues are raised. This is an unfortunate situation as far as studies have shown that in detached houses of the same size of m² less energy is used. This is remarkable considered that detached houses have more outer walls and thus less advantaged starting conditions for energy efficiency. However, their residents indeed act according to the energy bills based on measured energy consumption.

An important side effect of smart metering is that they could help to avoid peaks in energy demand. This is where the high CO2 emitting power plants are still needed. Demand Response is a key word in this context. Through smart meters, consumers can be re-minded that they should use energy during times when plenty of it is available – and thus cheap. This was habit e.g. in Finland for decades, mainly with regard to electricity based heating systems. They were charged during nighttime. Real time energy pricing and the IT equipment to observe it can help both: consumers to save money and the energy system to level demand as good as possible.

Italy is a forerunner in the the replacement of the traditional electricity meters with a smart metering infrastructure started between 2001 and 2002. Initially, the adoption of smart metering in the electricity sector was on a voluntary basis but became a mandatory roll-out in 2006. The implementation of the smart metering of electricity was originally driven by significant operating savings (500.000.000 €o per year for some 30 million meters), while the focus is now shifting towards involving customers also for energy-saving purposes. The cost-benefit analysis (CBA) carried out by major universities and the Italian experience in the use of smart electricity metering have shown that benefits far outweigh infrastructure installation and operation costs. Gas meters are also smartening up. In fact, Italy is ahead of the other Member States as it also has set up a regulatory framework for gas meters considering safety procedures and the description of the functional requirements of the electronic gas meter, in particular regarding physical safety and data security.

In ***Latvia***, towards the other end, a two-year pilot project of smart metering for households has been carried out. The project included a customer web portal and in-home display with benchmark comparisons. Substantial energy savings were achieved during the pilot.

In the ***United Kingdom,*** gas and electricity smart meters are part of the Government's plan for upgrading the UK's energy system. Consumers with smart meters will be offered an in-home display (IHD) that lets them see how much energy they are using and what it will cost. This will let them

have more control over their energy use and help them save energy and money. They will also receive energy efficiency advice as part of the installation process. Between 2015 and 2020 energy suppliers will be responsible for replacing over 53 million gas and electricity meters, but there will not be a legal obligation on individuals to have one. This will involve visits to 30 million homes and small businesses in the UK. They shall give consumers control over who sees their energy consumption data, and provide customers with near real-time information on their energy usage. The obligation is a storing up to 24 months of consumption data as well as up to 3 months of half-hourly export data. In addition, if domestic customers request metering data on their electricity export and/ or electricity/ gas consumption, it will be made available to them by their supplier.

In ***Finland***, the roll-out of smart meters for electricity is complete while for district heating is in progress. As a result of this, there is a growing market for services based on smart meter data. Finland has a long history of investing in the dissemination of information, advice and training relating to energy efficiency.

However, this metering often appears as a problematic issue in Finland. Services of companies operating in the energy market and energy suppliers at retail level have an obligation to provide final customers for district heating and district cooling with meters that can be used to verify energy consumption as well as to provide information about the temporal distribution of consumption whenever a new supply is installed and whenever it is technically and economically reasonable to provide metering otherwise. This economically reasonable, however, appears to be problematic when heating, cooling or hot water are supplied to a building from a district heating network or from a central source servicing multiple buildings the picture becomes more difficult. Due to the way pipes are installed in such houses there is no unique measuring point for an apartment, which is the requirement for precise measuring. To install such cost allocators would only pay for themselves once consumers would be able to use them to save more than 45% of their energy in apartment blocks. These thresholds have been calculated without factoring in any discount rates in profitability calculations. If discount rates are factored in, the required energy savings would have to be even larger. Therefore, in over 90% of existing buildings with multiple residential units, energy metering and indirect determination of heating consumption would generate costs beyond what can be covered by energy savings resulting from changes in consumer behaviour. At least in older buildings a heat or hot water meter only must be installed at the heating exchanger or point of delivery. Households there get their bills based on the size of their apartment's independent from real energy consumption.

At least regarding hot water use some more pragmatic ways of measuring could bring individual billing a step further. More flexibility towards electronic meters calculating the results from various measuring points would allow for at least approximate data for individual consumption and thus billing.

In ***Spain*** existing buildings which have a central heating, cooling or domestic hot water system serving more than one user or in buildings supplied by a district heating network serving multiple buildings needs individual consumption meters. They shall also be installed to measure the consumption of heat or cooling or hot water for each unit or final customer. In the case of heating systems, where the use of individual consumption meters is technically not feasible, alternative systems shall be used to measure consumption. The law also regulates billing content and the obligation for all sellers to offer their customers free online billing and complementary information on historical consumption.

In addition, there is a plan in place for the replacement of electricity supply metering equipment with a contracted power of up to 15 kW with new smart devices, which offer time, and remote

management settings before 31 December 2018, a two years shortened agenda compared to EU rules.

The ***Romanian*** Government in 2004 established the obligations for individual billing of consumers based on measuring the thermal energy consumption by meters. Since then it is mandatory to measure the heat and sanitary hot water consumptions at the building or staircase connection as well as sharing thermal energy cost on the basis of heat cost allocators. To enable this, the installation of energy thermal meters at the building or staircase connection for all the consumers was finished on 30th of June 2006. As a next step to better estimate individual energy consumption Intelligent Metering System (IMS) shall be implemented between 2015 and 2020.

2.2.4 Cross-cutting

Energy-related environmental taxes make important contributions to improving energy efficiency across the final demand sectors. Even though a high ratio of energy-related environmental tax revenues to total taxation does not necessarily indicate a high priority on energy savings, several European Member States have introduced taxes on energy products in order to create an incentive to reduce the consumption of energy, and thereby also the emissions of greenhouse gases into the atmosphere. These so-called eco-taxes are often levied on certain types of emissions such as CO_2 or on the consumption of energy. Although energy has always been taxed in European countries, apart from any intention of energy efficiency, some countries have integrated energy taxation as an energy efficiency policy tool. Finland and Sweden (as well as Norway) have established a CO_2 tax in the early 90s already. Also, other countries have introduced special taxes on energy, such as Denmark in the "Danish Saving Trust", or in the UK as part of the Climate Change Programme - Carbon Trust.

The cross-cutting measures are:

- Eco-tax on electricity/energy consumption or CO_2– emissions
- Eco-tax with income (mainly) recycled to energy efficient / renewables
- Eco-tax with income recycled to indirect labour cost
- Eco-tax with reduced rates for the industrial sector

Another example of cross-cutting measures can be illustrated with an example from ***Finland***.
Following the UN 'Plan of Implementation' which was adopted at the World Summit for Sustainable Development in Johannesburg 2002 (WSSD, 2002) the Finnish government as one of the first worldwide set up a national strategy for sustainable consumption and production (SCP). Their programme 'Getting more from less' was developed in a participatory process and launched in 2005. Beside a strong focus on material efficiency it also targeted energy efficiency. Some illustrative tools were developed in various research projects on this matter as a basis for assessing the environmental impacts of individual decisions. While the process of developing the programme went quite well, a real implementation was missing (Berg, 2007, 2011). In 2013 a second national programme 'More from less – wisely' updated the old program bases on the outcomes of the Rio+20 Sustainable Development Summit and the EU Sustainable Consumption and Production Action Plan. In it key goals for housing and other buildings especially endeavour to reduce energy consumption and encourage the use of renewable and hybrid energy solutions through 'reshaping energy policy in the nation's living rooms'. The programmes brochure targeting average consumers emphasis collaboration with the national energy agency Motiva, Demos/Peleton Club (see 4.5), and the HINKU Forum (see 4.1).

A recent study evaluated the saving potential and cross-fertilization of mixes of policy instruments. Nissinen and colleagues integrated instrument into packages, to minimize potential negative interferences, while strengthening synergies and complementarities between these instruments (Nissinen et al., 2015). They compared on a first level whether instruments were directly (D) or indirectly (I) interacting and further distinguished if the relationship for direct interactions was prerequisite P/D, supportive S/D, replacing R/D or conflicting C/D respective for the indirect interactions if they increased the potential of the instruments I/P or deduced it I/R. On a second level the degree of the influence was estimated with + weak, ++ moderate, +++strong or 0 none(Nissinen et al., 2015).

According to their findings the following policy instruments combinations seemed to be especially promising at least in the Finnish context:

A) Extend the scope of regulatory instruments (energy efficiency requirements on renovation of existing buildings and stricter requirements concerning energy performance certification of buildings);

B) Create incentives for energy renovations, heating systems upgrades and climate-friendly user behaviour (by influencing energy price expectations, and through energy taxes, a differentiated real estate tax, subsidies for energy efficiency investments and a tax deduction for energy renovations);

C) Offer guidance and advice for energy renovations and climate-friendly user behaviour (national energy advice, mandatory advice connected to building permits and energy renovation subsidies, application of environmental management systems also for homes, as well as improvements in the so-called energy expert scheme, i.e., the use of voluntary residents trained to offer energy advice to their neighbours);

D) Enhance supply-side capacities to design and implement cost-effective energy renovations (technology programmes and training).

3 Product specific instruments

The European Union helps consumers to save energy in their everyday lives in a number of ways. First through energy labelling, in order to raise awareness of consumers. Second, through energy efficiency requirements imposed to products on the design phase.

The Energy Labelling and Ecodesign Directives were adopted to address the basic problem that products can have a negative impact on the environment depending on how they are made, used and disposed. The Eco-design Directive addresses this problem by "pushing" the market towards greener products by banning the worst performing ones. The Energy Labelling Directive addresses this problem by "pulling" the market towards more energy efficient products by informing consumers about the energy efficiency and other resources use of products through an energy label, thereby encouraging them to buy more energy efficient ones (EC, 2015).

In particular, the Ecodesign Directive 2009/125/EC established a framework under which manufactures and importers of energy-related products are obliged to make effort to reduce energy consumption, and other negative environmental impacts, which will occur throughout a product's life cycle. The term "eco-design" implies that there will be a greater focus on lifetime energy use of a product, and other environmental aspects, during the conception and design phases, before the product is manufactured and brought to market.

Like eco-design, energy labelling has a two-fold objective: promoting energy efficiency, and ensuring the free movement of energy-related products. The Energy Labelling Directive 2010/30/EU provides relevant, standardized and comparable information on the specific energy consumption of particular product categories in order to enable end-users to compare appliances. It seeks to influence the end user's purchase decision in favour of those products that consume less energy during use, thus prompting manufactures to take steps to reduce the energy consumption of their products, or to withdraw and replace less efficient products.

Article 3(1) of the Ecodesign Directive 2009/125/EC and articles 3 and 4 of the Energy Labelling Directive 2010/30/EU place a number of responsibilities on Member States. In particular, article 3(1) of the Ecodesign Directive requires to Member States to take all appropriate measures to ensure that products covered by implementing measures may be placed on the market and/or put into service only if they comply with those measures and bear the CE marking. Once complying with the requirements established therein, products can be sold throughout the EU, i.e. they enjoy free movement. With regard of articles 3 and 4 of the Energy Labelling Directive, Member States are required to ensure that all suppliers and dealers fulfil the obligations laid down in articles 5 and 6 of the Directive, namely to supply and display labels in accordance with this Directive and the relevant delegated acts. Member States also have to ensure the placing on the market or putting into service of products, which are covered by and comply with this Directive and the relevant delegated act is not restricted, and that the display of other labels not complying with the Directive and the relevant delegated act is prohibited. Although these obligations are the core of the Member States' responsibilities, they must also conduct educational and promotional information campaigns, aimed at promoting energy efficiency and more responsible use of energy by end-users. Also, Member States should take appropriate measures in order to encourage cooperation and information sharing between relevant national and regional authorities and the European Commission.

According to the article 14 of the Energy Labelling Directive and to the article 21 of the Ecodesign Directive, the European Commission has to evaluate the effectiveness of the directives and of the delegated acts not later than 31 December 2014 and 31 December 2012, respectively.

In consequence, Ecofys published a report in 2014 commissioned by the European Commission to evaluate the effectiveness of the Directive 2010/30/EU on energy labelling and the Ecodesign Directive 2009/125/EC.

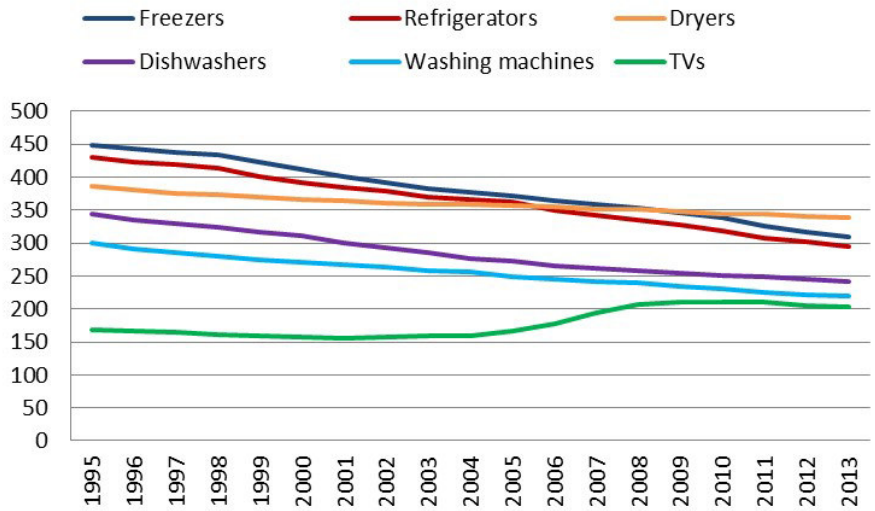
The main findings are the following:

- The ecodesign and energy labelling measures in place are effective because they bring tangible and substantial energy and cost savings. Implementation of the two Directives is estimated to save 175 Mtoe primary energy per year by 2020 (around 15% of these savings are due to energy labelling measures, bearing in mind that around half of product groups are only covered by ecodesign). This corresponds to 19% savings with respect to business-as-usual energy use for those products. These policies will deliver almost half of the 20% energy efficiency target by 2020. Dependency on imports of energy would be reduced by 23% and 37% for natural gas and coal, respectively. In total, the ecodesign and energy labelling measures in place to date are estimated to save end-users of products 100 billion €o per year by 2020 through lower utility bills.
- The two Directives are complementary and their implementation is largely done in a coherent way. EU-added value derives from the harmonised regulatory framework bringing down costs for manufacturers and making the EU a trendsetter in international regulatory and standardisation efforts.
- The level of requirements could be raised. Most stakeholder groups agree that while for some product groups implementing measures and labels have shown the right ambition level, many other groups have shown levels of ambition that are too low compared to what is technically and economically feasible.
- The capturing of the full potential of savings is limited in several ways: long rulemaking processes, leading to out-dated technical and preparatory work as well as increased lobbying; weak enforcement by national market surveillance authorities that contributes to noncompliance, reducing the envisaged energy savings by an estimated 10%; a trend towards larger products increasing absolute energy consumption; reduced effectiveness of labels following introduction of A+ and higher classes.
- The majority of consumers recognise and understand the energy label, and use it in their purchasing decisions. However, the introduction of A+ and higher classes under the 2010 Energy labelling Directive reduced the effectiveness of the energy label in motivating consumers to buy more efficient products. In fact, the design amendment that uses additional plusses to indicate higher efficiency classes beyond the A class is less effective in motivating the purchase of higher efficiency products than the original A to G scale. While consumer research shows that the new label scale is understandable for consumers, it has reduced their willingness to pay more for more efficient products, because they are less motivated by a difference between A+ and A+++ than by a difference between C and A. Some of the pictograms used to represent other parameters in the label are also difficult to understand.

