Guillermo Ivan de Loureiro Pereira

Connecting energy efficiency progress and job creation potential

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Master of Science in Energy for Sustainability

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ENERGIA PARA A SUSTENTABILIDADE
ENERGY FOR SUSTAINABILITY · EFS

Guillermo Ivan de Loureiro Pereira

Connecting energy efficiency progress and job creation potential

Master Dissertation in Energy for Sustainability, developed on the specialization branch in Energy Systems and Policy, presented to the Faculty of Science and Technology of the University of Coimbra, as part of the requirements for the award of the Master Degree.

Supervisor: Professor Patrícia Pereira da Silva Ph.D
Co-Supervisor: Professor Carla Oliveira Henriques Ph.D

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“The scientific man does not aim at an immediate result.
He does not expect that his advanced ideas will be readily taken up.
His work is like that of the planter — for the future.
His duty is to lay the foundation for those who are to come,
and point the way. He lives and labours and hopes.”

Nikola Tesla

In Modern Mechanics and Inventions (July 1934)

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ABSTRACT

The role of Energy Efficiency (EE) has evolved beyond its contribution towards a more sustainable energy system, being recognised as a way to foster socio-economic development and reduce climate change.

This dissertation presents a contribution, deriving from a Business Administration perspective, regarding EE progress and job creation potential.

Firstly, an analysis of the EE scenario for the European Union (EU) is disclosed, focusing on Member States and EU level actions. The review of progress indicators serves as input for a governance analysis and to outline strategies through a SWOT analysis.

Secondly, a review of studies on EE job creation potential is developed. This review is further complemented by an experimental study conducted in Portugal, developed in collaboration with the Portuguese Renewable Energy Association (APREN), based on an industry survey as a method to gather real data on jobs in the EE sector.

The research results reveal a general positive EE progress, and validate its potential to create jobs in a period when unemployment is a major concern. The EU and Member States have to focus on the opportunities of the available EE frameworks to tackle current barriers and challenges, as well as realise the existing and identified EE potential, especially in the industry and transportation sector.

Moreover the experimental study, conducted on organisations operating in the EE industry, outlined positive impacts on employment through the years of 2010 to 2012 where unemployment reached its highest rates in Portugal, enhancing the importance of studying such indirect benefits of EE investments.

Keywords: energy efficiency, job impacts, SWOT analysis, energy strategy, European Union, Portugal.

RESUMO

O papel da Eficiência Energética (EE) tem evoluído para além do seu contributo direto num sistema energético sustentado, sendo agora reconhecido por contribuir para o desenvolvimento socioeconómico e para a redução das alterações climatéricas.

A presente dissertação foi elaborada numa perspetiva oriunda de conhecimentos em gestão, contribuindo para a compreensão do progresso da EE e do seu potencial para a criação de emprego.

A primeira parte deste trabalho apresenta uma análise ao cenário da EE na União Europeia (UE), focando-se nas ações desenvolvidas ao nível dos Estados-Membros e da UE. O conjunto dos indicadores revistos serviu como base para uma análise do estado da governação, bem como para delinear estratégias através de uma análise SWOT.

Em segundo lugar, é apresentada uma revisão de estudos baseados no potencial para a criação de empregos da EE. Esta revisão é complementada pela aplicação de um estudo empírico em Portugal, desenvolvido em colaboração com a Associação Portuguesa de Energias Renováveis (APREN), baseado num questionário à indústria como método para a obtenção de dados reais sobre o emprego no sector da EE.

Os resultados obtidos revelam um progresso positivo da EE e validam o seu potencial para a criação de emprego, num momento em que a redução do desemprego é prioridade. A UE e os Estados-Membros devem focar-se nas oportunidades existentes, de forma a reduzir as barreiras e os desafios presentes, bem como realizar o potencial existente e já identificado da EE, particularmente no sector industrial e dos transportes.

Por fim, o estudo empírico conduzido em organizações inseridas na indústria da EE demonstrou um impacto positivo no emprego, entre 2010 e 2012, momento em que as taxas de desemprego alcançaram valores mais elevados em Portugal, evidenciando a importância de estudar os benefícios/impactos indiretos de investir na EE.

Palavras-chave: eficiência energética, impactos no emprego, análise SWOT, estratégia energética, União Europeia, Portugal.

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ABBREVIATIONS & ACRONYMS	MEANING
ACEEE	American Council For An Energy Efficient Economy
ADEME	Agence De L'environnement Et De La Maîtrise De L'energie
ADENE	Agência Para A Energia
AEC	Association For Energy Conservation
APREN	Associação Portuguesa De Energias Renováveis
B€	Billion Euros
BCP	Best Case Practice
CA	Canada
CEDEFOP	European Centre For The Development Of Vocational Training
CHP	Combined Heat And Power
CHPD	Combined Heat And Power Directive
CMI	Construction, Manufacturing And Installation
CO_2	Carbon Dioxide
DECC	Department For Energy And Climate Change
DEP.	Department
DGEG	Direcção Geral De Energia E Geologia
EC	European Commission
ECEEE	European Council For An Energy Efficient Economy
EE	Energy Efficiency
EEA	European Environmental Agency
EED	Energy Efficiency Directive
EEW	Energy Efficiency Watch
EFS	Energy For Sustainability Initiative
EP	European Parliament
EPBD	Energy Performance Of Buildings Directive
EU	European Union
EUCO	European Council
EUSEW	European Union Sustainable Energy Week
FTE	Full Time Equivalent
GDP	Gross Domestic Product
GHG	Greenhouse Gases
GWH	Giga Watt Hours
HEES	Home Energy Efficiency Scheme
HPI	High Policy Intensity
IEA	International Energy Agency
IEE	Intelligent Energy Europe
INE	Instituto Nácional De Estatística
INESCC	Instituto De Engenharia De Sistemas E Computadores De Coimbra
IPCC	Intergovernmental Panel On Climate Change
KM	Kilometre
KOE	Kilogram Oil Equivalent
LPI	Low Policy Intensity
M$USD	Million United States Dollars
M£	Million Great-Britain Sterling Pounds
M€	Million Euros
MTOE	Million Tons Of Oil Equivalent
MURE	Measures D’utilisation Rationelle De L’energie

N.A.	Information Not Available
N.I.	Information Not Identified
NO.	Number
NPO	Non-Profit Organizations
NUTS	Nomenclature Of Territorial Units For Statistics
NZEB	Nearly Zero Energy Buildings
O&M	Operation & Maintenance
OECD	Organization For Economic Co-Operation And Development
OPEC	Organization Of The Petroleum Exporting Countries
PPP	Purchase Power Parities
PV	Photovoltaic
R&D	Research And Development
RE	Renewable Energy
RES	Renewable Energy Sources
SEAP	Sustainable Energy Action Plan
SMEs	Small And Medium Enterprises
SWOT	Strengths, Weaknesses, Opportunities And Threats.
UN	United Nations
USA	United States Of America
WEC	World Energy Council

1. INTRODUCTION

Developing a sustainable energy system is becoming a globally shared concern, thus shaping it to be more secure and accessible, less harmful to people and the environment, whilst contributing to economic and social development is a critical path to follow (IPCC, 2012). The level of effort set to achieve such scenario will directly impact the quality and availability of resources for current and forthcoming generations, possibly changing their living standards and ability to survive on Earth, given the heavier burden on the environment and people caused from a less rational use of the available resources.

The efforts needed towards a more sustainable use of energy gain priority when global primary energy consumption demand is expected to rise over one-third[1] in the period from 2010 to 2035 (IEA, 2012a), accompanied with a population growth of approximately 1.7 billion for the same period.

The challenges for providing the required energy services enhance the risks of shortage of supply, unbalanced distribution, and access to energy. The consequences of energy consumption growth account for various factors, one of the most dangerous being climate change through the increase of CO_2 emissions and other hazardous greenhouse gases (GHG).

In order to address the current and upcoming energy challenges a set of measures and actions have been implemented. Initiatives such as the United Nations (UN) – Sustainable Energy for All (UN, 2012) are built upon large scale objectives. In this initiative the UN aims to: (1) double the rate of energy efficiency, (2) double the share of renewable energy in the global energy mix and (3) ensure universal access to modern energy services.

A more regionally focused initiative consists on the Covenant of Mayors (Covenant of Mayors, 2013) developed as an European level action where Mayors and Municipalities commit to exceed the European Union (EU) goals for 2020, being these: 20% increase on renewable energy generation, 20% reduction on GHG emissions and 20% increase of energy efficiency.

[1] This projection is presented by the International Energy Agency (IEA) World Energy Outlook (IEA, 2012a) based on IEA's New Policies Scenario, taking into account broad policy commitments and plans that have already been implemented to address energy related challenges as well as those that have been announced, even where the specific measures to implement these commitments have yet to be introduced.

The priority to invest comprehensively and enthusiastically on a new energy use scenario is hence justified by the fact that the energy sector is by far the largest source of GHG emissions, accounting for more than two-thirds of the total emissions in 2010, 90% of these being CO_2 (IEA, 2013). The scope of the possible measures to be implemented to accomplish this shift on energy use is wide-ranging. Actions on the supply side by increasing the security of supply through clean and more effective technologies are in the roadmap combined with demand side initiatives that aim at increasing the levels of efficiency throughout generation, transmission and end-uses of energy.

This research project focuses on the demand side of the energy system, specifically on understanding energy efficiency (EE) throughout the European Union (EU) and the assessment of indirect benefits, namely job impacts. For the previous, an experimental study was developed in Portugal in order to assess EE job impacts and future trends.

1.1. RESEARCH FRAMEWORK

EE has the potential to reduce energy demand growth and energy imports, whilst mitigating pollution and reducing climate change impacts. As stated by the IEA (2012a) this potential has been acknowledged by the major energy consuming economies, which have enacted legal instruments aiming to foster EE improvements, some of the set ambitions include: (1) 16% reduction in energy intensity in China, (2) new fuel-economy standards for the United States, (3) 10% electricity demand reduction in Japan and (4) 20% primary energy consumption reduction in the EU.

On the scope of this research, focusing on the EU is critical given that although of the existing strategies and legislative instruments, the EE improvements have been reported as evolving to only half of the 20% headline target set to 2020 (EC, 2011a, 2011b, 2011c, 2013a), putting at risk the achievement of the energy agenda for Europe and the delivery of its direct and indirect benefits.

The European Commission (EC, 2013b) stated that shifting to an energy efficient scenario and achieving the 20% energy savings by 2020 target, would avoid the import of 2,6 billion oil barrels, or account to savings of 193 billion euros[2]. This saving potential is equivalent to 1000 less coal power plants or 500 000 less wind turbines, also a close equivalent to the Portuguese GDP (EC, 2013b).

[2] Money savings calculated at 73 euros per barrel price, per year.

The realization of this potential is currently being sustained at the core of EU’s growth strategy known as *Europe 2020 Strategy* (EC, 2010a), by the newest overarching EE legislative instrument, the EU Energy Efficiency Directive (EU, 2012a), and by support initiatives which focus on developing a sustainable energy system for Europe. In spite of the efforts from the EU and Member States on moving forward, different barriers inhibit a good understanding of the state of development of EE in the EU, those motivating the current research project are:

(1) Understanding EE improvements and future targets across the EU is a challenging task, this difficulty is evident when analysing assessment reports and communications on EE, which often fail to provide a comparable framework to identify the level of achievement of the EE targets, given the use of different target years or savings measures (EC, 2013a, 2013c, 2013d). In addition, on the scope of the EU energy goals for 2020, the EE target is the most difficult to understand, given the common lack of data from Member States or the method used to report the achieved development or future targets, as well as the wide-range of actions, which contribute to the EE goal but that are not always tracked.

(2) Sideways from the direct energy related benefits of improving EE, a breadth of indirect benefits, result from improving EE, as presented by the IEA (2012b). Job creation is one of the indirect benefits frequently advertised with EE improvement measures across the EU. A potential 2 million jobs are presented across communications and reports, as a result of delivering the EU EE target by 2020 (EC, 2012a, 2012b, 2013e; Rademaekers et al., 2012). Nonetheless limitations to measure the current status of this job creation potential are also acknowledged by the EC (EC, 2012a) and also by Portuguese authorities (PT, 2013), given the lack of data and methodologies to track the evolution. Understanding the impact of EE on jobs creation is an important priority considering the high unemployment level across EU Member States, and the case of Portugal reaching 17.53% in the first quarter of 2013 (EUROSTAT, 2013).

These barriers represent obstacles on understanding the delivery of two key action areas of the *Europe 2020 Strategy* (EC, 2010a): (1) the Climate and Energy action area, on the delivery of the EE target and (2) the Employment action area, specifically on the jobs expected to be created through EE. The intertwined relationship between these two action areas defines the core framework of the research project presented in this Dissertation.

1.2. RESEARCH STRATEGY

The research strategy defined for the Dissertation consists on (1) an analysis of EE progress in the EU by assessing the state of implementation of EE improvement measures by Member States through a *bottom-up analysis* whilst considering the impacts and extent of *top-down* initiatives, in parallel with (2) an analysis of EE job impacts, complemented by an experimental study developed in Portugal.

1.2.1. ENERGY EFFICIENCY PROGRESS IN THE EU

The analysis of the EE progress in the EU aims to enable an understanding of the pattern of implementation of actions and measures to achieve the proposed EE target in the EU for 2020. The development of this analysis is centred on obtaining, aggregating and analysing data at national, regional and pan European level.

The development of this analysis provides the insights for the following research questions:

(1) How is EE driven across the EU from a *top-down* perspective?

(2) What is the current scenario on Member States action towards EE improvements?

(3) Is the EE target on track for 2020?

1.2.2. ENERGY EFFICIENCY JOB IMPACTS

On the scope of the multiple benefits of EE identified in the literature (Dietsch, 2007; IEA, 2012b; Rutovitz & Atherton, 2009), which have the potential to drive a new stream of EE improvements by increasing the perception of a higher social value to be generated from policies and actions that aim at its improvement. Job creation is presented as part of these multiple benefits, representing a key benefit for the EU. Nonetheless impact analyses of this benefit are limited considering the wide scope of action within the EE industry.

This analysis was designed to provide an updated overview on current studies and trends, focusing not only in the EU but also on other cases across the globe given the limited literature on this benefit of EE.

In combination with the analysis of the existing literature on EE jobs impacts, an experimental study was developed in Portugal, which had the goal to collect data and outline the impacts of EE in jobs on the Portuguese EE industry.

The analysis of EE job impacts, in parallel with the development of the experimental study, has the goal to provide insights for the following research questions:

(1) What is potential of EE to create jobs?

(2) What are the key challenges on measuring EE job impacts?

(3) What are the impacts of the EE industry on Portuguese jobs?

1.2.3. KEY RESEARCH OUTPUTS

The development of the strategies presented above converge with the main goal of the research project which aims at answering the following questions:

(1) Is the EU on track to deliver the complete range of benefits dependant on the EE target by 2020?

(2) What is missing in terms of Member States action?

(3) Is job creation through EE evolving as expected by 2020?

Addressing these research questions requires a blended perspective of the EU actions and Member States progress, both on direct and indirect EE benefits. Therefore the developed strategy of the Dissertation bridges two main areas: (1) Sustainable growth through the analysis of EE and its contribution for a resource efficient Europe, and (2) Inclusive growth on understanding the EE impacts on job creation and the potential for the future.

1.3. DOCUMENT STRUCTURE

The Dissertation document is organized according to the proposal on the Applied Research Project, presented to the Supervisor Professor Patrícia Pereira da Silva Ph. D. and to the Co-supervisor Professor Carla Oliveira Henriques Ph. D. in June, 2013, as defined in the guidelines for the development of the Master Degree Dissertation in Energy for Sustainability for the Master Degree award by the University of Coimbra.

The contents included throughout the Chapters represent the key results of the research and state of the art analysis. Further elements are included in the annexes which complement conclusions presented in the chapters.

The following diagram (Figure 1.1) outlines the content flow, through which this document is structured.

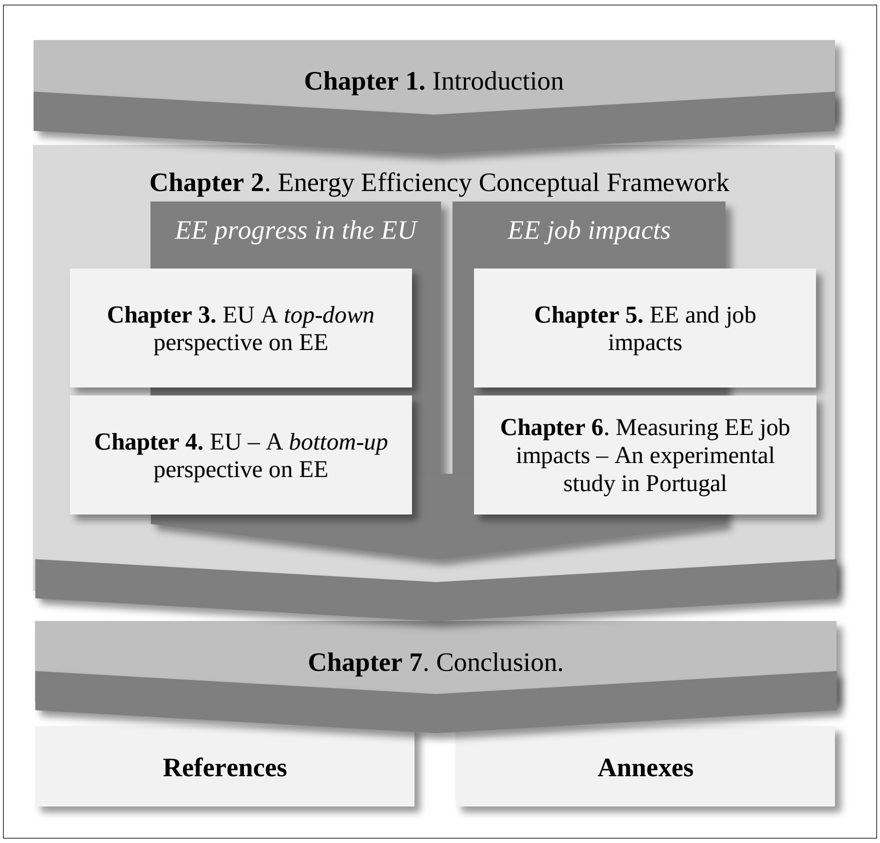


Figure 1.1 – Document structure flow. Source: Author.

The document, as presented above, is organized through seven chapters, references and annexes.

Chapter 1 embodies the starting point of the Dissertation providing the overarching motivation, framework and strategy for the development of the Applied Research Project.

After introducing the research project, Chapter 2 outlines the EE conceptual framework. This chapter should be seen as a foundation for the entire document, as the breadth of definitions, constraints and benefits are important for understanding the outputs of the two research strategies: (1) EE progress in the EU and (2) the EE job impacts analysis.

The analysis of *EE progress in the EU* is developed through the next two Chapters. Chapter 3 encompasses a analysis of the EU level actions towards EE, herein presented as *top-down* perspective. The range of strategic, legislative and support mechanisms available are analysed, as well as the expected impacts and evolution for the future, towards 2020 and 2050, according to the energy strategies for these target years.

Presenting the results from the EU Member States analysis, Chapter 4 completes the analysis of *EE progress in the EU* by disclosing the most recent available indicators and data on EE development across EU countries, herein presented as *bottom-up* perspective.

This includes the latest EE targets yet to be approved by the European Commission (EC), the evaluation of the second National Energy Efficiency Action Plans (NEEAPs) implemented by Member States, and the application of an EE governance assessment methodology developed by Jollands & Ellis (2009a). Furthermore, Chapter 4 bridges the two perspectives researched (i.e.: *top-down* and *bottom-up),* presenting a proposal for a scheme to foster a deep understanding of EE across the EU.

The research strategy focusing on *EE job impacts* is developed through Chapters 5 and 6. Chapter 5 establishes the connection between EE and jobs, outlining the intertwined EU level actions that focus on EE and their potential to deliver *green jobs* across sectors and provides definitions and concepts to understand job impacts studies regarding EE actions. In addition, an analysis of existing studies is developed resulting in the definition of a job creation potential from EE based on the available literature, as well as global and EU level trends for EE job creation in the future.

Chapter 6 reveals the methodology and results of the experimental study conducted in Portugal on measuring EE job impacts across the country. Ambitioning to contribute to the identified gaps in existing data and methods to assess job impacts, the case study for Portugal is presented in detail, serving as a potential tool to be used by other Member States or any other country outside the EU. To enhance the possibilities of methodology uptake by other entities, a critical analysis is presented enhancing the main limitations on developing the experimental study.

Aggregating the main results and outputs of the research developed, Chapter 7 beholds the key outcomes obtained on the scope of the research strategy. Future work is suggested both for the understanding of EE progress, the deployment of job creation studies across the EU, and for the relation between these two strategies. The main obstacles faced by the author during the research development process are expressed, outlining the underpinning steps on the research project development.

2. ENERGY EFFICIENCY CONCEPTUAL FRAMEWORK

Energy efficiency benefits and impacts on the energy system have been recognized over the years. In the 1970s and beginning of the 1980s, due to the oil crisis that led nations to plan new ways to source their needs and secure the necessary energy supply (Bosseboeuf *et al.*, 1997; Neves *et al.*, 2009; Ruffa *et al.*, 2012), the role of EE has thus evolved shaped by changes verified in the social, economic and technological structures. As stated by Patterson (1996), EE is an important element of the public policy agenda in industrialized countries. This importance arises from the overall benefits impacting commercial and industrial activities, as well as its environmental benefits to reduce CO_2 emissions.