Traditional large appliances represent an important target of energy efficiency policy strategies because they are responsible of a large share of residential energy consumption. Despite being characterized by rather mature technologies, this group of appliances still offers large potential in terms of efficiency gains due to their pervasive diffusion.

Figure 17 shows the unit consumption variation of large appliances and TVs from 1995 to 2013 in the European Union.

Figure 17. Unit consumption of the EU household white appliances and TVs 1995-2013 (kwh/year)



Source: Author's elaboration based on Odyssee database

At EU level, from 1995 to 2013, the unit consumption of the freezers decreased by 30.87%, the refrigerators of 31.35%, the dryers of 12.50%, the dishwashers of 29.36%, the washing machine of 26.62%, while the TVs has been the only major appliance that increased its unit of consumption by 20.67% due to the increasing screen size, more plasma screens, longer viewing hours.

These unit consumption variations indicate that for "workhorse" products such as white goods, energy efficiency is a key factor in purchasing decisions, but for goods such as consumer electronics (e.g. TVs), it is not.

Household appliances such as fridges and washing machines are considered to be "workhorse" products since they are typically purchased for a lifetime of heavy and prolonged use. They tend to be replaced when they break down. In this regard, Young (2008) assessed the replacement of major appliances (refrigerators, freezers, clothes washers, clothes dryers and dishwashers) for a sample of Canadian residential consumers and found that 40% of refrigerators were replaced after 20 years of use and an additional 20% were replaced after 25 years; dishwashers and clothes dryers took around 11–15 years to be replaced; and considering all appliances together, it took an average of 16–20 years for them to be replaced.

On the other hand, goods such as televisions are considered to be more "up-to-date" products and many consumers look to upgrade TVs periodically to the latest technology in a fast-moving market. In fact, for TVs, energy efficiency is not a priority: TV screens have generally become bigger and the purchase price and consumer purchase decisions are affected significantly by changes in product functionality, fashion, features and attributes other than energy efficiency. In addition, from 1995 to 2012 there has been a significant increase in the average numbers of TVs used in the home (27.05%), in the screen size and in the plasma screen.

Again, the choice of a new product seems to be influenced by its purpose - whether the product is "workhorse" or "up-to–date" – as confirmed by recent studies carried out in UK by the market intelligent agency Mintel (GMI/Mintel "Washers and dryers – UK", June 2013, GMI/Mintel "Fridges and freezers – UK", April 2014).

For workhorse appliances, energy consumption is a key consideration, as is brand. Evidence from a 2013 Mintel report on washers in the UK suggests that people are highly aware that buying a washing machine with a better energy rating could save them money on their utility bills; energy efficiency is reported to be the main consideration for fridges.

A trustworthy brand ranks second, especially among older consumers who have developed a lifetime relationship with certain brands and will call on this knowledge. For consumer electronics, such as TVs, energy efficiency is not a main factor. Evidence from the Mintel report suggests that many consumers will upgrade a television out of choice rather than out of necessity, and buy according to functionality and features.

Literature about the drivers of purchase decision of energy efficient appliances is quite scarce. Some attempts have been done by Mills and Schleich (2010) and Gaspar and Antunes (2011).

Mills and Schleich analysed the determinants of consumer knowledge of the energy label for household appliances and the choice of class-A energy-efficient appliances using data from a large survey of more than 20.000 German households. The results for five major appliances (refrigerators, freezers, refrigerator-freezer combination units, dishwashers, washing machines) suggest that lack of knowledge of the energy label can generate considerable bias in both estimates of rates of uptake of class-A appliances and in estimates of the underlying determinants of choice of class-A appliance. Simulations of the choice to purchase a class-A appliance, given knowledge of the labelling framework, reveal that residence characteristics and, in several cases, regional electricity prices strongly increase the propensity to purchase a class-A appliance, but socio-economic characteristics have little impact on appliance energy-class choice. They conclude that an ‘‘attribute-based approach’’ to energy efficiency choice, although important, is not sufficient, and should be complemented by assessing psychosocial variables such as attitudes, beliefs and perceived benefits.

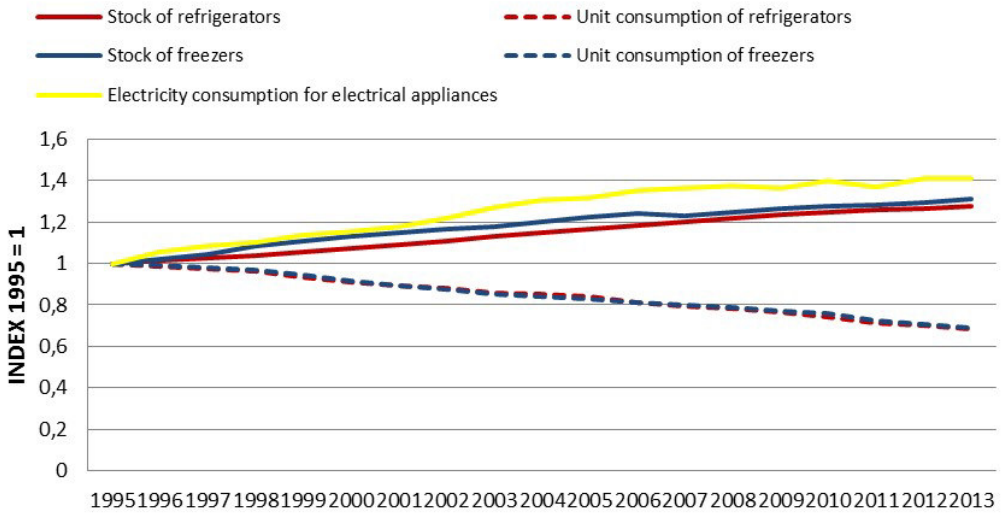
Gaspar and Antunes (2011) evaluated the factors considered by households when purchasing electrical appliances and the factors driving the consideration of energy efficiency class in consumer choice. Data collection was done by surveying consumers when they were about to buy an appliance (at the moment of the inquiry or in the near future). Results indicate that considering each type of appliance separately, cost is seen as the most relevant when choosing large (42%) and small appliances (49%), while quality (44%) is the most valued characteristic when choosing technology appliances (TVs etc.). With regard to environmental concerns, these referred mainly to energy efficiency (40.8%), energy labelling class (23%) and water consumption (20.7%); women considered environmental issues in general and energy and water consumption aspects in particular, more than men. Moreover, women searched more for information regarding energy efficiency class. Overall, consumer preference is the cost, followed by quality and energy consumption considerations. These are correlated positively with the consideration of energy efficiency class in consumer choices. Also, regression analysis shows environmental attitudes to be negative predictors of energy efficiency class consideration, while specific environmental behaviours were positive predictors.

European households buy and use ever more appliances, driven by technological development, falling prices and the trend towards smaller and therefore more households. Consumption trends have led to increased electricity consumption by European households, despite many appliances becoming more energy-efficient. The production-consumption system of electrical and electronic goods would be more sustainable with higher-quality appliances, replaced less rapidly, and with more options for leasing appliances and for materials recycling by producers. Opportunities for reducing the life-cycle environmental impacts include making products more energy (and resource) efficient, modular design enabling upgrading and repair, take-back and re-manufacturing, and capturing more of the valuable materials from e-waste (EEA, 2014).

While the energy efficiency of some types of appliances has improved significantly[17] over the period 1995 - 2013 (Figure 17) these product improvements have not been able to keep up with increasing ownership and use of appliances (Figures 18, 19, 20). As a result, overall electricity consumption per dwelling for appliances has gone up, illustrating the rebound effect[18] . The main reasons behind the increase in electricity consumption are the steady increases in the numbers of appliances — including TV sets and dishwashers owned by households, consumer electronics and information and communication equipment — and a rising demand for air conditioning and cooling technologies. Part of the increase in ownership is due to increasing disposable income, behavioural changes, and increasing numbers of households; an increase in the number of households of 17.6% in the period 1995 - 2013 (Odyssee database), has been followed by the growth of only the 5.2% of population in the same period. In particular, drivers behind this trend include increasing numbers of divorces, decreasing birth rates, ageing and changing lifestyles. With fewer people in each household and the increase in one-person households, each person on average takes up more square metres. This has led to higher demand for space and increases in stocks of household appliances and consumer goods (EEA, 2012). One-person households consume on average 38% more products, 42% more packaging and 55% more electricity per person than four-person households, as well as producing significantly more waste per person (Williams, 2007; Gram-Hansen et al., 2009).

The figures below (figures 18, 19, 20) show the trends in energy efficiency of appliances (refrigerators and freezers, dishwashers and washing machines, TVs) compared to the ownership numbers of these appliances and the total electricity consumption for appliances per dwelling. The figures illustrate that increasing ownership of appliances is more than offsetting gains from energy efficiency improvements in individual appliances. In a nutshell, the energy consumption per appliance decreased (with the exception of TVs); stock of appliances increased; total energy consumption for appliances increased and the consumption growth outweighed energy efficiency gains.

Figure 18. Trends energy efficiency/ownership of refrigerators and freezers (EU)

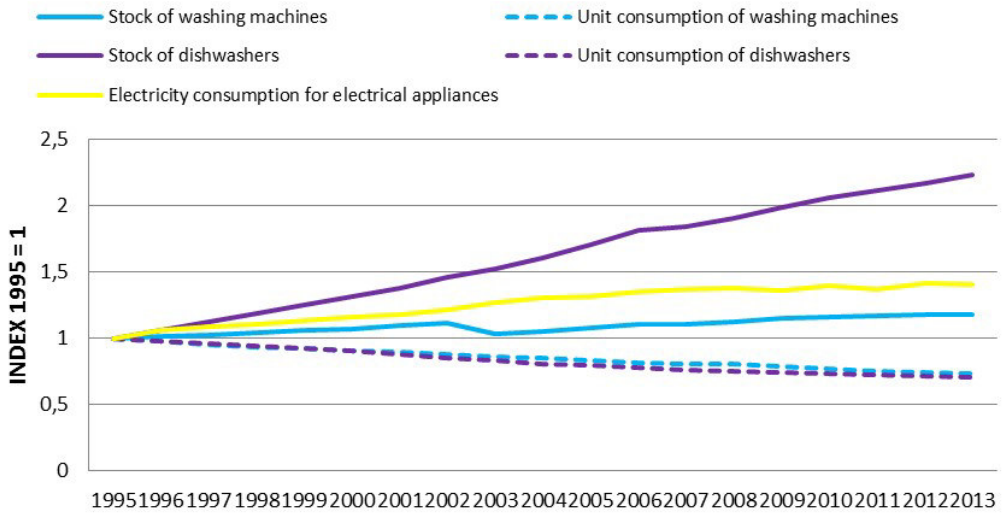


Source: Author's elaboration based on Odyssee database

[17] In the case of refrigerators and freezers, the average unit energy consumption has declined even though the appliances themselves have become larger.

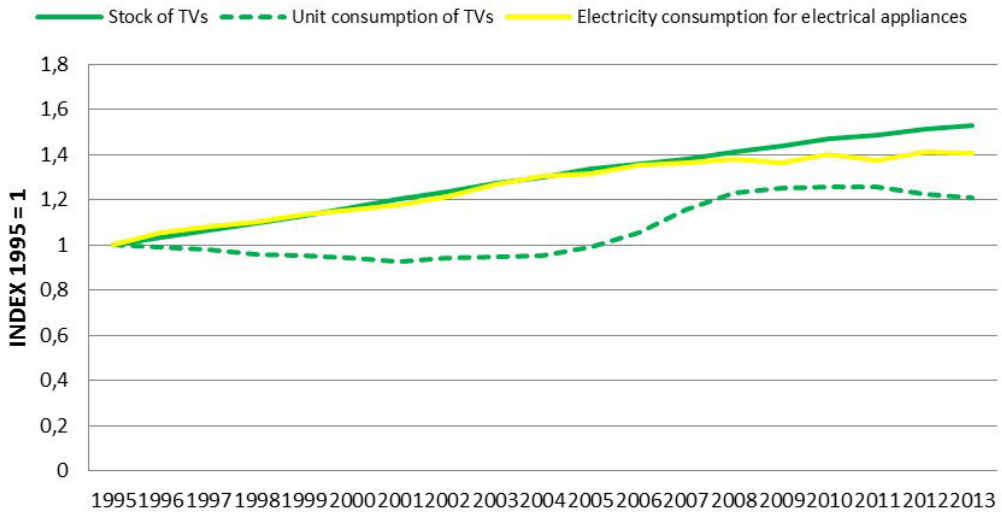
[18] The phenomenon that an increase in energy efficiency may lead to less energy savings than would be expected by simply multiplying the change in energy efficiency by the energy use prior to the change.