The evolution of the concept and importance that EE holds up until today was built with the intertwined contributions of different areas of expertise. These concepts lead to various characterizations and definitions that must be presented to set the framework for an understanding of its progress and potential. This chapter presents the key definitions related to EE, a description of the EE paradox and its wide range of associated direct and indirect are also presented.

2.1. DEFINING ENERGY EFFICIENCY

As referred by Oikonomou *et al.* (2009) the term – *energy efficiency* – is used in a wide spectrum of cases, applied on various situations and often with the goal to encompass different meanings, as well as explain different phenomena. While addressing energy efficiency discussions, the terms – *energy efficiency*, and *energy conservation* – are also used as if these were synonyms (Herring, 2006; Oikonomou *et al.*, 2009), however these two terms have different meanings.

According to Dietsch (2007), these terms can be defined as:

- Energy efficiency: consists on the use of less energy, whilst achieving the same or a higher standard of quality by the consumer or also, using less energy to achieve the same results/outputs.
- Energy conservation: is related to the reduction of energy use through the reduction of the energy services, or the reduction of their quality, which are

obtained by the consumer (e.g. not using the car to go to work, whilst on the energy efficiency term a more energy efficient car would be used to go to work).

These two terms can also be found in other literature references, as Herring (2006) and Oikonomou *et al.* (2009).

Reaching consensus on what EE is and how it should be acknowledged is a challenging task. A selection of definitions and standpoints on the subject of EE from different authors can be found below (Table 2.1):

Table 2.1 – EE definitions from different authors.

Author	EE definitions and standpoints
(Lovins, 2004)	"Broadly, any ratio of function, service, or value provided to the energy converted to provide it. "
(Schipper and Haas, 1997 *apud* Herring, 2006)	Energy efficiency is simply the ratio of energy services out to energy input. It means getting the most out of every unit of energy you buy. It is mainly a technical (and historic) process caused by stock turnover where old equipment is replaced by newer more efficient ones. It is generally a by-product of other social goals: productivity, comfort, monetary savings, or fuel competition. Measuring energy efficiency, particularly on a macro scale, is fraught with methodological problems and is very hard to measure over time, and between countries or sectors.
(Hanley *et al.*, 2009)	"Energy efficiency is *doing more with less,* therefore reducing the energy requirements associated with a given level of economic activity."
(Linares, 2010)	"Energy Efficiency is the improvement (increase) in the efficiency with which energy is used to provide a certain product or service, measured in units of output per energy unit."
(World Energy Council, 2010)	EE improvements consist on the reduction in the energy used for a given service (i.e. lighting, heating, cooling, etc.) or activity. This reduction is mainly associated with technological improvements, although it may also result from organizational or behavioural changes – being these non-technical drivers.
(Croucher, 2011)	"Energy efficiency typically focuses on adjusting input requirements for a particular consumption decision (output)—typically by reducing the electricity-intensive nature of the production process."
(Ruffa et al., 2012)	"[…] energy efficiency encompasses a set of activities that seek to optimize the use of energy resources in a more sustainable way."

Although deriving from different experts, scientists and associations that focus on EE issues, by observing the sample of definitions presented (Table 2.1) it is possible to find in any given case, the sense of – *doing more with less*. Some authors present their concern on the perspectives that should be taken into consideration (Patterson, 1996; Schipper and Haas, 1997 *apud* Herring, 2006) others present a broader view on what EE is and how it can be achieved (World Energy Council, 2010).

2.2. ENERGY EFFICIENCY CONSTRAINTS

Reducing the energy consumption to obtain the same level of energy services or to increase the level of energy services obtained from the same energy input seems reasonable in the context of EE. Nonetheless, achieving such scenario is compromised by a set of limitations: (1) the rebound effect, (2) the EE paradox and the EE barriers. These limitations and how they impact the realization of EE are now described.

2.2.1. REBOUND EFFECT

The development of technology allows more energy efficient equipment to be made available for consumers (Berkhout *et al.*, 2000 and Dietsch, 2007). However, as stated by Greening *et al.* (2000) the potential reductions that would be possible from these technologically improved devices may be reduced by the rebound effect.

Given that less energy is needed to obtain the same level of energy service[3], using the same equipment, the unitary costs of the service provided diminish (e.g.: if a bus can drive more kilometres with one litre of diesel, then the cost per kilometre falls). A price decrease tends to lead to increased consumption and in this scenario, consumers will tend to consume more energy services, increasing their energy consumption.

In general terms, rebound effect consists in the increase of energy services supplied with the corresponding decrease of effective price. The lost part of the possible energy efficiency improvements is thus the rebound effect (Berkhout *et al.*, 2000). The rebound effect as presented above can be divided into three main types (Maxwell *et al.*, 2011):

(1) **Direct rebound effect** occurs when the increased efficiency of a good or service results in a lower cost of consumption. As a result of this reduction in the cost, more consumption of this good or service occurs.

(2) **Indirect rebound effect** is the result of efficiency cost reductions in a given good or service that leads to an increase in the demand for another good or service.

An example for this type of rebound effect is of a household that manages to save electricity over the year from improved EE appliances and uses the saved money to buy more appliances, thus increasing energy consumption.

[3] Energy services consist on the commodity, which is actually used or demanded (i.e., refrigeration, hot water, and process heat) (Greening *et al.*, 2000).

The previous types of rebound effects (1) and (2) consist of microeconomic level effects and can be observed at individual, company and household levels. Whilst economic wide rebound effects are observed at a macroeconomic level.

(3) **Economic wide rebound effect** occurs when more efficient production drives a productivity increase that results in more energy being consumed at a macroeconomic level.

In this context, the rebound effect was therefore presented as a constraint to EE given that, regardless of the EE improvements the overall growing consumption of energy can counteract the expected gains for a given EE investment (Maxwell *et al.*, 2011). Further discussion under the implications and empirical evidence on the rebound effect are presented by Herring (1998), Berkhout *et al.* (2000) and Saunders (2000).

As stated by Berkhout *et al.* (2000) the rebound effect has been recognised by scientists considering: (1) the substitution effect, if energy becomes cheaper, then individuals will increase their demand for energy services; (2) the income effect, if households benefit financially from EE then the disposable income obtained will be used in other activities that increase energy consumption.

Illustrating the evidence on the existence of the rebound effect, data from the International Energy Agency (IEA), presents its magnitude in different goods and services.

Table 2.2 – Direct rebound effect estimates. Source: (IEA, 2005 *apud* Maxwell *et al.*, 2011)

Sector	Field of application	Direct rebound effect
Private Households	Heat	10 – 30%
Private Households	Air Conditioning	0 – 50%
Private Households	Hot water	<10 – 40%
Private Households	Lighting	5 – 12%
Private Households	White goods	0%
Private Households	Cars	10 – 30%
Industry and Commerce	Lighting	0 – 2%
Industry and Commerce	Process Technology	0 – 20%

Observing the set of ranges presented (Table 2.2), although some reach concerning values that can backlash the potential EE savings forecasted, other cases represent a lower priority to be considered by policymakers as a concern (Berkhout *et al.*, 2000). An example of this is the estimated rebound effect in lighting at private households. Even though it can reach up to 12%, the share of energy use by lighting in the overall energy consumption is not significant so, in most cases, no instrument to tackle the rebound effect is included in energy efficiency policies for lighting measures. This is due to the fact that in these cases the technological efficiency progress enabled is mildly offset by behavioural changes.

Whereas an instrument is required to tackle the rebound effect on sectors with a higher risk for offsetting EE improvements, the following instruments are pointed by Maxwell *et al.* (2011) as key categories[4] for action when designing mechanisms to reduce the rebound effect:

- Design and implementation of policy instruments;
- Actions towards sustainable lifestyles and consumer behaviour change;
- Actions on awareness and education for organizations;
- Technology and innovation development;
- New business models;
- Fiscal instruments development and implementation;
- Cross-cutting measures including two or more of the above.

2.2.2. ENERGY EFFICIENCY PARADOX

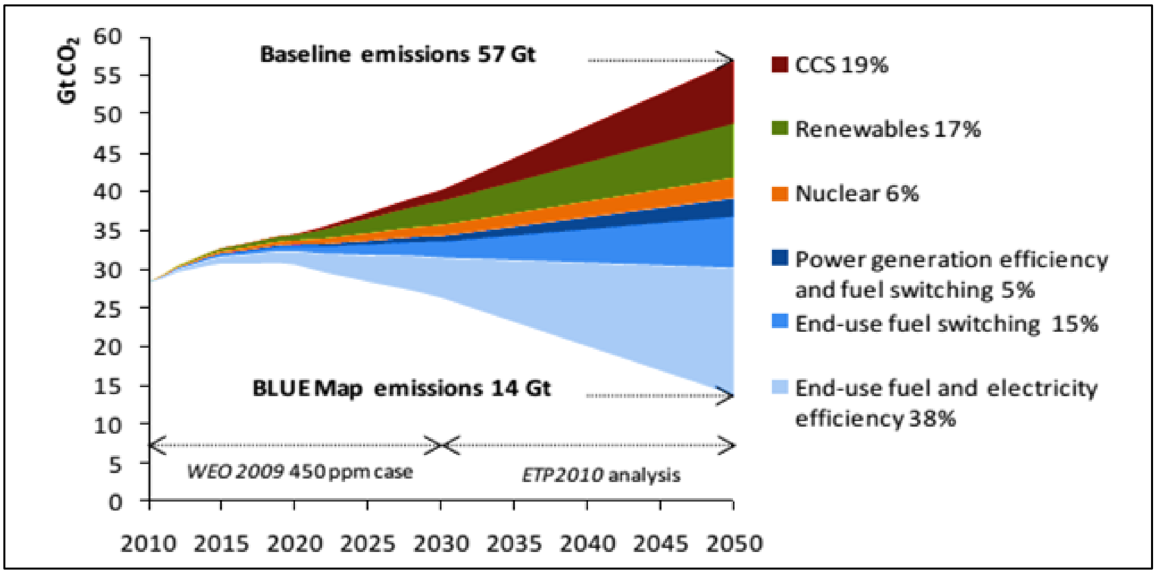
Enhancing EE is presented as the most effective path to achieve global greenhouse emissions targets (Schleich, 2009). This is evident in a scenario presented by the IEA, 2010a, where EE could contribute to 42% of the overall CO_2 emissions reduction target[5] (Graph 2.1), thus giving the highest contribution comparatively to other technologies available.

Alongside with the potential to contribute for reducing the burden on the environment and to provide savings that create disposable income for households and free up cash flows for companies, more benefits are associated with the increase of EE[6]. So "If EE and its promotion has these much benefits why is its use limited?" is the question presented by Levine & Kendall (2006).

[4] An analysis on different examples of real world applications of these types of mechanism to tackle the rebound effect can be found in the report "Addressing the rebound effect", developed for the European Commission – Directorate General Environment (Maxwell *et al.*, 2011).

[5] The scenario presented by the IEA (2010b) was based in the BLUE Map emissions target scenario. This scenario consists on "halving global energy-related CO_2 emissions by 2050 (compared to 2005 levels) and examines the least-cost means of achieving that goal through the deployment of existing and new low-carbon technologies"(IEA, 2010a).

[6] The range of energy efficiency benefits is presented in Section 2.3 – Chapter 2.



Graph 2.1 – Key technologies for reducing CO2 emissions. Source: (IEA, 2010).

This EE limitation introduces the concept of - *efficiency paradox* or *efficiency gap* , which consists in the difference between the technically feasible and economically viable improvements and the actual current level of investment on these EE improvements (Weber, 1997; Koopmans & Velde, 2001; IEA, 2007; Allcott & Greenstone, 2012).

This gap on EE results therefore in the efficiency improvement potential that is not accomplished (IEA, 2007), due to barriers in the energy market. Barriers to EE consist on mechanisms that block behaviours or investments that could contribute for an increase in the level of EE achieved (UN, 2011).

These inhibiting mechanisms derive from mainstream economics, organizational economics, and behavioural theories. Combined with the previous a set of institutional or structural barriers affect the level of EE achieved, even though not contributing directly to the *efficiency gap* (Palm, 2010). Therefore, depending on the barriers observed in a specific case, different levels of efficiency gaps may be outlined, (Jaffe and Stavins, 1994 *apud* Palm, 2010; Golove & Eto, 1996) (see Figure 2.1).

The literature presents a broad range of possibilities to classify these barriers (Weber, 1997; Koopmans & Velde, 2001; IEA, 2007; Schleich, 2009; UN, 2011).

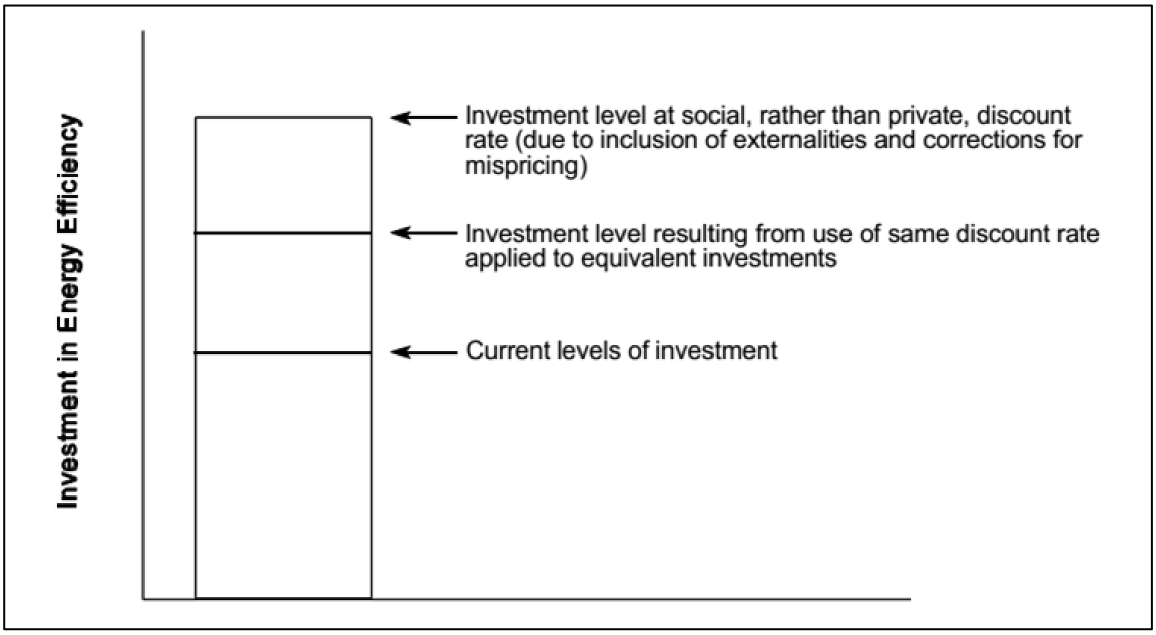


Figure 2.1 – Disaggregation of the energy efficiency gap. Source: (Golove & Eto, 1996)

Any barrier to EE independently of the proposed classification should specify the following features. “What is an obstacle, to whom, reaching what […]”? (Weber, 1997):

- *What is an obstacle?* (e.g.: persons, behavioural patterns, preferences, social norms, technical standards, etc.)
- *Is an obstacle to whom?* (e.g.: consumers, tenants, managers, policy makers, households, etc.)
- *Reaching what?* (e.g.: buying more efficient equipment, retrofitting, improving operating practices, etc.)

2.2.2.1. ENERGY EFFICIENCY BARRIERS - CATEGORIES

Palm (2010) presents an interdisciplinary perspective on categorizing EE barriers:

(1) **Economic barriers – market failures:** consist in the group of barriers that are seen as those violating the axioms of mainstream economic theory. The existence of a market failure may justify public policy intervention when the benefits of the action exceed the cost of implementation. Market failure barriers include the case of (1) imperfect information, (2) asymmetric information and (3) split incentives.

(2) **Economic barriers – non-market failures:** consist on other factors that account for the *efficiency gap* and cannot be categorized as market failures, but as market barriers. Market barriers (Brow, 2001 *apud* Palm, 2010) are obstacles that contribute to the slow adoption and diffusion of EE measures. Non-market failures

or market barriers include the case of (1) hidden costs, (2) limited access to capital, (3) risk and (4) heterogeneity.

(3) **Behavioural barriers:** include several barriers derived from behavioural sciences contributing to the *gap*. Weber (1997) states that these derive from individuals and their attitudes towards EE obstacles result from lack of awareness and missing links between attitude and actions. These barriers include the following cases: (1) form of information barrier; (2) credibility and trust; (3) values; (4) inertia and (5) bounded rationality.

(4) **Organizational barriers:** the range of barriers deriving from organizational theory. Considering that organizations are controlled by decision makers, therefore obstacles to EE may occur in budgeting, acquisition of new and more efficient equipment, or in operation and maintenance activities (Weber, 1997). The following cases represent examples of barriers: (1) power and (2) culture within organizations.

The above classification for EE barriers consists on the general definition available in the literature for the mechanisms hindering EE potential to be realized. From Palm (2010) standpoint it is crucial to re-define how these barriers are categorized, which can lead to new approaches for tapping the *efficiency gap*. A proposal is revealed to group barriers according to a new criterion, associated with each barrier system complexity.

The proposal is based in three categories: (1) technical system barriers, associated with technology and its associated costs; (2) technological regime barriers, based on the human factor influences combined with the corresponding technology; and (3) socio-technical regime barriers, strongly based on human factors and less influenced by the technology.

Developing new approaches as the proposed above consists on an important step towards lowering the constraints that affect the EE potential available. Fostering mechanisms that raise awareness both for (1) the rebound effect, that can backfire policies and programmes for efficiency improvement, and (2) the barriers responsible for the *efficiency gap* will contribute to successfully achieve CO_2 emissions reduction targets and unlock the benefits that derive from a more energy efficient society.

2.3. ENERGY EFFICIENCY BENEFITS

Improving EE unlocks many benefits, some of them are directly related to impacts on the energy system, such as cost reductions given the use of less energy and the need of fewer power plants. More efficiency contributes to reduced load, wear and maintenance needs and related costs of the electrical system, resulting on a higher level of reliability of the power grid (Levine & Kendall, 2006).

Other benefits derive from EE improvements, which do not result in direct impacts on the energy system, these are presented as indirect benefits. Dietsch (2007) defines these as the impacts resulting from an EE programme other than energy and demand savings. Examples of these indirect benefits are: (1) avoided pollution and greenhouse gases emissions; (2) economic impacts (e.g.: employment, income, tax revenues.); (3) national security impact; and (4) non-energy benefits, such as comfort and safety of consumers, water savings and reduced operation and maintenance costs.

The mentioned benefits impact the economy and society when EE measures are implemented. Although the former benefits are the most accounted for when assessing EE programmes (IEA, 2012b), the full range of benefits should be assessed when evaluating the outcome of a certain EE measure. By including the wider outcomes deriving from EE, it would be possible to highlight its benefits, not only from an energy systems perspective, but also for the wider economy and society frameworks (Holmes, 2012; IEA, 2012b).

Notwithstanding the advantages of including the full range of benefits when planning[7] and assessing an EE measure, these are often listed but not quantified. This is mainly due to: (1) lack of measurement standards for quantification; (2) costs associated with such quantification and (3) the idea that the higher share of financial benefits is related with energy savings alone (Dietsch, 2007).

The IEA (2012) presented a proposal for the typology of the extent of benefits including those related with EE and those that go beyond these. In this proposal the importance of the primary goal of any EE instrument is highlighted and it will continue to be - *to achieve energy savings*, but a new path for identifying the broad range of benefits available is disclosed.

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[7] Martins *et al.* (1998) presented a methodology for urban energy efficient planning, based on a case study of Coimbra's historical centre, highlighting the importance of including energy savings and other indirect benefits, such as comfort and environmental impacts, in cost effectiveness evaluations.

The benefits presented can be observed at different levels (i.e.: international, national, sectorial and individual), thus it is relevant to avoid double-counting when assessing EE benefits. The range of benefits and the levels on which these could be observed are represented below (Table 2.3).

Table 2.3 – Proposal for classifying EE benefits. Adapted from IEA (2012).

Type of benefit	Level / Field of impact	EE benefit associated
Direct	Energy system	Energy savings
Indirect	International	GHG emissions; Moderated energy prices; Natural resource management; Development goals.
	National	Job creation; Reduces energy-related public expenditure; Energy security; Macroeconomic effects.
	Sectorial	Industrial productivity and competitiveness; Energy provider and infrastructure benefit; Increased asset values.
	Individual	Health and wellbeing; Energy access; Increased disposable income.

With the proposed structure for categorizing EE benefits it is now important to develop the tools that will enable a quantification of these benefits in a useful timeframe, delivering data that could impact (1) the selection of projects for investment and (2) the evaluation of programmes and their outcome. By implementing this overarching inclusion of benefits, the value of saved energy will increase as well as the cost-effectiveness of measures developed towards EE improvement (Dietsch, 2007).

Recognizing such benefits will contribute to raise the awareness and action towards more energy efficient measures. If stakeholders perceive that apart from energy savings it is possible to contribute for improved health, energy affordability, economic growth, job creation and other positive impacts for society (IEA, 2012b), then the role and importance of EE will increase.