Figure 19. Trends energy efficiency/ownership of dishwashers and washing machines (EU)



Source: Author's elaboration based on Odyssee database

Figure 20. Trends energy efficiency/ownership of TVs (EU)



Source: Author's elaboration based on Odyssee database

However, the trends energy efficiency/ownership of appliances vary a lot among countries. For example, in the United Kingdom the unit consumption of refrigerators was 243.23 kWh/year in 2013, while in Italy it was 357.44 kWh/year (above the EU average, 295.49 kWh/year). In Germany, the unit consumption of refrigerators, freezers, washing machines and dishwasher in 2013 was much smaller than the unit consumption of the same appliances in Italy and the United Kingdom. Significant differences exist in terms of unit consumption of TVs: in Italy, it was 49.73 kWh/year (far below the EU average, 202.42 kWh/year), while in the United Kingdom it was 259.7 kWh/year in 2013.

The literature on the energy demand at the household level notes the existence of significant variations in consumption, driven by differing household characteristics. This is due to the fact that several factors determine the energy efficiency investment decisions and the habitual energy saving behaviours/practices (Steg, 2008; Kang et al., 2012; etc.). These factors can be grouped into:

- Socio-economic and demographic factors: income level, households composition, education background, working status, age, gender, marital status, home ownership, dwelling characteristics, geographical location.
- Psychological factors: attitudes, subjective norms, perceived behavioural control, residue effect.
- Structural factors: energy price inflation, policies and regulations – standards, tax credits & subsidies, etc.

It has been pointed out (Brounen et al., 2012) that residential gas consumption is determined principally by structural dwelling characteristics, while electricity consumption varies more directly with household composition and social standing — and thus may be more responsive to behaviour change programmes.

Energy behaviours and energy investment decisions are hugely complex, shaped by many factors, not only individual but also contextual. Due to this complexity, they are usually studied using fragmented and disciplinary studies from a wide range of thematic areas such as engineering, economics, psychology, sociology. However, each approach is limited by its own assumptions and often neglects important energy behavioural components. Therefore, energy behaviour studies require an integration of disciplines through interdisciplinary approaches, in particular, by bringing engineering and social sciences together (Lopes, et al., 2012).

New insight might come from the analysis of high frequency data combined with database of dwelling characteristics and studies analysing behavioural drivers affecting the level of energy demand (Kavousian et al., 2013).

In fact, many utilities are now able to capture real-time, customer-specific hourly interval usage data for a large proportion of their residential customers. These vast, constantly growing streams of rich data have the potential to provide novel insights into key policy questions about how people make energy decisions (Todd et al., 2014). For example, in UK, under the Energy Act of 2011, the Secretary of State for the Department of Energy and Climate Change (DECC) has the ability to collect information on energy efficiency measures installed in UK houses. This, along with the licensing and management requirements of storing and accessing high-frequency energy data output from UK smart meters will further add to the necessary legal framework (DECC, 2012). Further, the UK government has committed to making data available under its open data strategy (HM Government, 2012). For energy and the built environment, departments such as DECC are making “big data” available, under appropriate privacy controls, for use by industry and research, including the above-mentioned energy efficiency details and smart meter data, but also Energy Performance Certificates for houses and display energy certificates for non-domestic buildings (DECC, 2012b). Increasing collection of, and access to, high-quality data and information along with the use of sound methodological and analysis frameworks could significantly support the analysis of the complex interactions between the physical and built environment, socio-economic characteristics, and individual interactions and practices of the residential energy demand (Hamilton et al., 2013).

An example from Hungary shall illustrate how more efficient appliances can be better promoted. The European Committee of Domestic Equipment Manufacturers (CECED) is a Brussels-based trade association that provides a single, consensual voice for the home appliance industry in Europe. Apart from other issues, CECED works in the field of energy efficiency. In Hungary, they perform some rather well-known activities:

They operate an **interactive website on energy efficiency** with online activities, information and awareness raising tools, in the framework of the *"Spinning Grumbler's World"* programme targeting both adults and children through separate online tools. They offer saving calculators (e.g. how much energy one can save buy purchasing an energy efficient fridge or through exchanging your light bulbs with energy efficient ones), information, games, videos and advice/tips. The interactive website is available in both Hungarian and English language at http://www.forgomorgo.hu/en.

Related to the figure of *Spinning Grumbler*, CECED conducted a nationwide campaign between 2006-2008 to motivate the exchange of old devices for energy efficient ones, and provide information on the selective collection of e-waste. For the campaign they received the National Energy Globe Award in 2009.

Under the same name (Spinning Grumbler) they also issue a newsletter and have a community engagement site (on Facebook).

CECED Hungary actively cooperates with the government in the implementation of the **washing machine exchange programme** (which is the 5th sub-programme of the *Warmth of the Home* grant programme, see section 2.2.2.1), in the framework of which they also provide information on the energy consumption of washing machines. In this government funded programme, households receive funding (50% of the machine for A+, A++ or A+++ category equipment) to assist in the exchange of their old washing machines provided that with the exchange they achieve at least a 10% reduction in related energy use or avoid 20 kg/year CO_2 emission.

CECED also conducted research on the energy saving potential of replacing old household appliances in Hungarian homes as well as on the ratio of old appliances in households.

Based on CECED's research (CECED, 2013), Vadovics and Boza-Kiss (2013) observed that people have been delaying purchases and appliance exchanges, which causes the – already old – appliance stock in Hungary to slowly get more obsolete. Compared to the situation in 2009, the ratio of appliances older than 8 years has grown in all categories, in average from 43% to 46% in 2009 and 2013, respectively. This translates into a change from a total consumption of 2,673,589 MWh to 3,009,362 MWh and emission increase from 1,663,450 to 1,942,346 tCO_2.

Regarding appliances, only about 6-10% of owners plan to replace their washing machines or fridges and freezers in the near future, despite the fact that the stock is so old. This ratio is slightly higher in the case of owners of products that are at least 10 years old. Decisions are influenced primarily by the price, and much less by the energy performance of appliances (CECED, 2013).

4 Support from further actors complementing national activities

Beyond public programs and policy instruments, energy efficiency improvements in the residential sector are supported by the private sector in a variety of ways:

- By providing input to policies, analysing policy and initiating discussion;
- Organizing awareness raising and information and knowledge exchange programs;
- Initiating and implementing concrete actions, e.g. through providing loans, investment and implementing demonstration programs, alternative solutions to low-energy buildings.

This section provides examples from the case countries about activities from municipalities, energy providers, energy service companies, banks, NGOs, research and housing companies.

4.1 Municipalities

From as early as the 1990s, ***Finland*** has employed voluntary agreement schemes to promote energy efficiency which prove to be a powerful tool. Next to industry, the contracts for voluntary commitments are also applied for municipalities, the sector closest in touch with households and consumer decision making. The purpose of the energy efficiency agreement scheme is to contribute, in accordance with the national energy and climate strategy, to the fulfilment of international commitments. This new agreement scheme is especially important to the implementation of the Energy Services Directive. Under the new agreement scheme, efforts have been made to take the obligations of this Directive into account, and Finland succeeded in negotiating agreements on the implementation of these obligations as alternatives to regulatory steering.

However, in municipalities, the picture looks different and not as homogenously successful as in the private sector. Some towns are very enthusiastic but some of them appear to be less engaged. The incentive for municipalities to sign such agreements is to have better access to and higher shares of state subsidies. Less engaged municipalities, which do not report as required first get a warning (yellow card) and after 2 years lose the contract (red card) after several contacts. This however only happened few times compared to over 100 contracts. The problem appears mainly for small municipalities where staff capacity is very low.

The municipal sector energy efficiency agreements were a major incentive to carry out ESCO projects (see 4.3). Local governments that have signed the local government energy efficiency agreement have committed themselves to acquiring sufficient expertise in considering and subscribing to ESCO services whenever a viable energy efficiency investment would otherwise need to be abandoned due to lack of funding (Finnish Ministry of Employment and the Economy, 2014). But here as well public procurement rules in municipal ESCO projects create a major barrier for successful ESCO projects. Generally, political guidelines are somewhat unclear and hard to predict which makes it difficult to make investment decisions for the future, and reduces overall willingness to get involved with energy efficiency investments. In addition, political discussion concentrates too much on energy production, and in many ways ignores possibilities of energy efficiency.

Finish towns also cooperate in various networks. Through the *Carbon Neutral Municipalities* project, initially five small Finnish municipalities committed themselves in 2008 to reducing their greenhouse gas (GHG) emissions more extensively and more rapidly than would be required according to current EU targets – to become carbon neutral. By end of 2015 the number of municipalities in the CANEMU Forum increased to 26 and the amount of inhabitants involved in the project comes close to 400 000. The goal of the next step is to share the progress of the carbon neutral municipalities with larger Finnish towns in order to accelerate the transition towards a low-carbon society in Finland.

In the beginning of the process, public seminars are arranged in the joining municipalities to discuss the initial emission levels and the aims of the project. Feedback from local people is gathered for planning the next steps of the project. At the same time media (newspapers, radio and TV) is engaged to get media coverage for the launch of the project.

In the municipalities, every target group – municipal authorities, residents and business – are encouraged to participate to reduce their GHG emissions. Actions include measures to save energy and improve energy efficiency, particularly in homes, public offices, companies and transportation, as well as measures to promote the production and use of renewable energy.

Another tool motivating for renovation is the 'energy triathlon' where housing companies compete and get awarded for best performance in electricity, heating and water consumption.

The Finnish Sustainable Communities agreed on: no waste, no emissions, no overconsumption. In the network, four Finnish have committed to working towards becoming carbon neutral and waste-free and curbing overconsumption by 2050 with mutual help. A service centre consisting of experts from the Finnish Environment Institute (SYKE) and the Finnish energy agency has been established to support and coordinate its work.

In ***Hungary***, on the other end of the spectrum so to say, no specific responsibilities are assigned to regional and local authorities (RLAs) for the promotion of energy efficiency in the households sector. However, RLAs are encouraged to work out sustainable energy action plans (SEAPs), on a voluntary basis. Although the focus of SEAPs is on the activities of the RLAs themselves, the furthering of energy efficiency in the household sector by local means might be addressed in them as well.

It is the aim of the government to establish a *National Network of Energy Engineers*, integrated into the administrative structures of regional and local authorities. The objective of this planned network is to provide consulting services to the different groups of energy consumers, amongst them households, as well as to contribute to the monitoring of energy savings throughout the economy. It is planned the Network will provide targeted services to low-income families suffering from / endangered by energy poverty.

Independently from official requirements, Hungarian municipalities often in cooperation with NGOs founded several organizations to assist in their work towards more sustainable energy use, higher energy efficiency and the utilization of renewable energy sources.

The *Alliance of Energy Efficient Municipalities* (EHÖSZ) was founded in 2007. The Alliance is an organization for municipalities (as of Dec 2015 with 20 members) in order to join forces and achieve a higher level of energy efficiency in their settlements. Among other things, the Alliance organizes events to facilitate the exchange of experience between municipalities.

The *Alliance of Climate-Friendly Municipalities* was also founded in 2007 and has 27 member settlements from all over Hungary (as of Dec 2015). The Alliance publishes a monthly newsletter, organizes events, and makes publications to facilitate the work of municipalities in the field of climate adaptation, energy efficiency and the utilization of renewable energy sources.

The *Alliance* also cooperates with the Hungarian Academy of Sciences to help spread good practice and support the development of local climate change, adaptation and energy strategies. An important feature of the work of the alliance is that they place great emphasis on the involvement of the local population and communities, and suggest that all member municipalities support the founding of a local climate club. Furthermore, the Alliance published recommendations for its members, which, among other issues, contain advice for employing a climate coordinator.

The local climate clubs founded by the municipalities are often very active and organize numerous programmes with the involvement of the local population, for example in the towns of Tatabánya

and Szekszárd. In the case of the latter, the municipality cooperates with a local NGO for the running of the climate club, and managing the local climate change fund.

Between 2008 and 2010, with financial support from the Environment and Energy Operational Programme in Hungary through EU funding, the municipality of Tatabánya implemented a very innovative programme called "Climate Ticket". The aim of the programme was to set up a system that helped people and organizations to offset their emissions voluntarily at the local level through green investments. The climate-ticket system works by helping businesses and individuals to assess the size of their carbon footprints and to voluntarily pay for them as well as providing investment in projects in the Tatabánya Region. All of the proposed investment projects have numerous co-benefits such as improving the quality of life and well-being of local communities. The local municipality has had plans to continue with the project as the climate ticket idea appears to be popular among local people and organizations (Vadovics et. al., 2012).

The third relevant organization established in 2009 by municipalities and a Hungarian NGO, on authority from the European Climate Alliance, is the *Hungarian Climate Alliance*. The Alliance has municipality as well as NGO members. The aim of the Alliance is to join forces between initiatives that involve municipalities and NGOs/local communities in the field of climate change and climate protection.

Several municipalities offer local support for the energy efficient renovation of private homes as well as apartment houses or multi-owner housing blocks. Both the amount of support available and the list of towns where the support is available vary from year to year. Although it would prove to be challenging to prepare a summary study on such initiatives by municipalities, it is worth mentioning an example.

One of the most active Hungarian towns in this field is Tatabánya, a town of 65-70,000 inhabitants. Through various means, the municipality has supported the energy efficient renovation of buildings, with specific emphasis on apartment houses (or blocks of flats) since 2010. Most recently, in 2014 and 2015, the municipality provided support for blocks of flats on a competitive basis (based on competitive calls for proposals) partly by providing interest-free loans for energy efficient renovations, partly by supplementing the support blocks of flats can receive from the central grant programme, *Warmth of the Home*.

Latvia will start a voluntary energy efficiency agreement for municipalities in 2016. The municipalities entering the agreements shall commit to at least 10% of energy efficiency improvements within five years after signing the agreement. The government has developed methodological support for energy planning in municipalities as well as financial support in the establishment of revolving funds in cities in the form of soft loans. The activities are subject to variations according to the size of municipalities as the agreement is planned to cover municipalities of different sizes.

There are several instruments municipalities can use to stimulate energy efficiency in its territory. Municipality has a right to decrease real estate tax rates for the buildings who has implemented energy efficiency projects. However, Riga City council and most of the other municipalities in Latvia apply up to 95% real estate tax breaks to all the buildings so this tax break would not be good enough stimulus.