The first step towards achieving such a scenario consists in communicating the purpose and importance of this evolution in the framework of EE benefits. The following actions include (IEA, 2012): (1) structuring the necessary mechanisms and tools to collect the data necessary for quantifying the benefits; (2) through the collected data develop benchmarks for policy makers to assess the importance of designing specific instruments that boost a certain benefit to the society, and (3) work closely with government to place

EE as a key instrument in economic policy contributing to welfare gains and economic development.

2.4. SYNTHESIS

A clear understanding of the conceptual framework related to EE is of high importance. This chapter main purpose was to present the key concepts and theory that have been progressing on the scope of EE, aiming to include the contents that are often spread in the literature. Different perspectives available in the state of the art were presented providing a contribution on understanding the complexity that is associated with any EE decision-making process at a planning, developing or assessment stage. From the literature review conducted, the following remarks provide up-to-date concerns and drivers of the EE conceptual framework:

(1) EE has a strong potential to contribute to slow the energy demand growth by fostering a more efficient use of the rising consumption at a global scale. This will have impacts on the energy system as well as in the economy and therefore at a societal level. Besides the increased potential from EE measures, the real potential for EE improvements must be calculated considering the impacts of the rebound effect and the existence of barriers that contribute to the *efficiency gap*. When planning an investment, a policy instrument or any other mechanism that aims at EE improvements, the potential results must be assessed considering the set of present barriers that limit the maximum potential which would otherwise be achieved.

Failing to include such limitations in the development stage of measures may result in not achieving the planned outcome, eventually creating negative impacts for the stakeholders involved in the EE measure associated.

(2) Combined with the energy savings expected from any EE improvement measure, other benefits that go beyond the direct impacts are now gaining momentum. These new benefits have the potential to change the outcome value of a programme or the decision-making towards new EE investments.

A possibility to change the priority given to EE in the economy relies in the indirect benefits presented on a proposal from IEA (2012). In order to unlock these advantages it is important to develop mechanisms that allow for correct data collection and for the development of methods to quantify the impacts of these indirect benefits in the outcomes of an EE measure. Working closely with key market actors is crucial to raise awareness and drive the necessary efforts towards strategies that include this evolution.

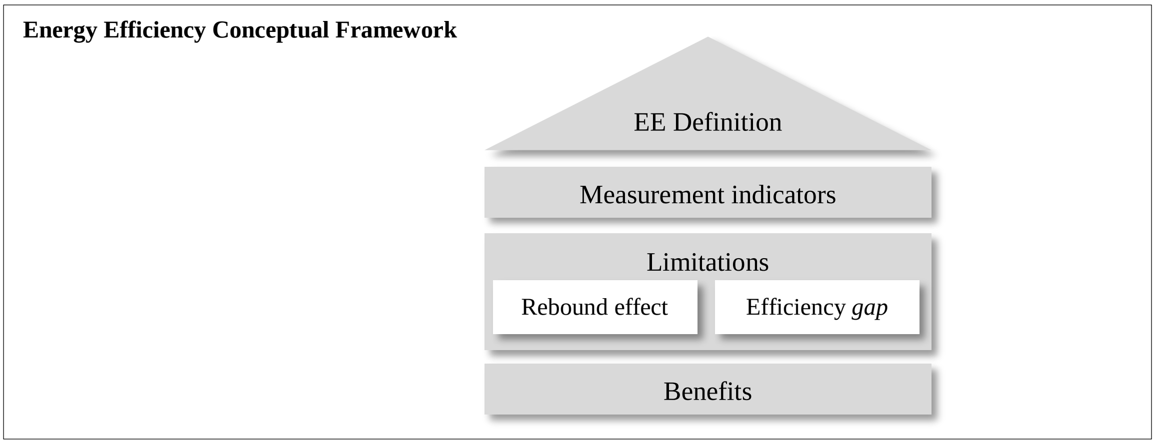


Figure 2.2 – EE conceptual framework design proposal. Source: Author[8].

The combination of concepts, constraints and benefits that EE encompasses constitutes the conceptual framework design proposed (Figure 2.2), which represents its diversity and complexity. Each concept must be applied in accordance to the specific context and limitations of the real world situation that is being addressed through an EE improvement action.

A strategy towards increasing awareness and understanding on the forthcoming challenges for the energy system, and how these can be eased through EE must be a priority. This effort should be based in a strong multidisciplinary collaboration, applying solutions based on a combination of different perspectives.

The following chapters are in line with this priority, bridging energy progress with its ability to create jobs, enhancing the importance of both direct and indirect impacts and progress of EE in the European Union.

[8] Figures, Tables and Graphs developed entirely by the author present no source throughout the document.

3. EUROPEAN UNION – A TOP DOWN PERSPECTIVE ON ENERGY EFFICIENCY

The EU has placed EE improvements as a critical component on its energy policy given its importance for the achievement of *competitive, sustainable and secure energy* (EC, 2011d). This has also been motivated through increasing concerns regarding security of supply, economic performance, environment and health protection and EE's potential to contribute for long-term global climate stability (EC, 2010a; EU, 2012b; Farinelli et al., 2005).

EE on the scope of EU's strategy is part of a broader effort to deliver growth and jobs. This underpinning programme is known as the *Europe 2020 Strategy* (EC, 2010a; EU, 2012b), which is composed by five key areas of action and corresponding targets, represented below (Table 3.1):

Table 3.1 – Europe 2020 Strategy action areas and corresponding targets. Adapted from (EU, 2012b).

Action Area	Target
Employment	75% of 20-64 year-olds to be employed
R&D / Innovation	3% of the EU's GDP (public and private combined) to be invested in R&D/innovation
Climate change / energy	Greenhouse gas emissions 20% lower than 1990 (or 30% in the best case scenario). 20% of energy from renewables 20% increase in energy efficiency
Education	Reducing school drop-out rates below 10% At least 40% of 30-34–year-olds completing tertiary education
Reducing poverty and social inclusion	Lifting at least 20 million people out of the risk of poverty and social Exclusion

The *top down perspective* presented in this chapter focuses on the Climate Change & Energy area, 20% reduction on energy consumption target by 2020, and other associated strategies beyond the 2020 timeframe. Focusing on the EU's perspective for the developments on EE is important to understand: (1) The EU energy market strategy for the future, (2) the EE policy mechanisms and (3) other instruments present at European level, and how these contribute to the EE goals. From the presentation and analysis of the different activities developed by the EU on EE it will be possible to outline its role and impact in delivering a sustainable energy future through the contribution of EE.

On a scenario where the EE target of 20% is at risk of not being achieved it is necessary to understand the developments contributing for the accomplishment of the planned agenda (EC, 2011a, 2011e, 2013a; EU, 2012a).

3.1. EUROPEAN UNION ENERGY STRATEGY

Energy is at the foundation of economic and social development in Europe. The well-being of people and industries prosperity depends on safe, secure, sustainable and accessible energy (EC, 2011c, 2011d). Being both an underpinning resource and a challenge, it is critical that the EU energy policy evolves towards delivering sustainable energy products and services whilst contributing to the span of social and climate actions.

The EU energy policy aims at: (1) security of supply, (2) competitiveness and (3) sustainability, as proposed by the EC (2007), which in combination with the Europe 2020 Strategy (EC, 2010a) outlined the strategy for transforming the energy market. The necessary evolutions for achieving this strategy include that by 2020: 20% of our final energy consumption is sourced by renewable energy sources; GHG emissions fall by 20% and energy savings of 20% are achieved.

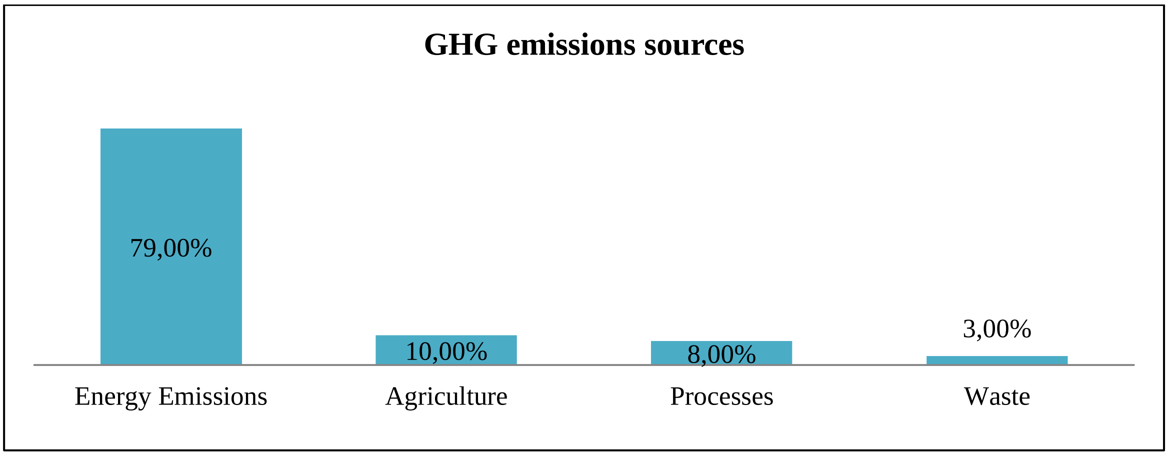
The design of these policy instruments, supports the development of strategies for a sustainable, secure and safe energy future (EC, 2011d), is shaped by the needs of the EU energy, economic and social realities. On understanding the ambitious purpose it is also important to clarify the main drivers and priorities for action, presented throughout this section.

3.1.1. BACKGROUND FACTS ON ENERGY IN EUROPE

A combination of factors led to the need for action at EU level towards the transformation of the energy system. As presented by the EC (EC, 2011b, 2013f) these facts require a high level of policy implementation and target delivery, whilst representing major concerns, affecting EU's competitiveness and growth.

Ensuring a pan-European energy policy is thus a priority, considering that (EC, 2011b):

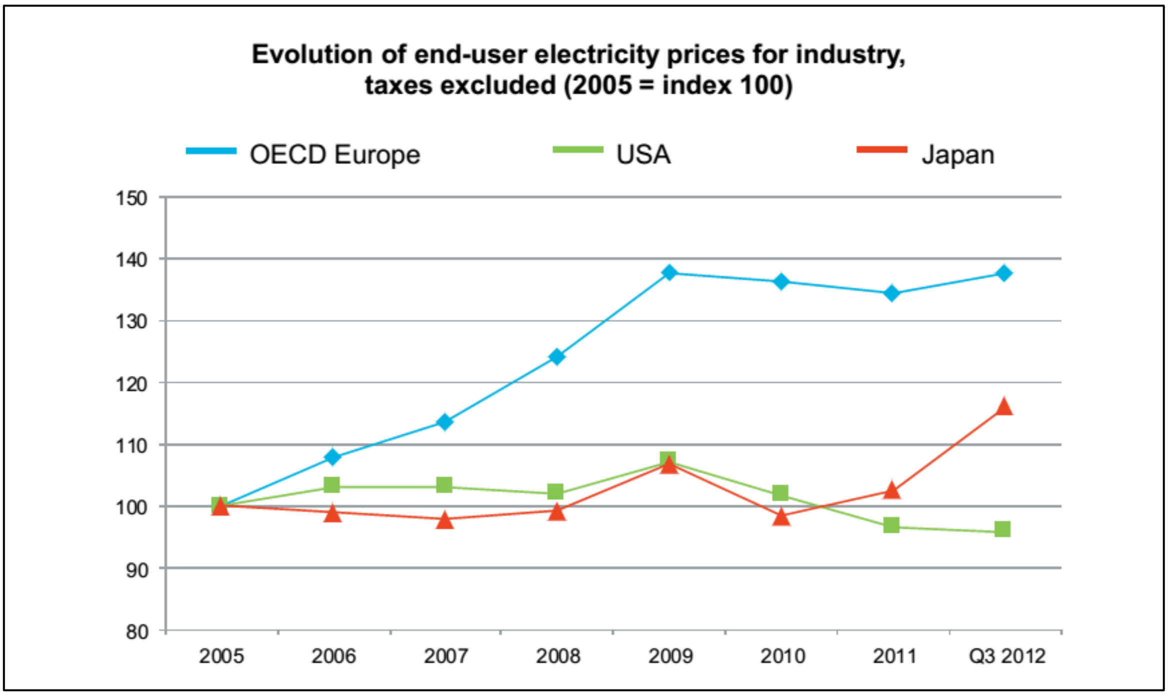
(1) The energy sector contributes to 79% of EU's GHG emissions (Graph 3.1).



Graph 3.1 – GHG emissions per source in 2008. Adapted from: (EEA, 2010 *apud* EC, 2011f).

Energy related emissions derive from: energy end use, 31%; transport related, 19%; industry, 13%; households, 9% and others, 7% (see Graph A.1, Annex A for EU's energy mix).

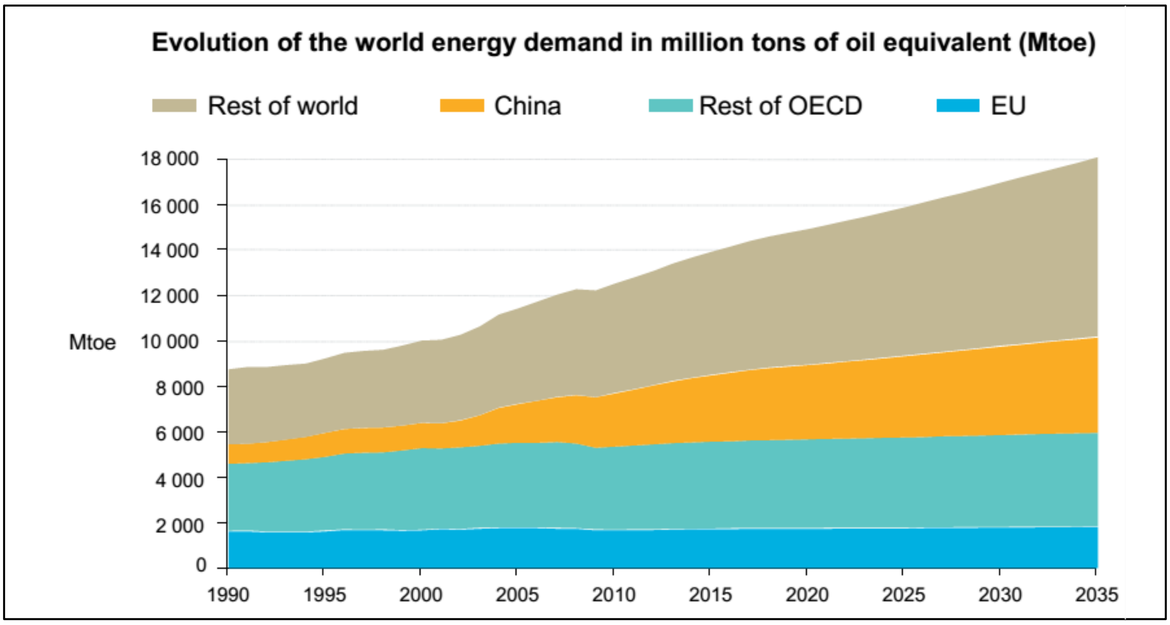
(2) Energy imports consist of carbon-intensive fuels at increasing prices.



Graph 3.2 – Electricity price evolution in industry. Source: (IEA, 2012 *apud* EC, 2013c).

The United States are leveraging their advantage on accessing energy at competitive prices (see Graph 3.2), whilst the challenge for the EU increases (EC, 2013f, 2013g). Although the EU energy consumption is stable, the world energy demand is increasing

(Graph 3.3), which considering EU's energy import dependence rises the risk on energy security and access (see Graph A.2 and Graph A.3 on Annex A for EU's main energy suppliers and imports dependency respectively).



Graph 3.3 – Evolution of world energy demand. Source IEA (EC, 2013c).

(3) High levels of investment needed for the EU's energy infrastructure maintenance and renovation. Projections from the EC show that between 2010 and 2020 over 1 trillion euros would have to be invested in the electricity and gas sector (EC, 2011c, 2011f, 2012c, 2013f), of which, approximately 500 billion euros (B€) for power generation (310-370 B€ for renewable power generation); and approximately 600 B€ in transmission and distribution networks.

These investments would be for power plant renovation, modernization of networks with new technologies and ensure low carbon supply for the increasing demand.

Achieving coordinated action at European level can support on managing the impact and disadvantages of the facts presented that drive EU energy policy developments. As stated by the EC (2012b), the necessary structure exists to implement a policy oriented towards: (1) securing EU energy supplies; (2) ensuring that energy prices do not slow down competitiveness; (3) contribute to climate change protection and (4) improve energy grids.

The EC presented the priorities to follow on energy policy and the existing challenges (EC, 2012d, 2013f, 2013g). The priorities to achieve a sustainable European energy market include: (1) Energy efficiency, (2) Achieving a European level energy market, (3) Renewed energy grids towards a smarter infrastructure, (4) Cost-effective integration of renewable sources, and (5) External energy policy development,

These priorities reflect the major drivers of energy policy also present in the European Council (EUCO) conclusions presented in both 2011 and 2013 (EUCO, 2011, 2013).

3.1.2. ENERGY POLICY AGENDA FOR THE EUROPEAN UNION

The rising concerns regarding the future of energy in Europe have contributed to the definition of a European energy policy agenda, aligning efforts, visions and mechanisms to develop integrated solutions across Member States. The sustaining actions as well as their ambitions are outlined below (Table 3.2):

Table 3.2 – EU Energy & Climate policy agenda.

Action	**Main goals / Ambitions**	**References**
Europe 2020 20-20-20	20% reduction of primary energy consumption; 20% increase in renewable energy; 20% reduction of GHG emissions.	(EC, 2010a, 2011d; EU, 2012b)
2030 framework for climate and energy policies	This action sets the standards to build the 2030 European strategy for energy and climate, taking into account the learning points from Europe 2020 20-20-20 and the Europe 2050 Roadmap; 40% reduction of GHG emissions (indicative)	(EC, 2013h, 2013i)
Europe 2050 Roadmap	A secure, competitive and decarbonised energy system; 80-95% reduction of GHG emissions (indicative).	(EC, 2011g; EP, 2013; Faber *et al.*, 2012)

The existing policy agenda discloses plans for the upcoming 30 years, stimulating change and ensuring that improvements continue to be delivered throughout 2020 towards a low-carbon economy by 2050. The EU demonstrates the concerns on public welfare, industry competitiveness and general functioning of society (EP, 2013).

Supporting the transformation ambitioned towards 20-20-20 by 2020, seven *flagship initiatives* were developed, addressing the most important areas for action that can boost the outcomes of the policy framework towards growth and jobs (EC, 2010a, 2013j; EU, 2012b). The initiative oriented towards energy and EE was presented by the EC (2011g) as the *Resource efficient Europe Initiative*, designed to support the decoupling process of economic growth and resources use, supporting the shift towards a low carbon economy whilst boosting the use of renewable energy sources, EE improvements and the modernization of the transport sector.

This flagship initiative aggregates a range of policies and goals to achieve high levels of resource efficiency. The links of this initiative with the EU energy policy agenda are outlined on the following table.

Table 3.3 – Resource efficiency initiative interlinks with EU Energy policies. Adapted from (EC, 2011g).

EU Energy policy initiative	References
Energy 2020: A strategy for competitive, sustainable and secure energy.	(EC, 2011d)
Strategic Energy Technology Plan for Europe.	(EC, 2007b)
Energy infrastructure priorities for 2020 and beyond - A Blueprint for an integrated European energy network.	(EC, 2011f)
European Energy Efficiency Plan 2020.	(EC, 2011i)
Revision of the Energy Taxation Directive.	(EC, 2011j)
Energy infrastructure package.	(EC, 2011f)
Energy Roadmap 2050.	(EC, 2011g)
Smart grids.	(EC, 2011k)
Security of energy supply and international cooperation.	(EC, 2011l)

The roadmap presented by this initiative represents a step forward in building action plans that cross cut different policy areas as the above presented EU policies which are combined in this flagship initiative (Table 3.3), providing a common perspective throughout the EU for transforming the economy with the active participation of both public and private actors that are crucial for delivering planned targets (EC, 2011h).

Ensuring the development of EU's energy policy is thus critical, being the world's largest importer and the second largest economy, paying 350 B€ every year for the imported energy. Therefore it is critical to work together on developing, implementing and delivering policies and ambitious goals for EE improvements (EC, 2012d).

The EU energy policy strategy delivery process can be outlined through the combination of various background energy concerns, energy priorities and the policy instruments and initiatives in place. This process (Figure 3.1) represents the different aspects taken into account, namely: (1) the local complexities at each Member State regarding their energy mix and challenges for the future, (2) targets that contribute to the range of challenges and needs at each Member State are defined (e.g.: 20-20-20 by 2020 objectives) and (3) a common legislative policy framework is developed and implemented, creating accountability and the required support mechanisms to deliver the planned agenda.

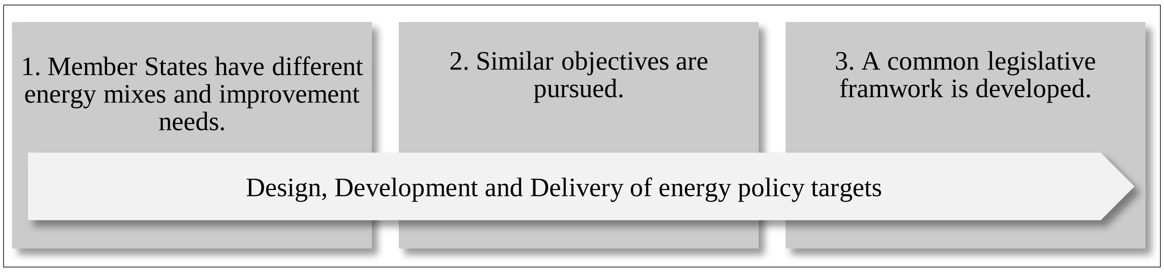


Figure 3.1 – Energy policy delivery process. Adapted from (EC, 2013c)

Presenting the current and future plans for the energy sector in the EU is relevant to understand the role that EE has in achieving such goals for a much ambitioned low carbon, resource efficient economy. EU EE policy in place is a critical instrument in the energy framework. The EU – *top down perspective*, on available policies, mechanisms and instruments fostering EE is presented in the following section.