Currently, financial support for the development of technical documentation for the implementation of energy efficiency measures is provided only in a few municipalities, but this support is crucial for EE project implementers to meet all requirements and deadlines. EE measures introduced during the previous EU funding period show that there is still not enough time devoted to the development of

technical documentation, which then contributes to delays in project implementation and significant cost increases.

The ***Romanian*** *Energy Cities* form an NGO network of towns (32 municipalities and two metropolitan areas at the end of 2015). It focuses on improving energy efficiency in public services (heating, public lighting, water supply and gas gathering, storage and transport of household waste etc.) and promoting renewable energy sources and environmental protection. OER network is a useful tool in disseminating technical and commercial information, about the equipment, technologies and local energy policies.

In ***Italy*** the Covenant of Mayors was launched in 2008, a unique model of multi-level governance in which local and regional authorities take the lead in increasing energy efficiency and the use of renewable energy sources in their territories through the Sustainable Energy Action Plan (SEAP). Among the 6.569 signatories of the Covenant of Mayors, 54.8% are Italian, showing the sensitivity of Italian local governments to the issues of energy efficiency and renewable energy sources. The SEAP is a powerful tool for cities and regions to plan, implement, monitor and evaluate climate and energy policies, and in doing so contribute to global mitigation and adaptation achievements ("Ways to successful sustainable energy action planning in Cities", 2011). Through the SEAPs cities can implement measures in a structured and integrated way, allowing them to systematically monitor their efforts in going beyond national legislation in these fields. A SEAP is also an instrument for cities to communicate to stakeholders – both locally and beyond – the importance of energy and climate protection, and to encourage citizens and other relevant actors to take a part in the city's ambitions.

In ***Germany*** there are many municipal programmes helping to ensure that private homeowners increase their investment in energy-efficiency refurbishment. Some of the funds come directly from municipal budgets, while in some cases they come from programmes launched by overarching levels of government or development banks (e.g., the KfW Bankengruppe). Most importantly, in the last years German municipalities have played a vital role in empowering households to set up energy cooperatives - a groups of citizens who organise themselves to collectively take action on energy renewable energy and energy efficiency projects. Energy cooperatives as a mean towards energy transition (Energiewende) are a growing sector in Germany and contribute to the development of the local community. Although the major focus of these energy cooperatives is to produce electricity by using renewable energy sources, recently, as part of the National Climate Protection Initiative the German Environmental Management Association developed a pilot project to establish regional energy efficiency cooperatives (Regionale EnergieEffizienz Genossen schaften, REEG) in three pilot municipalities of Aachen, Berchtesgadener Land and Norderstedt. REEG cooperatives operate through "Future Funds" where private capital is collected to finance energy efficiency measures in companies, public institutions, and private households. The cooperative business structure enables individuals to share the costs, risks and responsibilities of capital-intensive projects that they may be individually unable to undertake. The cooperatives receive a dividend calculated as a percentage of immediate energy saving costs after completed retrofitting. Customers immediately enjoy lower energy costs, while simultaneously repaying part of the loans to the cooperative.

4.2 Energy providers

Energy providers play important roles in delivering end-use energy efficiency improvements. Governments turn to energy providers to deliver energy efficiency for several reasons, because they:

- Have long-standing commercial relationships with the end-use customers, allowing them to influence energy saving activities in diffuse markets;
- Have the technical capacity and infrastructure for delivering services, by virtue of offices and facilities in their area of operations or service territory;
- Are often viewed as impartial or objective sources of information and expertise;
- Possess detailed information on the consumption habits of their energy consumers, a useful resource when providing energy savings advice;
- And produce large revenue streams from selling energy which can be an alternative to public budgets as a source of energy efficiency funding (IEA, 2013).

For some observers it might seem illogical for an energy provider to undertake activities, which reduce sales of their product. Indeed, in many countries the idea that energy suppliers should seek to reduce energy demand remains counter-intuitive. However, energy provider business models that incorporate energy-savings activities are becoming commonplace (IEA, 2013).

The principal driver of the energy providers to deliver energy saving activities is induced by regulatory mechanisms or market opportunities created by the "Energy Efficiency Obligation Scheme" which calls e*ach Member State to ensure that energy providers achieving new savings each year from 1 January 2014 to 31 December 2020 of 1,5 % of the annual energy sales to final customers of all energy distributors.*
Compliance with regulations is not the only way to mobilize energy providers to take on energy saving activities: market mechanisms, financial incentives, funding opportunities, business retention and development, etc., can also stimulate energy providers to delivery energy efficiency.

With regard to the energy saving activities that energy providers are engaged in, the most common is the advice and assistance to energy consumers, followed by informational/educational programmes, technology development, on-bill financing, bulk procurement and distribution, comprehensive implementation, equipment replacement, direct installation; these activities are observable in most the European countries.

For example, regarding informational/educational programmes, in ***Hungary***, E.ON Hungária organized in 2015 for the second time an called EnergyExperience for children and young people in different age groups (from the age of 5 till 16) that increases energy awareness and improves their knowledge of energy; with respect to the equipment replacement, the Enel Energia (the biggest provider of electricity in Italy), offers the possibility to have a high efficient boiler through a payment by instalments in the bill at zero interest-rates.

Similarly, to E.ON Hungária, the provider ELMÜ-ÉMÁSZ also offers a variety of incentives and programmes intended to increase household energy efficiency and awareness:

- GREEN and GEO (geothermal) tariffs - to allow households to purchase green energy;
- Interest-free loans for households for the installation of solar energy systems;
- Energiapersely, an energy saving programme providing tips and advice for saving energy in the home, both online and in the form of printed flyers, including a service that allows households to borrow energy meters from ELMÜ-ÉMÁSZ customer service offices.

In the ***United Kingdom***, the Energy Companies Obligation (ECO), which started in 2013, is a Government scheme for Great Britain that placed legal obligations on larger energy companies to deliver energy efficiency measures to domestic premises. ECO was introduced as a successor to the

Carbon Emissions Reduction Target (CERT) and Community Energy Savings Programme (CESP) schemes, which ran from April 2008 to December 2012 and October 2009 to December 2012, respectively. As part of ECO, the UK Government estimated that £1.3 billion per year worth of energy efficiency and heating measures will be delivered across Great Britain.

ECO helps people to install energy-efficiency measures to their home. Under this scheme, the big energy suppliers are legally obliged to help the following with energy-efficiency measures:

- Low income and vulnerable households;
- Homes in low-income areas.

The ECO Order established three phases for ECO:

- Phase 1: 1 January 2013 to 31 March 2013;
- Phase 2: 1 April 2013 to 31 March 2014;
- Phase 3: 1 April 2014 to 31 March 2015.

Energy companies' obligations were determined for each phase of ECO. The obligations did not need to be met separately for each phase, but cumulatively for the overall obligation period.

Over the course of ECO, there were several legislative changes to reflect amendments to the overall intent of the scheme and which affected the eligibility criteria of measure. The most significant was announced by DECC in December 2013, which included among others a reduction of the CERO target by 33% from 20.9 $MtCO_2$ to 14 $MtCO_2$;

The changes were largely the result of concerns around the cost to energy companies of delivering the scheme, which were passed on to consumer fuel bills. The changes reduced the cost of meeting the targets by reducing the overall carbon savings to be achieved, allowing for wider delivery of lower cost measures and simplification of some of the requirements.

In December 2014, was introduced a new obligation period starting on 1 April 2015 (referred to as ECO2). It included:

- Extending the scheme to 2017 allowing energy companies to carry forward the majority of savings that were not needed to achieve their obligations under ECO towards their ECO2 obligations (referred to as surplus actions);
- Introducing a provisional solid wall minimum requirement (PSWMR) of 4 $MtCO_2$ carbon savings to be achieved across all energy companies between January 2013 and March 2017, equivalent to approximately 100.000 solid wall insulation measures;
- Making changes to HHCRO including: the introduction of the uplifts in the cost savings for qualifying boiler replacements and measures delivered to non-gas premises; the repair and replacement of qualifying electric storage heaters as a new measure; minimum warranty requirements for replacement boilers and electric storage heaters.

The extension of the ECO scheme appeared to provide the energy companies with enough assurance for them to continue delivery, even after they had achieved their obligations.

Energy companies delivered savings significantly in excess of the ECO targets. The majority of energy companies chose to deliver their obligations via managing agents or direct contracts with installers. Overall, the most frequently installed measure type under ECO was cavity wall insulation, followed by loft insulation and boiler replacements.

On the other end, private utility companies in ***Italy*** generally do not appear proactive. One of the few is *A2A*, a utility company in northern Italy, which in some municipalities (e.g. Brescia) provides funding for energy efficiency projects allowing repaying the loan in instalments on the same energy bill.

4.3 Energy Service Companies (ESCOs) and Energy Performance Contracts (EPCs)

Energy Service Companies (ESCOs) and Energy Performance Contracts (EPCs) are seen as private-sector delivery mechanisms for energy efficiency.

The *energy service company* (ESCO) can be a natural or legal person that delivers energy services and/or other energy efficiency improvements in a user's facility or premises, and accepts some degree of financial risk in so doing. The payment for the services delivered is based (either fully or in part) on the achievement of energy efficiency improvements and on the achievement of other agreed performance criteria. In fact, the basic role of an ESCO is to provide energy efficiency services to consumers, such as project finance, engineering, project management, equipment maintenance, monitoring and evaluation. An ESCO generally performs any or all of the following services: auditing, developing packages of recommended measures, arranging financing, installing or overseeing installation of measures, resident and staff education, equipment commissioning, maintenance, measuring, verifying, and guaranteeing savings. These are usually made through Energy Performance Contracts (EPCs), which are self-reimbursing loans (i.e. that are repaid through savings). The EPC is a contractual arrangement between the beneficiary and the provider (e.g. an ESCO) of an energy efficiency measure, where investments are paid in relation to a contractually agreed level of energy efficiency improvement. EPCs shall give all buyers and renters transparent and accurate information on the energy running costs of their homes and practical advice on how to improve it. This helps them to cut their fuel bills and their carbon emissions.

The most common types of energy performance contracts are well described by the Carbon Trust (UK):

- Guaranteed savings: the ESCO guarantees to deliver the customer with a minimum level of savings. If the total savings are less, the ESCO pays the difference.
- Shared savings: the customer and the contractor agree to share the savings over the contract period according to an agreed formula.
- DBOOT (Design-Build-Own-Operate-Transfer) contracts: the ESCO designs, builds, funds, owns and operates the scheme for a defined period and then transfers this ownership across to the customer. Customers enter into long term supply contracts with the ESCO and are charged accordingly for the service delivered.
- Chauffage contracts: the ESCO takes complete responsibility for the provision of energy services and energy. Effectively the contractor takes responsibility for the operation of a customer's utility or production facilities as well as upgrading them, and often for paying the customer's utility bills. The fee paid by the client is calculated on the basis of its existing energy bill, minus an agreed percentage (e.g. 5-10%).
- First-out contracts: the ESCO pays for and installs an energy efficiency upgrade, then takes all the savings until it has recovered its costs. Once these costs are paid, the contract terminates and on-going savings revert to the customer.

Despite the large energy saving potentials in the EU the energy performance contracts and the energy service companies market for residential buildings is much less developed than in other demand sectors (e.g. the industry or public/service sectors), as indicated in several studies (e.g., Irrek et al., 2013; Bertoldi et al. 2014; Labanca et al., 2015).

Labanca et al. (2015) provide a comprehensive overview of the barriers preventing a large-scale application of the ESCO concept in the residential sector:

- The particularly high transaction costs for ESCOs relative to the small amount of energy costs and thus potential cost savings per single energy efficiency service supplied;
- The landlord/tenant problem, that is when the landlords have little incentive to invest in the energy efficiency of their properties, given that it is the tenant who benefits from lower energy bills
- The decision-making processes existing in multi-apartment buildings, where only the general assembly of apartment owners can take decisions about building investments;
- The perception of the ESCO as not a trustworthy organisation and the fear of households to become too much dependent on the ESCO;
- The difficulties for residential customers to understand the ESCO model and the EPC financing and contract and lack of information on the availability of ESCO services.

The number of ESCOs, their market size and the type of services provided varies a lot among Member States. For example, in ***Germany*** there were approximately 500-550 ESCOs in 2013, with a market size of € 3-4 billion, while in ***Italy*** (that ranks second in terms of number of ESCOs in Europe) there were about 50-100 ESCOs in 2013, with a market size of €500 million (Bertoldi and Boza-Kiss, 2017).

Good levels of market activity for the provision of energy efficiency services to the residential sector in ***Germany*** and ***Italy*** have been typically supported by energy efficiency policy measures like energy saving obligations, tax deductions, tax credit schemes or subsidies (Bertoldi et al., 2014).

Germany has been seen as the champion amongst the European ESCO markets in terms of maturity and the number of stakeholders (Marino et al. 2011). Energy service companies' activities in the residential sector mainly address space and water heating, including heat supply services. Compared to other EU countries, the ESCO and EPC concepts are well developed, especially in specific regions or cities (e.g. Berlin). Moreover, the German government-owned development bank KfW is particularly active in promoting energy efficiency in residential buildings (Irrek et al., 2013).

In ***Italy,*** not many ESCOs couple energy services with other functions. Within the "energy services" area, the most commonly offered service is the energy audit, followed by concluded EPC contracts. Excluding "energy services", the three principal functions of ESCOs are: "technologies for the generation and use of thermal energy", "CHP and CCHP systems" and "efficient buildings". The main sectors covered by these businesses are commercial, services, and partially residential, which generate 76.7% of their total turnover; the remaining share comes from the industrial sector (23.2%), and a negligible portion from the agricultural sector. The national organization representing and promoting the energy efficiency industry is FederESCO.

More recent and detailed information about the ESCOs activities in the residential sector are provided by the latest Energy Efficiency Report of the Polytechnic University of Milan (2017). In Italy, there were about 272 ESCOs in 2016, with a market size of €836 million, corresponding to approximately 14% market share of the total energy efficiency investments (Polytechnic University of Milan 2017). Although the total energy efficiency investments in 2016 have been driven by the residential sector (53%), the support of the ESCOs has been marginal. In fact, only 3.4% of the total energy efficiency investments in the residential sector have been financed by ESCOs. This means that the residential sector covered by ESCOs accounted for €110 million, representing 13.4% of the total investments made by ESCOs in 2016.