3.2. Energy efficiency strategy at the European Union

EE is the central pillar of the EU's Europe 2020 strategy (EC, 2010a) delivering benefits to both the energy strategy (EC, 2011d) and the economy and climate agendas. The importance of EE and its delivery gained impetus on the EU's agenda when the prospect of achieving only half of the 20% savings planned for 2020 was revealed (EC, 2011a, 2011b, 2011c, 2013a).

On this *top down perspective* the aim is to present the focus areas of EU's policy instruments towards EE improvement, which focus on different sectors of the market. As indicated by Rezessy & Bertoldi (2010), EE is not a single market, covering measures in a breadth of sectors (e.g.: transport, buildings, industry, households, government, etc.), given this the EU has developed different policy instruments and programmes to foster EE improvements. Thereby strategies, legislation and support programmes are analysed presenting the EU's efforts on EE.

As part of the EE strategy for Europe (EC, 2007a), different policy orientations and directives have been developed to ensure a common work ground and instruments that legislate action towards the expected results.

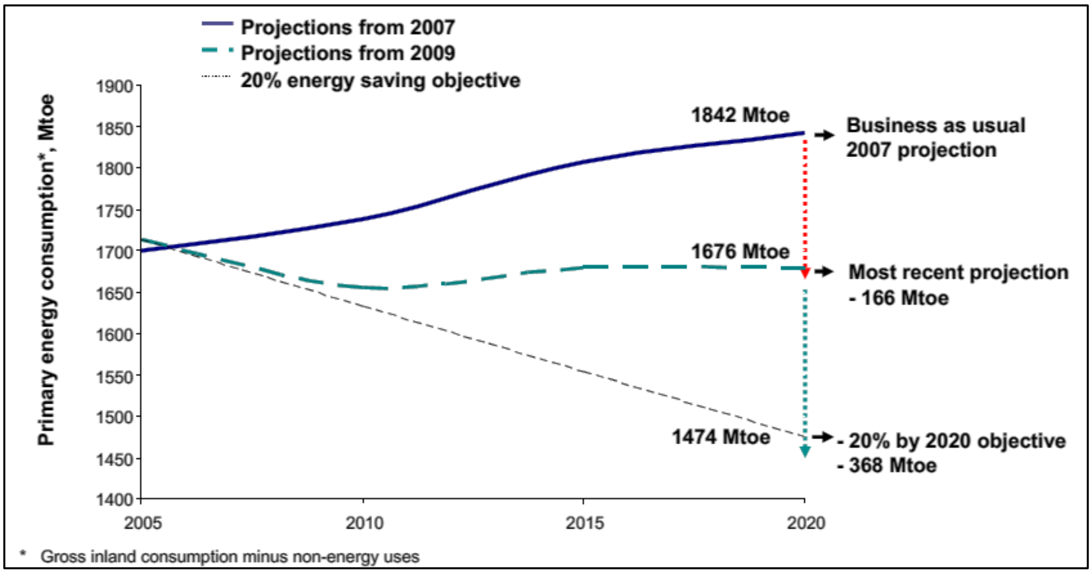
3.2.1. Strategy for energy efficiency

Strategic policy orientations are developed and issued by the EU through the Commission, ensuring that the EU is pursuing the right goals and targets.

The EC on the scope of the ambition towards 2020, adopted a communication to foster higher levels of EE, presented as the *Energy Efficiency Plan 2011*[9] (EC, 2011i). The policy orientations revealed in this communication, result from the conclusion of the European Council of 4th of February, 2011 (EUCO, 2011):

> The 2020 20% energy efficiency […] which is presently not on track, must be delivered. This requires determined action to tap the considerable potential for higher energy savings of buildings, transport and products and processes.

This plan is being implemented consistently with other policy actions, as well as flagship initiatives supporting the 2020 goals (i.e.: Resource efficient Europe, see Table 3.3). The measures presented are oriented to households, transport[10], industry and buildings, being these the sectors with higher potential to contribute to EE improvements, aiming at achieving the full potential of energy savings towards and throughout 2020.



Graph 3.4 – Projections on EU's primary energy use by 2020. Source:(EC, 2011c)

Having as background the risk of only achieving half of the target for 2020 (Graph 3.4), the EE plan presents new actions redefining the role of the EU, Member States and other relevant stakeholders on their contribution towards the delivery of new measures and targets.

[9] The Energy Efficiency Plan 2011 (EC, 2011i) is the evolution of the Energy Efficiency Action Plan 2006 (EC, 2006). Whilst the previous was considered the first major step towards EE improvement, the former consists in the second step towards an overarching cross-country effort, for energy efficiency from generation to end-use.

[10] The presented plan does not cover the issue on the Transport sector, policy orientations in this field were provided in the White Paper: Roadmap to a Single European Transport Area – Towards a competitive and resource efficient transport system (EC, 2011r).

The key sectorial actions included on the scope of this plan consist on the measures described on the following table (Table 3.4):

Table 3.4 – Energy efficiency plan sectorial actions. Source: (EC, 2011m, 2011n)

Sector	Actions
Public sector	• Promoting the contribution of the public sector, proposing a binding target to increase the refurbishment rate of public sector buildings[11] of 3% of the existing building stock each year. This target if achieved would double the current rate of renovation in the public building stock. • EE criteria introduced on public procurement procedures. Aiming at high levels of EE in the goods (e.g.: appliances, electronic equipment, office devices, etc.), and services (e.g.: refurbishment for buildings) purchased by public authorities[12].
Private building sector	• Promotion of privately owned building renovation and improvement of the energy performance of appliances. Member States are called to act: (1) enacting measures that address the problem of split incentives, and also (2) supporting the development of the Energy Service Companies (ESCOs) market as drivers for renovation.
Energy companies	• Energy companies have to be at the forefront of promotion of EE improvements, enabling their consumers to save energy. These can be achieved through energy companies own action or in cooperation with ESCOs to upfront the necessary investments.
Industry	• Promotion of the efficiency of industrial equipment, and increasing the level of access to information for small and medium enterprises (SMEs), as well as energy audits and energy management systems for large companies. • Exchange of best practices and knowledge in EE and initiatives designed to build energy management capacities on micro and small companies.
Transport	• Improving the EE performance of vehicles in all transport modes, developing and deploying sustainable fuels and propulsion systems, which contribute to tackle the transport challenge in Europe.
Consumers	• Promotion of the roll-out of smart grids and smart metering technologies, fostering more and higher quality of information regarding energy consumption for consumers. Through innovative technologies it must possible to breakdown consumption per time, room or appliance giving detailed data to support behavioural changes on energy use. • Enable better information and communication streams for consumers. Billing has to be clear and understandable.

In combination with the sectorial measures presented, a new governance approach aiming to increase national efforts is also brought forward in the plan (EC, 2011i), which changes the role and scope of National Energy Efficiency Action Plans[13] (NEEAPs) (EC, 2011o),

[11] Public Buildings are 12% of the EU building stock (EC, 2011n).
[12] Public spending represents 17% of EU GDP (EC, 2011i).
[13] NEEAPs were introduced as an obligation to Member States, by the Directive 2006/32/EC on Energy End-Use Efficiency and Energy Services (EU, 2006). These plans are intended to define and present strategies, measures and actions to achieve EE in the end-use sectors. With the new energy efficiency plan these NEEAPs have to be redesigned to include the broader scope of EE from generation to end-use.

therefore Member States will have to adapt their national EE plans to cover the whole energy chain from generation to end-use targeting higher levels of EE improvements.

The effects of full implementation of the plans measures has an estimated potential to generate up to 1000 € of energy savings per house each year and to create approximately 2 million jobs (EC, 2011n).

In addition to the *Energy Efficiency Plan 2011* the following communications have also been released by the EC, providing insights for the development of the most adequate policies to boost energy savings: (1) *Green Paper – Doing More with Less*, providing orientations towards a high EE European society increasing competitiveness, environmental protection and security of supply (EC, 2005a), and (2) *Green paper – A 2030 framework for energy and climate policies* (see Table 3.2) (EC, 2013h).

Policy orientations provided by the EC, deliver strategic insights to assess the necessary adjustments to current legislation or the need for new legislative proposals to be developed and presented. These orientations are the preceding step to the development of legislative instruments.

The EU laws in place on the scope of the current energy policy agenda towards EE are presented in the following section.

3.2.2. LEGISLATION FOR ENERGY EFFICIENCY

The legislation addressing the implementation of the EE strategy in the EU is composed by a set of directives and regulations[14] enacted by the European Parliament and Council. These will be presented[15] and analysed in groups, namely: (1) Framework Legislation, (2) Sectorial Legislation, and (3) Product Legislation (The Coalition for Energy Savings, 2013).

3.2.2.1.FRAMEWORK LEGISLATION

Consist of cross-cutting acts that determine goals for EE in the EU.

Energy Efficiency Directive – EED – Directive 2012/27/EU enacted on October 25th of 2012, amended Directives 2009/125/EC (Ecodesign Directive) and 2010/30/EU (Energy

[14] EU regulations consist on binding legislative acts, which must be applied entirely across the EU. EU directives are legislative acts that set a goal that the EU Member States must achieve. In this case the individual countries decide how to reach such goals (EU, 2013c).

[15] The EE legislation analysed on the scope of this dissertation focuses on EU level instruments, a review of Portuguese EE strategy, programmes, plans and laws is outlined by Cera (2012), which is relevant as a foundation for the study presented through Chapter 6 on EE job impacts in Portugal.

Labelling Directive), and repealed Directives 2004/8/EC (Cogeneration Directive) and 2006/32/EC (Energy End-Use and Energy Services Directive). This act was adapted by Directive 2013/12/EU on May 13th, 2013 given the accession of the Republic of Croatia and the necessary adjustments required on the target to comply with the 20% by 2020 for energy savings.

The development of this legal instrument, was the result of the call of action from the European Council (2011) and the need to close the gap on the EE target for 2020. This call of action led to the development of the *Energy Efficiency Plan 2011* (EC, 2011i), providing the strategic policy orientations on which the EED was based to define the binding measures based on the actions proposed on the efficiency plan (EC, 2011a) .