In ***Hungary*** the complex refurbishment of residential blockhouses (involving heating, insulation, and window replacement) has become a fast emerging market area for ESCOs mainly due to state and municipal grants available for panel blockhouse refurbishment (Irrek et al., 2013). Unfortunately, the market has experienced a strong decline during the last 6-7 years. While in the early 1990s Hungary was known as an exemplary ESCO market, it started fluctuating from around 2006, and continued its

insecure stride during 2007-2010. Since 2009-2010, obstacles have grown so significant that the previously 20-30 active companies were reduced to 6 in 2013. Key barriers are:

- Problems with the policy framework: such as the weak energy efficiency and buildings policies; promise of non-refundable grants that however prove to be rare and little, no accepted definition of EPC/ESCO, and thus a lack of understanding of the concept.
- Policy instability: lack of supportive legislation and measures, rapid policy-making and unexpected legal changes, counteractive policies and decisions.
- Therefore, the financial bases are also instable: liquidity problems of the potential clients and also of many ESCOs, unexpected special taxes on banks and energy providers (among others), available bank products are not designed to the preferences of an ESCO project participant.
- Information barriers: political goal of utility cost reductions by legal means, support for nuclear energy, discouraging bank loans, general public and public building owners are afraid of bank products due to the credit crash, lack of trust in the construction sector in general, lack of trust in subcontractors by ESCOs, lack of long term thinking and planning (Boza-Kiss and Vadovics, 2013).

In ***Romania***, thermo-rehabilitation of existing buildings has been increasingly performed as of 2005, mainly thanks to the availability of a public funding programme covering up to 80% of building rehabilitation costs (Irrek et al., 2013). However, the Romanian energy services market appears currently underdeveloped and is seen in need for active and constant stimulation from local and central State authorities. Efficient support for energy services companies involves overcoming the relatively sceptical attitude of Romanian consumers towards energy efficiency and enable easier access to such services.

In the ***United Kingdom***, despite the fact that the ESCO market is one of the most developed in Europe, ESCOs activities have been mostly concentrated in the commercial and industrial sector (Labanca et al. 2015; ENSPOL 2015). There are about 30-50 energy service companies active on the UK market. The major players are large international manufacturers of building automation & control systems but a growing number of construction and property companies, smaller consultancies and dedicated ESCO firms started to populate the market in recent years. An ESCO in the residential sector builds, operates and maintains the community or district energy scheme, sells energy to the end customers and provides customer care services. New ESCO entrants and in particular utilities see it reasonable to engage in the field of energy savings as they see a serious national commitment to a low-carbon transition (Hannon et al. 2013) - framed by the Climate Change Act 2008 - and an increased attention towards energy efficiency in the residential sector. Alongside the Energy Company Obligation (ECO), which encouraged large energy suppliers to team up with ESCOs in order to deliver energy efficiency measures to vulnerable households, the Green Deal was expected to set the necessary framework to open up the residential market to ESCOs, but failed to achieve its purpose.

The role of the ESCOs has been incorporated into ***Spanish*** legislation. In 2014, 968 companies were registered as energy service providers, a number that has grown continuously since it started in 2010. The profile of these companies is essentially that of engineering, installation, and assembly companies, some of which are associated with building heating system maintenance companies, as well as with subsidiaries of building companies and electricity suppliers, primarily. About 80% of the registered companies provide services in industrial activities and service buildings, 70% in residential sector, 65% in outdoor lighting and just 50% in cogeneration. 93% of these companies are SMEs, that is, they have fewer than 250 employees and annual revenue of less than €50 million, while 7% are large enterprises. In the last years, the ESCO market for the residential sector has benefited from the support of the IDAE-managed programmes, BIOMCASA II, GEOTCASA, SOLCASA and GIT. However,

the main aim of these programmes is to promote renewable energy investments such as heating and cooling systems powered by biomass, solar power or geothermal energy, and only to limited extent energy efficiency investments.

Energy efficiency services (EES) in ***Latvia*** are not well developed and in general, the national framework conditions are not sufficient for sustaining a real market transformation. To promote ESCO in the Baltic States and other Eastern Europe countries a new NGO called "Building and Energy Conservation Bureau" was established in Latvia in 2012. It is focussing on the multi-apartment Soviet Era buildings providing information on deep retrofit and energy efficiency improvements using a long term EPC. The EPC scheme addresses technical measures (external walls insulation, window and doors replacement, heating, ventilation and hot water systems renovation) as well as practical, fundamental elements (i.e. staircases, doors, roofs, fire equipment, balconies, etc.). While these additional measures do not directly contribute to reducing energy consumption, financing them within the energy efficiency renovation increases the payback period of the ESCO investments.

Like many other countries, the main barriers to the development of energy service companies in Latvia can be classified as follows: insufficient quality of public information on the ESCO, lack of client confidence, concept of excessively high technical and business risks, lack of adequate legislation on public procurement, the lack of standard savings measurement and verification process, lack of appropriate funding sources, etc.

In ***Finland***, there are about 5-8 ESCOs are actually active companies, with a market size of €10 million. The energy government agency Motiva plays supports the facilitation of the ESCO market and EPC usage and maintains lists of ESCOs that have submitted information to the ESCO project register. In addition, the development of energy services in Finland is promoted by means of programmes coordinated by the Finnish Funding Agency for Innovation (Tekes).

Compared to other EU countries, the ESCO market in the residential sector is even more limited. Pätäri and Sinkkonen (2014), by following a two-round Delphi study, analysed the reasons for the immaterialised volume of activity in Finland. The findings of this study indicate that the generally weak knowledge about ESCOs and their offerings is among one of the key reasons why the ESCO market is not developed. Also, customers may regard ESCO projects as complicated and time-consuming, and potentially not 'worth the trouble'. Therefore, the study recommends ESCO to become more active and take larger role in promoting their activities and energy efficiency in general. ESCOs should try to make potential customers see benefits of ESCO projects and asses ESCO projects objectively.

In a previous study, Sinkkonen (2013) emphasises the importance of the starting phase of an ESCO project. The beginning of the project determines, by far, the overall success of the whole ESCO project. At the beginning, trust is formed between ESCO and the client because at this point savings potential, project design and investment negotiations are done. If savings potential is calculated carelessly and investment decisions are done according to erroneous calculations success of the whole project is questionable. Failure in the starting phase also ruins trust between ESCO and the client, and consequently preclude possibility to carry out any future energy efficiency projects. For this reason, ESCO's are recommended to focus extremely well on the first stages of ESCO projects (Sinkkonen, 2013).

4.4 Banks

Some national or regional banks have recognised the potential of energy efficiency financing and have developed specific packages for households to support energy efficiency improvements,

renewable energy and broader green investments or to complement national energy efficiency programmes (to cover own contribution, match funding).

The ***UK*** Green Investment Bank (GIB) was the world's first investment bank dedicated to greening the economy. With government funding of £3.8 billion, the GIB invests in innovative, environmentally friendly areas for which there is a lack of support from private markets. This includes offshore wind power generation, waste-handling plants, energy efficiency measures, biofuels, biomass, carbon capture and storage, marine energy and renewable heat generation.

In ***Germany***, KfW (Germany's state owned promotional bank) offers programmes for energy efficiency in the residential sector. KfW provides refinancing for the loans via the capital market. The interest rate of the promotional loans is further subsidised by funds provided by the Federal Ministry of Building, Transport and Urban Development (Concerted Action, 2015).

The international KfW branch operates also in ***Latvia*** (in collaboration with Latvia's Ministry of Environmental Protection and Regional Development, the Latvian Environmental Investment Fund and Hipoteku un Zemes Banka) with the project "Heat insulation of buildings for energy saving purposes". In this project, associations of apartment owners and individuals were offered an opportunity to receive loans for the complex insulation of apartment buildings on favourable terms. Generally, third-party financing is a common form of energy efficiency project financing in Latvia. In Latvia, bank credits in the form of loans rank among the most common form of external financing. It can be furnished for even relatively small projects.

In ***Hungary***, loans to supplement the funding available on a competitive basis to multi-apartment houses (with between 5-60 apartments) are available to cover the 50% own contribution required for eligible blocks of flats from the OTP Bank. A *National Green Bank* with the aim to provide financial products to promote energy efficiency also in the household sector was established in 2014. At present, however, the related financial products are not yet available.

In ***Italy***, there are already many cases in which private banks have started to use tools targeted for this type of interventions. According to a survey conducted by ABILab, in the first half of 2014, 86% of surveyed banks provided specific products for energy efficiency financing. All banks surveyed are involved in private property refurbishing projects. In contrast, the percentage is rather low for funding dedicated to projects concerning the Public Administration (33%); even lower the amount related to projects implemented by ESCOs (17%). The bank BNL through a specific product offers reduced interest rates for investments of energy efficiency up to € 100.000, while UniCredit with the product supports those who can benefit of the tax deductions of 65% related to reductions of IRPEF (personal income tax) in respect of actions to improve the energy efficiency of existing buildings (maximum amount € 150.000). Two banks are especially devoted to support energy efficiency investments:

Officinæ Verdi is an Energy Efficiency Group originally created by UniCredit in cooperation with the World Wide Fund for Nature (WWF). In two years of activity has arranged green energy operations in Italy with investments of about 93,4M€, consolidating a high level of know-how and an integrated approach in energy efficiency for key sectors of the real economy. Beside infrastructure, large-scale trade, manufacturing Officinæ Verdi also supports families and households to reduce their energy costs and produce their own clean energy in small equipment's.

Banca Etica has developed various products related to energy efficiency. Relevant for individuals and families are:

- *Mutui prima casa "energetici"*: offers favorable mortgage conditions if the purchase and/or renovation of a building is combined with fulfilment of specific energy efficiency criteria;

- *Mutuo Chirografario Ristrutturazione Efficiente*: Restructuring of residential property according to energy efficiency criteria;
- *Mutuo Micro Energia*: supports photovoltaic systems with a capacity of less than 20 kWp, small plants using other renewable energy sources and small energy efficiency measures at the household / family level.

In ***Romania***, with the support of the European Bank for Reconstruction and Development (EBRD), loans for energy efficiency projects under the "Sustainable Energy Financing Facility (SEFF)" are provided. The Romanian SEFF programme RoSEFFpartners with financial institutions such as banks, establish strategies for financing sustainable energy investments. These strategies help direct more finance towards investment opportunities that use energy and other resources more rationally. The national financial institutions on-lend the funds which they have received from the EBRD to their clients, among others residential borrowers. Residential loans cover a few thousand to a few hundred thousand Euros, most often to support improvements on the building envelope. Various groups have benefited from SEFF loans including individual owners and groups of home owners and multi-apartment associations. However, individuals are representing a very small share only.

In ***Finland*** only the Local Savings Bank, a regional bank with about 10 offices, is offering tailored money e.g. for heat pumps.

4.5 Non-Governmental Organisations (NGOs)

Non Governmental Organisations, namely such with an explicit environmental, social or consumer focus are important partners when it comes to the promotion of energy efficiency. According to Eurobarometer they are perceived as trustworthy organisations, ranking much higher than local authorities or the press, not to speak about political parties or business. Therefore, NGOs always were a motor for political developments and e.g. the strengthening of regulations and standards as well as for activating campaigns among the public.

Even more than in the previous sections the examples mentioned below only reflect a small share of the activities.

The *Transition Town* movement, *Friends of the Earth Europe* and the *European Environmental Bureau* (including their national members), the *Degrowth* movement, all carry out initiatives engaging individual consumers but as well ensure international exchange for mutual learning and common lobbying.

An international cooperation NGOs from six countries[19] e.g. joined forces in 2010 to develop an international ecolabel for electricity. *EKOenergy* promises electricity from 100% renewable sources and even more like: strict criteria for the tracking and auditing of green electricity, proper information for consumers, and investing parts of the green premium in new projects through their own Climate Fund.

Since the *EKOenergy Network* opened up in November 2012 for new partners 40 organisations have signed the agreement ranging from Iceland to Georgia and from Tampere to Crete and even beyond Europe[20]. In 2013, a secretariat was set up to manage and promote the label and a team of international trainees and volunteers was hired focusing on Finland, Spain, Italy and Latvia in the beginning.

[19] Finland, Latvia, Italy, Spain, Rusia and Estonia
[20] as of January 2016

In ***Italy*** as a civil society initiative, the *EnergoClub* was founded in 2002 by a group of friends with the aim of making clear and accessible to all the fragmentary and incomplete information regarding the renewable energy sources. EnergoClub, is registered as a non-profit association since 2005. On a national level, it is working for the dissemination of good practices of energy conservation, the sustainable use of renewable sources in households, businesses, public authorities, schools.

In particular, the Energy Project Diritti a viva voce (Speak up for rights), is a set of face-to-face and electronic services for the protection of consumers and users of energy services in Italy. Its aim is to inform consumers and to raise their awareness and support them in all energy-related issues. The project has been promoted by the 18 Consumer Associations members of CNCU, the National Consumer and User Council with the support of the Electricity and Gas Authority.

At the other end of the political spectrum works the ***Hungarian*** Energiaklub, a network of NGOs all over the country, which has initiated studies, legal procedures and public consultation to reveal democracy gaps and to try to bring the decision on energy projects back under democratic control. One of the main arguments of Energiaklub is from the technical point of view the expansion of the already existing capacity is not justified by the current and expected future trends in the consumption of energy in Hungary. Taking energy efficiency serious would even more reduce the need for new energy plants. Nevertheless Hungarian NGOs also offer possibilities for concrete consumer engagement e.g. through the *EcoTeams, EnergyNeighbourhoods* and the *Small Footprint* programmes - that have an important group and community building element. Furthermore, the *Alliance of Climate-Friendly Municipalities* actively encourages municipalities to help the formation of local climate groups or clubs. All these programmes recognize the importance of small groups or communities in achieving and sustaining behaviour change towards lower carbon lifestyles and more sustainable energy consumption (Heiskanen et. al., 2010; EEA, 2013).

Generally speaking raising competition (*Renovator of the year* award from the Hungarian Energy Efficiency Institute) or bringing people in touch through e.g. through the *Green Walk*, a series of open days showcasing the most renowned examples of Hungarian green buildings or the annual *Passive House Open Door Days* appeal to consumers in times of decision making and can better help to spread motivation for energy efficiency measures than brochures or newspaper clips.

In a very practical project ***Lativian*** NGOs from various cities joint an initiated by the Public Policy Institute. Volunteers in participating Latvian cities were trained in window and door weather-stripping, using specially adapted carpentry tools and silicon strips. Average energy savings are 10–20%, depending on the building. The advantage of using silicon strips is that they last at least 10 years, can be removed and put back again after painting windows, and allow windows to be freely opened and closed for ventilation throughout the heating season. Weather-stripping can be done in any individual apartment to increase temperatures and comfort levels, reduce noise and dust from outside. Economic benefits, however, are only possible if all apartments are treated and there is a heat substation in the basement where the heat supply to the building can be regulated. During the pilot project, one small multi-family building in each of the three towns were weather-stripped. The first results show temperature increases in apartments of approximately 2^{o}C. The future aims of the program were to provide a free volunteer service to pensioners and socially disadvantaged groups. The service will also be available to other residents who are **t**o pay for the cost of the silicon strips.

General lessons from the pilot projects are that comprehensive retrofit packages are most beneficial, but that it is very important that controls are installed first in order to insure that residents have both an incentive and a means to reduce heat consumption.

The ***Finnish*** NGO *DEMOS* runs and supports the PELOTON Club, a network for start-ups for energy efficient society. It brings together different organisations to work together in workshops to develop new ideas. Many new companies were started this way (smart ups). The PELOTON Club (named after

the first project of the organization) by now has over 400 members which have the possibility to meet once a month to present business ideas, critically discuss them and develop them further. From time to time, the meetings are visited also from people from ministries (even up to the minister). Peloton Club is a dynamic and open community of entrepreneurs. The purpose of the community is to provide consumers with products and services that allow e.g. low emission and resource-smart housing, transport or food.

In Germany there are many NGOs working on the environmental issues at different levels. Among others, Climate Action Network, ECOTERRA International, German Advisory Council on Global Change (Wissenschaftliche Beirat der Bundesregierung Globale Umweltveränderungen), Hanns Seidel Stiftung e.V., International Council of Environmental Law (ICEL), Stiftung Wissenschaft und Politik (SWP), World Future Council (WFC), iuventum, Alliance Effizienzwende (Bündnis Effizienzwende), BUND-Bund für Umwelt und Naturschutz Deutschland. Like other countries, there is limited place for NGOs that are specialized in supporting energy efficiency in the residential sector. However, given the strong reliance of the residential heating system on gas-heating technology, NGOs have recently lobbied against the extension of gas extraction through fracking and for refurbishment measures of outdated gas-heating systems (PATHWAYS, 2015).

4.6 Research

The basis for all activities towards energy efficiency finally is solid research. Technological innovations often find their way through the market, but also research on optimal policy instruments and social settings for change are needed and carried out in all countries. The research project presented here reflects the selection made for the various country reports the report is based on.

Energy-efficient technologies offer considerable promise for reducing the financial costs and environmental damages associated with energy use, but these technologies appear not to be adopted by consumers and businesses to the degree that would apparently be justified, even on a purely financial basis (Gerarden et al., 2015). Researchers worldwide have focussed their efforts on understanding the reasons that explain underinvestment in energy efficiency solutions and how to set appropriate policy responses and actions in overcoming these impediments (see Gillingham et al. 2009 for an overview). Low levels of investments in energy efficiency have long been associated with market failures, which are among the most important barriers to energy efficiency in the residential sector, assuming 'rational' (i.e. utility maximising) behaviour. Commonly cited market failures include: credit constraints, landlord-tenant dilemma, imperfect information for consumers (Allcott and Greenstone, 2012).

More recently, behavioural economists and psychologist have stressed the irrational aspect of decision making that may make individuals act against their own long-term interest (Gowdy, 2008). Many behavioural features and psychological phenomena affect consumers' patterns of energy choices and usage including heuristic-decision making, status quo bias, loss and risk aversion, endowment effects, temporal and spatial discounting, normative social influence (Gillingham and Palmer 2014; Pollitt et al. 2011; Frederiks et al. 2015). Such behaviours can also be perfectly rational, but following different criteria than a social utility maximisation upon which the economic rationality definition is based (Sallae, 2014). Some authors have pointed out the role of information and social incentives in energy sufficiency/conservation (Allcott and Mullainthan, 2010). From a policy perspective, providing more reliable information can reduce uncertainty in the decision-making process leading consumers to make better decisions (Ameli and Brandt, 2015) in cases when an information deficit is the cause of not investing in energy efficiency solutions.

In the ***United Kingdom***, one of the major project of the last years was to test how consumers react to improved information about their energy consumption over the long term. The Energy Demand Research Project (EDRP) ran between 2007 and 2010. It has been managed by Ofgem on behalf of DECC. The EDRP trailed a range of methods of providing customers with improved feedback on their energy consumption, including:

- Smart electricity and gas meters;
- Real-time display devices, which show energy use in pounds and pence;
- More accurate and more frequent bills;
- Energy saving information;
- Community engagement.

The trials were made up of different combinations of these actions and explored the responses of over 60.000 different households and the installation of 18.000 smart meters. Four energy suppliers ran the trials: EDF Energy Customers Plc, E.ON UK Plc, Scottish Power Energy Retail Ltd and SSE Energy Supply Ltd (EDF, E.ON, Scottish Power and SSE). The Government allocated £9.75 million to the trials, match-funded by the energy suppliers taking part.

The interventions were primarily directed at reducing domestic energy consumption, with a minority focused on shifting energy use away from periods of peak demand. The measures were generally applied at household level, but one supplier also tested action at community level. The findings are as follows:

- Interventions using smart meters were often successful and resulted in larger energy savings compared to other measures.
- Electricity savings can be promoted through provision of advice and historical feedback on consumption but they cannot be relied upon individually; a combination with a direct feedback measure is likely to have higher benefits.
- The delivery of information through the Web or customers' TVs was not successful.
- Community engagement can also be effective, but may require a higher initial investment and will not necessarily work in all localities.
- Financial incentives and commitment to reduce consumption had either no effect or a very short-term effect.
- The provision of a Real-Time Display (RTD) was particularly important in achieving savings in electricity consumption.
- The combination of smart meters and RTDs consistently resulted in energy savings of around 3% on average. Providing an RTD with a smart meter is important: savings were generally 2% to 4% higher than with a smart meter only.

The project also highlighted that support from the equipment installers may be particularly important for users to learn how to operate the devices in an optimal way. Furthermore, customer surveys on RTDs showed that cost information was used and valued more than unit (kW) information, and electricity information more than gas. Displays of CO_2 emissions were generally not widely noticed, used, or perceived as useful.

Programmes that could lead to long-term behaviour change through the introduction of new, pro-environmental social norms are the community-based initiatives. Within these programmes, participants benefit from a relevant frame of reference for their behaviour. They encourage households to participate toward community-level savings goals, or as part of a community through social marketing and social norms or encouragement.

The benefits of putting communities at the heart of energy policy are underlined by literature (Darby, 2006; Fischer, 2008) and by the report ‘Community Energy Strategy’ (Department of Energy

& Climate Change 2015) which set out how communities should change the way they think and act on energy. According to this report, the implementation of the strategy can help underpin the diversification of the current centralised energy system to a much more distributed approach, whereby local people have more control of and a stake in how energy is generated and supplied, and how their community's energy demand can be managed and reduced. Within the framework of such initiatives, small groups of people gather together and decide on a range of behaviours and attitudes that can be changed either to reduce their overall environmental footprint and/or to increase energy efficiency, in a report group format

Similar guidelines emerged from the report undertaken by RAND Europe in 2012, entitled "What Works in Changing Energy-Using Behaviours in the Home?", commissioned by the UK Department of Energy & Climate Change (2012) and aimed at understanding which interventions designed to change energy use behaviour in the home are the most successful. The report, which is drawn from 48 selected behaviour change programmes, examined the evidence from the published literature on the effectiveness of two different innovative approaches - such as the provision of Home Energy Reports that compare households' consumption with their neighbours - and more traditional approaches (including advertising campaigns) to encourage behaviour change in the reduction of home energy use.

The interventions studied in the report are diverse, involving different combinations of mechanisms to encourage change and often implemented in very different contexts. This diversity means that there is no single model for the 'best' intervention to encourage behaviour change in energy-using behaviours in the home. What is clear from the evidence is that two broad classes of interventions have been undertaken to date: broad universal initiatives, such as Home Energy Reports, which have been rolled out across large segments of the population and tend to save between 1% and 3% of energy consumption per household, and small-scale targeted community-based programmes. Interventions that operate at the community or neighbourhood level do seem to be effective in influencing domestic energy use. However, there are challenges concerning the extent to which these might be scaled, as by design, they assist households and neighbourhoods in a tailored manner. Although the evidence is limited, it suggests that among these target groups should be those that currently have the highest levels of energy.

Giving households feedback about their energy savings may encourage them to reduce energy use, because their level of self-sufficiency (i.e., perceived possibilities to conserve energy) increase (Abrahamse et al., 2005). In addition, comparing their use to their neighborhood, have caused households to reduce energy consumption (Fischer, 2008; Allcott, 2011), but also undesirable boomerang effects[21] (Ayres et al., 2012; Sælen and Westskog, 2013).

Thus, consumers need appropriate frames of reference in order to determine whether their energy consumption is excessive. This may induce households to save energy through daily energy saving practices or energy efficiency investments, or a combination of both.

In this context, the ***German*** project *Power Efficiency Classes For Households* developed an illustrative tool to make the own/family electricity consumption comparable to average data.

[21] The "descriptive norm" element of the Home Energy Report treatment, in which a household's energy use is compared to that of its neighbors, would cause households that previously used more than the norm to decrease usage, but would cause households that used less than the norm to use more (Allcott, 2011).

Figure 21: Household power efficiency class

Source: Stieß et al. 2015

Here, households can easily see how they perform in their energy consumption and how their neighbors are performing; the households themselves can set targets and try to achieve at least one better class within a given timeframe. Overall, the power efficiency classes were perceived as an incentive to save power and achieve a better class. The participants of the focus groups emphasized the positive effects of the feedback and impetus over the duration of the field test. Most of the participants were stimulated by the campaign to reach a better class. The campaign was considered as a way to receive useful information about one's individual power consumption and ways to improve it (Stieß et al. 2015).

Incorrect "perceptions" of fuel cost savings and lack of information and attention about energy costs may significantly contribute to explain the apparent efficiency gap (Tietenberg 2009; Allcott et al., 2014), although they represent a significant part of household income (Brounen et al., 2013). However, even with adequate knowledge about how to save energy and a professed desire to do so, many consumers still fail to take noticeable steps towards energy efficiency and conservation (Frederiks et al., 2015). A person who is knowledgeable about energy and aware of energy-related issues will not necessarily adopt energy saving behaviors or participate in actions that promote a more sustainable energy future. It is therefore very important not only the understanding of how energy is used in everyday life or the awareness of the need of energy conservation, but moreover, the ability and willingness to use that knowledge in a functional manner and to take actions that reflects these understanding and attitudes with respect to energy behaviors.

Recently, Trotta et al. (2017) carried out a survey in ***Finland*** in order to evaluate the level of energy literacy, financial literacy, energy awareness, and the range of energy behaviours and attitudes towards energy consumption of Finnish households. Results show that energy use seems to be not on the mind of the consumers and only 42% of the respondents are "energy literate". Energy literate respondents correctly answered to questions about the optimal choice of the heating system, thus having been able to translate their knowledge about energy-related issues into energy behaviours. Respondents overestimated their ability to read and understand the electricity bill. On the other hand, 58% of the respondents correctly answered to the three financial literacy questions, proving to

be able to use knowledge and skills to make effective and informed money management decisions. While 70% of the respondents stated to have a high capability to understand the electricity bill, less than one-quarter provided the right answers about the electrical energy and distribution costs. In addition, only 20% of the respondents are aware of the operating costs of the electrical appliances and heating system, and 55% of the respondents provided a reasonable estimation of their latest winter and summer electricity bills.

Another ***Finnish*** research project (Mattinen et al. 2014) investigated on *Resource Wise Trials* – among others – to foster energy efficiency. One of the results was a successful trial of a housing company to reduce energy use for lighting through innovative promotion of LEDs. They offered occupants a testing box with various LED's to learn through experience how they affect light in different rooms of an apartment. The experiment resulted in a reduction of energy consumption for lighting by up to 75%. Most of the trials also identified positive effects related to well-being and the local economy.

The *Ecohome* project, ***Finnish*** as well, aimed to help households to decrease their energy consumption through changes in lifestyles, and renovations improving the energy efficiency at home (Salo et al., 2014). It focused on both everyday consumption patterns and more effective but much less frequent actions, e.g. the changing of a heating system. Recognising the limits effect of pure information provision Salo et al. (2014) investigated which agents are of specific help for households to live more energy efficiency lifestyles. They identified several groups of specific importance to support households in increasing energy efficiency: general education, regional advisory centers for energy and environmental issues, and NGOs. They generally pave the floor and raise awareness among population for more sustainable consumption. On the other hand professionals and small and medium-sized enterprises (SMEs) providing maintenance and renovation services for households and housing corporations are targeted as they play an important role in specific situations of decision making. The lack of reliable and competent third party information on energy renovations was identified as main barrier of energy efficiency investments for owners of detached/terraced house as well as decision makers in housing companies. In fact, in Finland there are not many small consultant companies or individual experts that can cover the essential aspects of an energy efficiency improvement: housing technology, renovation construction and the prevention of moisture and mould risks. Furthermore, the consultants do not always have the skills for properly communicating the technical alternatives to the average house owner or housing boards. Therefore, the training of experts and support in development of networks appeared to be essential.

The ***EcoHome*** project developed tools such as web-based and personal advisory services in order to raise the *informational basis* and promoting energy efficiency and sustainable consumption. For example, web-based carbon footprint calculator are important to communicate the difference that households can make with their consumption and life-style choices and are an important basis for discussing carbon footprint and mitigation measures with ordinary people in different occasions. Especially NGOs are in a good position to raise the knowledge about such calculators among households and connect the calculator and related activities with stakeholders' own agendas and activities. However, the public and free information services can rarely go into detail for an individual house owner. Computerised monitoring and feedback on individual energy use has the potential to reduce households' energy consumption but often even this is not enough to encourage behaviour change. Often only personal feedback mechanism close to real life actions and accompanied by interviews with the families they provided a real insight into the possibilities for change and make it possible to give relevant advice. This opens a niche for commercial advisory and consulting services, even for individual house owners.

In ***Latvia***, with the aim of developing strategies that promote more energy-conserving lifestyles and energy efficiency investments, several energy efficiency research projects are actually on the way. For example, The Ministry of Economics has developed an energy saving catalogue in cooperation with researchers and business associations, which is based on the Danish example (Standardværdikatalog for energibesparelser, version 3.1). It provides suggestions for energy efficiency measures and gives estimates of potential energy savings.

The project "Renovation Impact on Climate Change and Energy Efficiency Habits of Residents" has been launched in May 2015, and the research conducted within the scope thereof will involve comprehensive and in-depth analysis in the multifamily residential housing sector combing research methods used by social and environmental engineering sciences. The ESEB along with its partners strive to understand how to motivate residents of Latvia to renovate their homes, to make them comfortable, safe, sustainable, so that their operation would leave as less impact on climate change as possible; also, which business model would be most feasible to protect interests of the residents, and which package of measures reducing impact on climate change (energy efficient) should be implemented in the multifamily buildings in order to achieve as significant reduction of GHG emissions as possible at optimal costs.

Additionally, in 2014 the Latvian Association of District Heating Companies commissioned Ernst & Young to do the study on implementation of energy efficiency obligation schemes. They calculated that implementation of article 5 of EU Energy efficiency directive will increase heating tariffs to final customers by 5 to 25%. They also suggests that there is a need to promote the involvement of residents: for example, in the case of households, legislation should define a concrete minimum energy consumption threshold above which households would be required to implement energy efficiency measures. Serious consideration should be given to the fact whether the achieved energy savings can cover the heating cost increase to residents.

In ***Hungary***, as part of the TRANSPARENSE project (supported in IEE), a European Code of Conduct for EPC was established and introduced in about 20 countries.

The *European Code of Conduct for EPC* launched by Transparense in 2014 defines the basic values and principles that are considered fundamental for the successful preparation and implementation of EPC projects. It went through a two year long stakeholder process to make sure market players accept the principles. The main role of the Code of Conduct is to bring confidence to the EPC market in the EU taking into account its variety across the member states. Compliance with the Code of Conduct serves as a minimum guarantee of the quality of EPC projects implemented. During the Transparense project, the Code of Conduct has been tested in 37 pilot projects which at the same time contributed to the promotion of good practice principles both on the side of ESCOs and clients.

In Hungary, the Code was successfully introduced by GreenDependent Institute and signed by 5 companies and 2 supporting organizations. In the future, following the conclusion of the project, the Code will be managed by MEHI (the Hungarian Energy Efficiency Institute) in Hungary.

4.7 Housing companies

A common way of flat ownership is that people buy a flat in form of shares of a building. The sums of shares form the housing company. The description in this section is based on experiences in Finland but parallels might be found in other countries as well.

Housing companies are important but not necessarily proactive agents when it comes to energy efficiency measures. All parts of the building relevant for energetic modernization, like the heating

and pipe system, belong to the housing company. The company is governed by a board, which consists of elected owners. Issues like major renovations, as renovations for efficiency purpose, have to be made unanimous by all owners. This already cause quite some problems as 'normally' there is at least one voice not in favour of any change which implies money. Blocks of flats are typically managed by a housing board and a professional house manager. The housing board consists of elected representatives of the flat owners. The role of the board and the manager are essential when major renovations are prepared and the guidelines for the maintenance work are set. The flat owners are collectively responsible for the costs of major renovations and maintenance. Space heating energy (typically also including centrally heated water) in the whole building and the electricity used in common areas are usually collectively paid for by the owners. The electricity used in the flats is paid by the users. When major renovations are needed, there is a need for unbiased information, independent from any single technical solution, to find the best solution for the house (Salo et al., 2014).

The complicated decision-making process in the housing companies often hinders the progress of energy efficiency. The role of the housing manager is essential as attitudes and practices of the managers showed having an impact on the energy performance of the buildings (Kyrö, Heinonen, & Junnila, 2012). The value of the energy efficiency study is not always fully appreciated by the board members as this lay team is often not familiar with life cycle calculations and therefore requires education, explicit examples and consultation support. This would help to communicate to and convince board members about the potential benefits of the energy efficiency measures.

One way which proved to have some beneficial aspects is going beyond talking but literately drawing pictures how the building and its surrounding might look like in a future after renovation. Additionally the rather high and complicated legislative regulations for renovation often make housing companies shy away from modernization or, even worse, administration is bypassed. Also the new energy label for houses appeared not to be really helpful in this context as it only give theoretically calculated figures but do not reflect at all the real energy situation of a building.

Conclusions

This report shows the importance of the EU initiatives to stimulate Member States to take action to improve energy efficiency in the residential sector, but also shows the very different approaches of Member States, resulting in large differences in structure, contents and level of details.

In light of the increasing importance of energy efficiency as a mean towards contributing to climate and energy security goals, the move towards higher levels of energy efficiency appears to be too slow and there continues to be a degree of inertia on a national level.

Most of the energy efficiency policies have promoted efficiency through technical standards of buildings or incentive for investments in energy efficient solutions. However, even the best-designed energy efficiency policy cannot be effective if applied in isolation. Thus, what makes a good energy efficiency strategy is the combination and coordination among policies and initiatives from the private sector that target different segments of the residential sector.

When designing energy efficiency interventions, policy-makers should take into account not only the direct impact from reduction in energy consumption, but also the non-energy benefit that can be produced. This is particularly true for the impact that energy efficiency can have on low-income households. In this case, the rebound effect driven by the desire of low-income households to catch up with middle-class living standards may be counterbalanced by positive impacts on health and thermal comfort.

In addition, getting private investments supporting public activities in energy efficiency in the residential sector would be needed. Compliance with regulations should not be the only way to mobilize energy providers to take on energy saving activities, and the barriers preventing a large scale application of the ESCO concept in the residential sector should be lessened to make the residential sector more attractive for ESCOs, and the ESCOs more attractive for households. None of these issues has been really considered in the “Clean Energy For All Europeans” package (Winter package).

A major focus on policies that help in triggering a behavioural change and that induce a real reduction of energy consumption at personal and household level is necessary. There is a strong consensus that technological advancements in energy efficiency alone cannot obtain the full potential of energy savings in the residential sector and reaching ambitious climate and energy target. The residents themselves must decide to adopt new technology, employ it correctly and perhaps, most significantly adjust their lifestyle, attitudes and behaviour. The new EU energy efficiency target for 2030 will require a change in the energy consumer behaviour. As homes become more energy efficient due to stricter low-energy regulations, the behaviour of their occupants can play an increasingly important role in energy consumption and long term de-carbonisation goals.

In this setting, an important part of the future energy policy agenda on behavioral and efficiency interventions is to give people a tangible sense of their energy consumption and helping them to make optimal investment choices.

References

Allcott, Hunt and Sendhil Mullainathan (2010): 'Behavioral Science and Energy Policy', Science 327(5790): 1204-1205.

Allcott, H. (2011). Social norms and energy conservation. Journal of Public Economics 95 (2011) 1082–1095.

Allcott, H., & Greenstone, M. (2012). Is there an energy efficiency gap?. *The Journal of Economic Perspectives*, *26*(1), 3-28.

Ameli, N., Brandt, N. (2014). Determinants of Households' Investment in Energy Efficiency and Renewables: Evidence from the OECD Survey on Household Environmental Behaviour and Attitudes. OECD Economics Department Working Papers, No. 1165, OECD Publishing, Paris.

Amstalden, R. W., Kost, M., Nathani, C., Imboden, D. (2007). Economic potential of energy-efficient retrofitting in the Swiss residential building sector: The effects of policy instruments and energy price expectations. Energy Policy(35), 1819-1829.

Aroonruengsawat, A., Auffhammer, M., Sanstad, A.H. (2012). The Impact of State Level Building Codes on Residential Electricity Consumption. Energy Journal 33 (1).

Ayres, I., Raseman, S., Shih, A. (2012). Evidence from two large field experiments that peer comparison feedback can reduce residential energy usage. Journal of Law, Economics, and Organization, 29(4), 1-31.

Berg, A. (2007). The Making of Finland's Programme on Sustainable Consumption and Production. Analyzing dramaturgy and deliberation in a pioneering SCP policy process. Paper presented at the Amsterdam Conference on the Human Dimensions of Global Environmental Change, Amsterdam 24-26 May

Berg, A. (2011). Not roadmaps but toolboxes: Analysing pioneering national programmes for sustainable consumption and production. Journal of Consumer Policy, 34(1), 9-23.

Bertoldi, P., Boza-Kiss, B., Panev, S., & Labanca, N. (2014). ESCO Market Report 2013.

Bleischwitz, R. (2009). Eco-innovation - putting the EU on the path to a resource and energy efficient economy. MPRA Paper 19939, University Library of Munich, Germany.

Blumstein C, Harris, J. (1993). The cost of energy efficiency. Science 261:970.

Blumstein, C. (2010). Program Evaluation and Incentives for Administrators of Energy Efficiency Programs: Can Evaluation Solve the Principal/Agent Problem? Energy Policy, 38, 6232-6239.

Boza-Kiss, B. and Vadovics, K. (2013). D2.4 Country Report on Identified Barriers and Success Factors for EPC Project Implementation – Hungary (Transparense project). GreenDependent Intézet, Gödöllő, Hungary.

Boomhower, J., Davis, L. (2013). Free Riders and the High Cost of Energy efficiency Subsidies. Draft manuscript, University of California, Berkeley, March.

BPIE (2014). Energy Performance Certificates across the EU.

Brounen, D., Kok, N., & Quigley, J. M. (2012). Residential energy use and conservation: Economics and demographics. European Economic Review, 56(5), 931-945.

CECED Hungary (2013). A magyarországi háztartásokban található régi háztartási gépek cseréjével elérhető energia-megtakarítási lehetőségek. [Energy saving potential through replacing old household appliances in Hungarian homes.].

Clark, B., Foster, J.B. (2001). William Stanley Jevons and the coal question: An introduction to Jevons's "Of the Economy of Fuel". Organization & Environment 14, 93-98.

Concerted Action (2015). Funds and financing for energy efficiency.

Costa, Dora L., Kahn, Matthew A. (2013): 'Energy Conservation "Nudges" and Environmentalist Ideology: Evidence from a Randomized Residential Electricity Field Experiment', Journal of the European Economic Association 11(3): 680-702.

Darby, S. (2006). The Effectiveness of Feedback on Energy Consumption. Working Paper, Oxford Environmental Change Institute.

Davis, L., (2008). Durable Goods and Residential Demand for Energy and Water: Evidence from a Field Trial. RAND Journal of Economics 39 (2): 530-546.

Delmas, Magali A. and Neil Lessem (2014): 'Saving Power to Conserve Your Reputation? The Effectiveness of Private Versus Public Information', Journal of Environmental Economics and Management, 67: 353-370.

Department of Energy and Climate Change (DECC). (2012). Smart Metering Implementation Programme Smart Energy Code: Consultation. London: DECC.

Department of Energy and Climate Change (DECC), (2012b). DECC's open data strategy. London: DECC.

Dennis, K. (2006). The Compatibility of Economic Theory and Proactive Energy Efficiency Policy. The Electricity Journal, Vol. 19, Issue 7, ISSN: 1040-6190.

Directive 2010/31/EU of the European Parliament and of the Council of 19 May 2010 on the energy performance of building (recast), OJ L153, 18.06.2010.

Directive 2010/30/EU of the European Parliament and of the Council of 19 May 2010 on the indication by labelling and standard product information of the consumption of energy and other resources by energy-related products that substantially replaces the Directive 1992/75/EEC on the indication by labelling and standard product information of the consumption of energy and other resources by household appliances.

Directive 2009/125/EC of the European Parliament and of the Council of 21 October 2009 establishing a framework for the setting of ecodesign requirements for energy-related products.

Directive 2004/8/EC of the European Parliament and of the Council of 11 February 2004 on the promotion of cogeneration based on a useful heat demand in the internal energy market.

Directive 2002/91/EC of the European Parliament and of the Council of 16 December 2002 on the energy performance of buildings.

Dumagan, J.C., Mount, T.D. (1993). Welfare effects of improving end-use efficiency: theory and application to residential electricity demand. Resour. Energy Econ. 15:175–201.

Ecofys, (2014). Evaluation of the Energy Labelling Directive and specific aspects of the Ecodesign Directive.

EEA, (2012). The European environment — state and outlook 2010: Consumption and the environment — 2012 update, European Environment Agency, Copenhagen, Denmark.

ENSPOL, (2015). D2.1.2: Report on Context Profiles of EU MS countries - Part III: Context analysis of countries with existing/planned EEOs. http://enspol.eu/sites/default/files/results/D2.1.2%20Report%20on%20Context%20Profiles%20of%

20EU%20MS%20countries%20-%20Part%20III%20Context%20analysis%20of%20countries%20with%20EEOs.pdf?v=2

Eto, J., Vine, E., Shown, L., Sonnenblick, R., Payne, C. (1996). The Total Cost and Measured Performance of Utility Sponsored Energy-Efficiency Programs. The Energy Journal 17 (1):31-52.

European Commission (2015). Evaluation of the Energy Labelling and Ecodesign Directives.

European Commission (2011). A Roadmap for moving to a competitive low carbon economy in 2050.

European Commission (2011). Energy roadmap 2050

European Commission (2011). Proposal for a Directive on Energy Efficiency. COM (2011) 70 final.

European Environment Agency (EEA) (2013). Achieving energy efficiency through behaviour change: what does it take? Copenhagen, Denmark. pp. 52.

Filippini, M., Hunt, L., Zoric, J. (2013). Impact of energy policy instruments on the estimated level of underlying energy efficiency in the EU residential sector. Surrey Energy Economics Centre.

Fischer, C. (2008). Feedback on Household Electricity Consumption: a Tool for Saving Energy? Energy Efficiency, Vol. 1, pp.79–104.

Frederiks, Elisha R., Stenner, Karen, V. Hobman, Elizabeth (2015). 'Household energy use: Applying behavioural economics to understand consumer decision-making and behaviour.' Renewable and Sustainable Energy Reviews, 41: 1385-1394.

Galvin, R. (2010). Thermal upgrades of existing homes in Germany: The building code, subsidies and economic efficiency. Energy and Buildings 42: 834-844.

Gaspar, R., & Antunes, D. (2011). Energy efficiency and appliance purchases in Europe: Consumer profiles and choice determinants. Energy Policy, 39(11), 7335-7346.

Geller, H., Attali, S. (2005). The Experience with Energy Efficiency Policies and Programmes in IEA Countries: Learning from the Critics. Paris, France: International Energy Agency.

Gerarden, T. D., Newell, R. G., & Stavins, R. N. (2015). Assessing the energy-efficiency gap (No. w20904). National Bureau of Economic Research.

Gillingham, K., R. Newell, K. Palmer, (2006). Energy Efficiency Policies: A Retrospective Examination. Annual Review of Environment and Resources, Vol. 31: 161-192.

Gillingham, K., Newell, R. G., & Palmer, K. (2009). Energy efficiency economics and policy. Annu. Rev. Resour. Econ., 1(1), 597-620.

Gillingham, K., Palmer, K. (2013). Bridging the Energy Efficiency Gap: Policy Insights from Economic Theory and Empirical Evidence. Resources for the future Discussion Papers. no-13-02-rev.

Gillingham, K., & Palmer, K. (2014). Bridging the energy efficiency gap: Policy insights from economic theory and empirical evidence. Review of Environmental Economics and Policy, 8(1), 18-38.

Gowdy, J. M. (2008). Behavioral economics and climate change policy. Journal of Economic Behavior & Organization, 68(3), 632-644.

Gram-Hansen, K., Scherg, R. H. and Christensen Skovgaard, R., (2009). One-person households — a growing challenge for sustainability and housing policy. Paper presented at ENHR, European Housing Research Network Conference '09, Prague, Czech Republic.

Green Paper: A 2030 framework for climate and energy policies COM(2013) 169 final.

Hamilton, I., Summerfield, A., Lowe, R., Ruyssevelt, P., Elwell, C., Oreszczyn, T. (2013). Energy epidemiology: a new approach to end-use energy demand research. Building Research & Information, 41:4, 482-497.

He, H. A., Greenberg, S., & Huang, E. M., (2010). One size does not fit all: applying the transtheoretical model to energy feedback technology design. Proceedings of the SIGCHI Conference on Human Factors in Computing Systems. ACM. 927-936.

Heiskanen, E., Johnson, M., Robinson, S., Vadovics, E., Saastamoinen, M. (2010). Low-carbon communities as a context for individual behavioural change. *Energy Policy* 38: 7586-7595.

Herring, H., (2006). Energy efficiency—a critical view. Energy 31, 10–20.

HM Government. (2012). Open Data White Paper: Unleashing the potential. London: The Stationery Office (TSO).

Howarth, B., Sanstad, A.H.(1995). Discount rates and energy efficiency. Contemporary Economic Policy, Volume 13, Issue 3, pages 101–109.

IEA (2014). Capturing the Multiple Benefits of Energy Efficiency. OECD/IEA, Paris. http://www.iea.org/publications/freepublications/publication/Captur_the_MultiplBenef_ofEnergyEfficiency.pdf

IEA, (2013). Energy Provider-Delivered Energy Efficiency. OECD/IEA, Paris.

IEA, (2011). Energy efficiency policy and carbon pricing. OECD/IEA, Paris.

Irrek, W., Bertoldi, P., Labanca, N., & Suerkemper, F. (2013). ESCOs for residential buildings: market situation in the European Union and policy recommendations.

Jacobsen, G., Kotchen, M. (2012). Are Building Codes Effective at Saving Energy? Evidence from Residential Billing Data in Florida. Review of Economics and Statistics forthcoming.

Jaffe, A., Stavins, R. (1994). The Energy-Efficiency Gap: What Does It Mean? Energy Policy 22(1): 804–810.

Joskow, P.L., Marron, D.B. (1992). What Does a NegaWatt Really Cost? Evidence from Utility Conservation Programs. The Energy Journal, 13, 41-73.

Kang, N.N., Choa, S.H. and Kim, J.T. (2012). The energy-saving effects of apartment residents' awareness and behavior. Energy and Buildings, 46, 112–122.

Kavousian, A., Rajagopal, R., & Fischer, M. (2013). Determinants of residential electricity consumption: Using smart meter data to examine the effect of climate, building characteristics, appliance stock, and occupants' behavior. Energy, 55, 184-194.

Labanca, N., Suerkemper, F., Bertoldi, P., Irrek, W., & Duplessis, B. (2015). Energy efficiency services for residential buildings: market situation and existing potentials in the European Union. Journal of Cleaner Production, 109, 284-295.

Lopes, M. A. R., Antunes, C. H., & Martins, N. (2012). Energy behaviours as promoters of energy efficiency: A 21st century review. Renewable and Sustainable Energy Reviews, 16(6), 4095-4104.

Lourdel, N., Martin, J., Bérerd, O. (2006). Overcoming obstacles to understanding sustainable development–an approach based on personal experiences. In EESD 06 Conference. Lyon.

Malm, E. (1996). An Action-Based Estimate of the Free-Rider Fraction in Electric Utility DSM Programs. The Energy Journal, Vol.17:41-48.

Marino, A., Bertoldi, P., Rezessy, S., & Boza-Kiss, B. (2011). A snapshot of the European energy service market in 2010 and policy recommendations to foster a further market development. Energy Policy, 39(10), 6190-6198.

Markowitz, E. M., Goldberg, L. R., Ashton, M. C., & Lee, K., (2012). Profiling the "pro-environmental individual": A personality perspective. J. Pers. 80(1), 81-111.

Mattinen, M., Antikainen, R., Salo, M., & Suomen ympäristökeskus. (2014). Resource wise trials - Jyväskylän resurssiviisaiden kokeilujen vaikutusarviointi sekä laajenemisvaikutukset Sitran selvityksiä 75.

Mills, B., & Schleich, J. (2010). What's driving energy efficient appliance label awareness and purchase propensity?. Energy Policy, 38(2), 814-825.

Nissinen, A., Heiskanen, E., Perrels, A., Berghäll, E., Liesimaa, V., & Mattinen, M. K. (2015). Combinations of policy instruments to decrease the climate impacts of housing, passenger transport and food in Finland. *Journal of Cleaner Production, 107*, 455-466.

Noailly, J. (2012). Improving the energy efficiency of buildings: The impact of environmental policy on technological innovation. Energy Economics 34, 795-806.

OECD (2011). OECD Green Growth Studies: Energy.

OECD/IEA, (February 2007). Financing Energy Efficient Homes Existing policy responses to financial barriers.

Pätäri, S., & Sinkkonen, K. (2014). Energy Service Companies and Energy Performance Contracting: is there a need to renew the business model? Insights from a Delphi study. *Journal of Cleaner Production, 66*, 264-271.

PATWAYS, (2015). Exploring transition pathways to sustainable, low carbon societies. http://www.pathways-project.eu/sites/default/files/Country%20report%204%20German%20heat%20regime.pdf

Polimeni, J., Mayumi, K., Giampietro, M., and Alcott, B (2008). Jevons' Paradox: the Myth of Resource Efficiency Improvements. Earthscan Research Edition, London, 192 pp.

Pollitt, M. G., & Shaorshadze, I. (2011). The role of behavioural economics in energy and climate policy.

Polytechnic University of Milan (2017). Energy Efficiency Report. La filiera dell'Efficienza Energetica in Italia. Energy & Strategy Group. http://www.energystrategy.it/assets/files/EER_17_conCover_alta.pdf

Rudin, A. (1999). How Improved Efficiency Harms the Environment. http://home.earthlink.net/~andrewrudin/article.html

Sælen, H., Westskog, H. (2013). A Multi-Method Evaluation of the Potential for Using the Electricity Bill to Encourage Energy Savings in Norwegian Households. Energy and Environment Research.

Sallee, J. M. (2014). Rational inattention and energy efficiency. The Journal of Law and Economics, 57(3), 781-820.

Salo, M., Nissinen, A., Liija, R., Olkanen, E., O'Neil, M., & Uotinen, M. (2014). Education, training, tools and services to enhance sustainable household consumption. Paper presented at the 17th European Roundtable on Sustainable Consumption and Production, Portoroz, Slovenia,14.-16.10.2014.

Santin, O. G., Itard, L., & Visscher, H. (2009). The effect of occupancy and building characteristics on energy use for space and water heating in Dutch residential stock. Energy and buildings, 41(11), 1223-1232.

Saussay, A., Saheb, Y., Quirion P. (2012). The Impact of Building Energy Codes on the Energy Efficiency of Residential Space Heating in European countries – A Stochastic Frontier Approach. International Energy Program Evaluation Conference, 12–14 June 2012, Rome.

Schultz, P., Nolan, J., Cialdini, R., Goldstein, N., Griskevicius, V. (2007). The constructive, destructive, and reconstructive power of social norms. Psychological Science, 18(5), 429-434.

SEC (2011) 276 final. National Energy Efficiency Action Plans (NEEAPs): update on implementation.

Sinkkonen, A. (2013). Barriers of ESCO Services Business in Finland: Lappeenranta University of Technology.

Spaargaren, G. (2003). Sustainable Consumption: A Theoretical and Environmental Policy Perspective, Society and Natural Resources, vol. 16, p. 687-701.

Steg, L. (2008). Promoting household energy conservation. Energy Policy, 36, 4449–4453.

Stern, P. (1992). What Psychology Knows about Energy Conservation. American Psychologist, Vol. 47, No. 10, pages 1224-1232.

Stieß, I., Fischer, C., Kunkis, M. (2015). Power Efficiency Classes for Households – a comparative feedback approach for speeding up energy efficiency on a household level. Institute for Social-ecological Research, Paper ID 8-039-15 Stieß.

Todd, A., Perry, M., Smith, B., Sullivan, M., Cappers, P., Goldman, C. (2014). Insights from Smart Meters: Identifying Specific Actions, Behaviors, and Characteristics That Drive Savings in Behavior-Based Programs. State and Local Energy Efficiency Action Network.

Trotta, G., Kalmi, P., Kazukauskas, A. (2017). The role The Role of Energy Literacy as a Component of Financial Literacy: Survey – based evidence from Finland. IAEE Conference 2017. https://www.eeg.tuwien.ac.at/conference/iaee2017/files/paper/381_Kalmi_fullpaper_2017-09-01_14-52.pdf

Tukker, A., Mont, O., Lorek, S., Diaz-Lopez, F., Spangenberg, J., Giljum, S., et al. (2008). Sustainable Consumption Policies Effectiveness Evaluation (SCOPE2) - Final Report. Delft: TNO, IIEEE, SERI.

Vadovics, E., Antal, O., Gáll, V., Vadovics, K. (2012). Kislábnyom projektbemutató kiadvány esettanulmányokkal a mindennapi kislábnyomos életmódról. pp. 48. [Case studies of everyday small-footprint and sustainable living] GreenDependent Sustainable Solutions Association, Hungary.

Vadovics, E. and Boza-Kiss, B. (2013). Voluntary consumption reduction – experience from three consecutive residential programmes in Hungary. Residential energy master as a new carrier? In: Proceedings of the SCORAI Workshop, June 2013, Istanbul.

Vine, E., Du Pont, P., Waide, P. (2001). Evaluating the Impact of Appliance Efficiency Labeling Programs and Standards: Process, Impact, and Market Transformation Evaluations. Energy, 26, 1041-1039.

Vringer, K., Aalbers, T., Kornelis, B. (2007). Household energy requirement and value patterns. Energy Policy 35 p. 553–566.

Young, D., (2008). When do energy-efficient appliances generate energy savings? some evidence from Canada. Energy Policy 36, 34–46.

York, R., Rosa Eugene, A., Dietz, T. (2005). The Ecological Footprint Intensity of National Economies. Journal of Industrial Ecology, vol. 8, 139-154.

Williams, J., (2007). Innovative solutions for averting a potential resource crisis—the case of one-person households in England and Wales. Environment, Development and Sustainability 9(3), pp. 325–354.

Various country reports are accompanying this deliverable. They served as source for the contry related information presented here and provide a broad variety of additional, indepth information.

Benkő, I., Járy, K., Molnár, J. Péter, E., Lorek, S. and Trotta, G. (2015). Consumers and Energy Efficiency – **Country Report Romania**. An inventory of policies, business and civil society initiatives, focusing on heating, hot water and the use of electricity. *EUFORIE – European Futures for Energy Efficiency.*

Brizga, J., Trotta, G. and Lorek, S. (2015). Consumers and Energy Efficiency – **Country Report Latvia**. An inventory of policies, business and civil society initiatives, focusing on heating, hot water and the use of electricity. *EUFORIE – European Futures for Energy Efficiency.*

Lorek, S. and Trotta, G. (2015). Consumers and Energy Efficiency – **Country Report Finland**. An inventory of policies, business and civil society initiatives, focusing on heating, hot water and the use of electricity. *EUFORIE – European Futures for Energy Efficiency.*

Lorek, S. (2015). Finnish country report - Interviews. EUFORIE – European Futures for Energy Efficiency. Internal document.

Slezák, J., Vadovics, E., Trotta, G., Lorek, S. (2015). Consumers and Energy Efficiency – **Country Report for Hungary**. An inventory of policies, business and civil initiatives at the national level, focusing on heating, hot water and the use of electricity. December, 2015. *EUFORIE – European Futures for Energy Efficiency.*

Trotta, G. and Lorek, S. (2015). Consumers and Energy Efficiency – **Country Report Spain**. An inventory of policies, business and civil society initiatives, focusing on heating, hot water and the use of electricity. *EUFORIE – European Futures for Energy Efficiency.*

Trotta, G. and Lorek, S. (2015). Consumers and Energy Efficiency – **Country Report United Kingdom**. An inventory of policies, business and civil society initiatives, focusing on heating, hot water and the use of electricity. *EUFORIE – European Futures for Energy Efficiency.*

Trotta, Gianluca; Ripa, Maddalena and Lorek, Sylvia (2015). Consumers and Energy Efficiency – **Country Report Italy**. An inventory of policies, business and civil society initiatives, focusing on heating, hot water and the use of electricity. *EUFORIE – European Futures for Energy Efficiency.*