The EED brings rigorous measures to enable energy savings across the EU. As stated by the EC (2011a) and The Coalition for Energy Savings (2013), the act determines a framework for targets and measures to be achieved through a coherent and collaborative set of actions that cover EE from generation to end-use. The overarching impetus for energy savings of the EED combines: (1) sectorial measures (i.e.: public sector, households, services, energy suppliers and industry); (2) general measures promoting EE, (3) monitoring and reporting procedures and (4) indicative targets from Member States (EC, 2011p).

The key measures implemented by this Directive are (EC, 2011a, 2011b):

- Energy saving schemes across Member States: energy distributors and retail energy sales companies will be obliged to save 1,5 % on their energy sales every year in volume of energy supplied to costumers. Delivered through EE measures targeting heating systems, windows replacement, and roof insulation implemented on final energy users' premises. Member States may also provide their own mechanisms to achieve the level of savings (e.g.: funding initiatives, communication programmes, agreements, etc.) that are not based on mandatory savings for energy companies.

- Public sector role be responsible for the uptake of energy efficient products and services, whilst improving their own energy savings through the renovation of 3%[16] of the building stock every year.
- Consumer access to accurate real-time data on their consumption and their history, empowering consumers and households to manage better their use, whilst more clear bills provide information on real consumption for users to track their evolution.
- Incentives for SMEs to conduct energy audits and implement best case practices, whilst supporting large companies to increase their energy usage awareness and unlock potential energy savings.
- Efficiency in generation through: (1) the monitoring of efficiency levels of new energy generation plants, (2) definition of national heating and cooling strategies to avoid energy waste.
- Ensure that EE is taken into account by energy regulators on decision making, aiming at efficiency gains in energy transmission and distribution.

On the scope of its implementation the EED engages Member States and the EC into a set of binding procedures to complete within the defined deadlines. The most relevant deadlines are outlined in Figure 3.2.

Complying with the first milestone of April 30th of 2013 Member States have reported their national targets for primary and final energy consumption[17] by 2020 to the EC, which are now being revised.

[16] Target for yearly public building stock renovation of 3 % as presented on the *Energy Efficiency Plan 2011* (EC, 2011i).
[17] National targets on primary and final energy consumption presented by Member States to the EC are further discussed on Chapter 4.

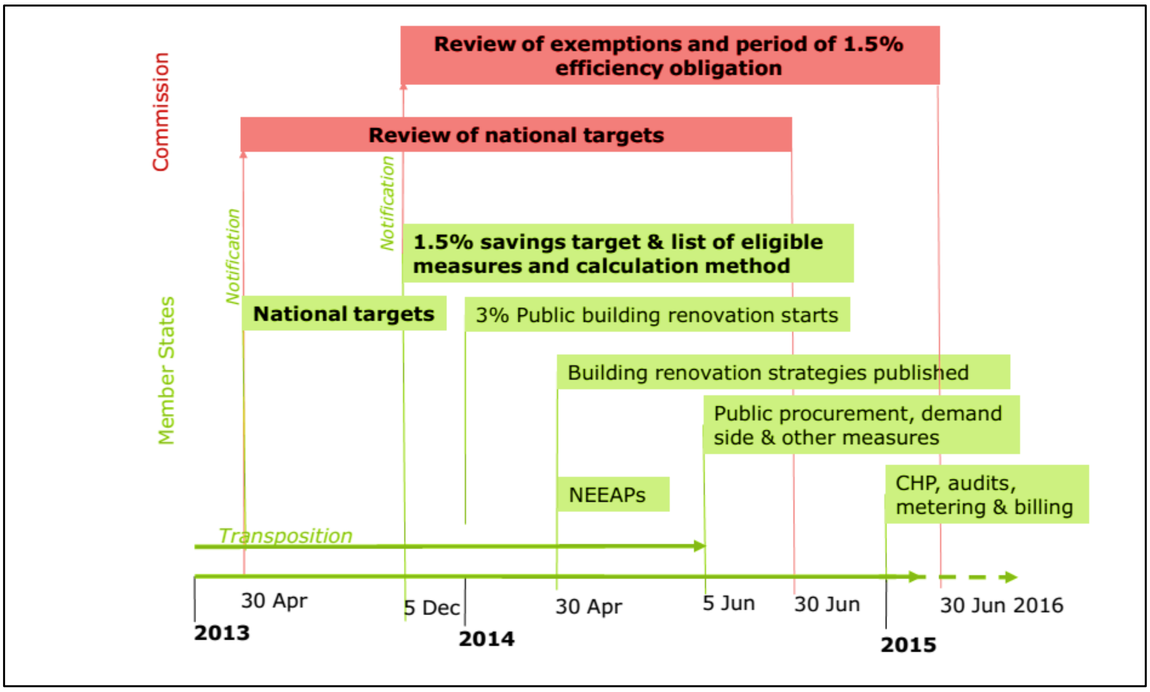


Figure 3.2 – Relevant deadlines on the EED. Source:(The Coalition for Energy Savings, 2013)

The EED is at the forefront of the EE law within EU's ensuring that energy savings are delivered on a collaborative approach at the Member States level. The act is based on binding measures, instead of binding targets (EC, 2011e; EU, 2012a), in this approach Member States have to implement the range of measures within the EED. As regards to the national energy efficiency targets that were due until April 30th of 2013, these are non-binding. Although if by 2014 the EC evaluation concludes that the EE target is not on track binding targets will be proposed to ensure the achievement of the set targets.

The targets set for EU primary and final energy consumption enacted through the EED are presented in Table 3.5, as well as the new targets adjusted for the accession of Croatia on the EU. These targets must be achieved through the transposition of the enacted measures.

Table 3.5 – Amended targets of the EU EED after Croatia's accession. Sources:(EU, 2012a, 2013a)

	Directive 2012/27/EU 27 Member States	**Directive 2013/12/EU 28 Member States**
Primary energy consumption (Mtoe)	1474	1483
Final energy consumption (Mtoe)	1078	1086

The Directive 2012/27/EU defines the legal scope of EE measures and targets for the entire energy system, fostering the removal of market barriers and failures. Providing Member States a framework of measures to implement, whilst stimulating more ambitious actions at the country level, as long as, these are compatible with the law obligations enacted through the EED.

As a legislative act setting the framework for EE in the EU, the EED is supported by sectorial and product oriented directives and regulations.

3.2.2.2. Sectorial Legislation

Include legal acts targeting specific groups of the economy, defining obligations and measures to be implemented in specific sectors, those on the scope of EE are:

Energy Performance of Buildings Directive – EPBD – Directive 2010/31/EU, enacted on May 19th of 2010. This act was the recast of Directive 2002/91/EC (Energy performance of buildings), which was repealed in February 2012.

As released on *Article 1* of the EPBD (EU, 2010a), the act promotes enhanced EE in the EU's building stock, taking into account local climate and constraints, indoor quality standards and cost-effectiveness. The act defines the methodology to calculate the energy performance of buildings, minimum requirements on EE for new buildings and a range of requirements for existing buildings.

The recast of Directive 2002/91/EC was based on the potential identified in buildings to contribute to energy savings of 60 to 80 Mtoe[18]. The EPBD also contributes to job creation and new investment streams for sustainable buildings in the EU (EC, 2008).

Energy Services Directive – ESD – Directive 2006/32/EC enacted on April 5th of 2006. This act repealed Directive 93/76/EEC (Directive to limit CO_2 emissions by improving EE). As amended by Directive 2012/27/EU (EED), Directive 2006/32/EC will be repealed in part on June 5th of 2014 and fully[19] repealed on January 1st of 2017 (EU, 2012a).

The ESD when enacted had a role comparable to the new EED, although with a focus on EE in end-uses and energy services. As presented by the EU (2006) the scope of the Directive was to enable cost-effective end-use EE improvements at Member States level. Accomplished by the definition of national targets and development of the required legal framework.

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[18] Enabling a reduction of 5 to 6% on EU's energy consumption (EC, 2008).

[19] *Article 4.1 to 4.4* and *Annexes I, III and IV* will be repealed by January 1st, 2017 (EU, 2012a; The Coalition for Energy Savings, 2013).

The repeal decision of the ESD was based on the need of an overarching legal scope of action for the EU, which was accomplished through the new EED.

Combined Heat and Power Directive – CHPD – Directive 2004/8/EC, enacted on February 11th of 2004 on the promotion of cogeneration based on useful heat demand in the internal energy market, amending Directive 92/42/EEC (Boiler Efficiency Directive). As amended by Directive 2012/27/EU (EED), Directive 2004/6/EC will be repealed from June 5th of 2014 (EU, 2012a).

As defined on *Article 1* of the CHPD (EU, 2004), its main purpose was:

> […] to increase energy efficiency and improve security of supply by creating a framework for promotion and development of high efficiency cogeneration of heat and power based on useful heat demand and primary energy savings in the internal energy market, taking into account the specific national circumstances especially concerning climatic and economic conditions.

The CHPD will be repealed given the integrated approach ambitioned to tap all EE potential in the EU, which required its provisions to be strengthened through the new EED (EU, 2012a).

3.2.2.3. PRODUCT LEGISLATION

Consist on legal acts that determine the specification and obligations to be applied on products regarding their energy consumption, or associated impacts. The legislation explored for products in this section is not exhaustive, aiming to provide an overview of this type of legal acts.

Labelling of energy-related products – Directive 2010/30/EU, enacted on May 19th of 2010 on the indication by labelling and standard product information of the consumption of energy and other resources by energy-related products, being a recast of Directive 92/75/EEC (Labelling of household energy-related products). Directive 2010/30/EU was amended by the new EED (Directive 2012/27/EU).

The scope of the Directive, defined on *Article 1* (EU, 2010b), establishes a framework for harmonized end-user information through the implementation of labelling and standard product information enabling customers to make energy efficient choices on their product purchases.

The amendment enacted through the new EED (Directive 2012/27/EU) states that the scope of Directive 2010/30/EU should be accelerated and widened, prioritizing products with high energy savings potential (EU, 2012b).

Ecodesign of energy-related products – Directive 2009/125/EC, enacted on October 21st of 2009, on establishing a framework for the setting of ecodesign requirements for energy-related products. This Directive was amended by the new EED (Directive 2012/27/EU).

The directive contributes to EE increase and environmental protection through the requirements stipulated that energy-related products must comply with in order to be launched and traded on the market or put into service. The scope of application excludes means of transport for persons or goods (EU, 2009).

Through the same framework as Directive 2010/30/EU (Labelling of energy-related products), Directive 2009/125/EC is amended by the new EED (Directive 2012/27/EU), based on the need to accelerate the energy savings tapped from the energy-related products with the highest energy savings potential (EU, 2012b).

Tyres Labelling – Regulation EC No 1222/2009, enacted on November 25th of 2009 on labelling of tyres with respect to fuel efficiency and other essential parameters. Amended through Regulation EU No 228/2011 and Regulation EU No 1235/2011.

The aim and subject of the Regulation legislated through *Article 1* (EU, 2009b) is to increase safety, economic and environmental efficiency of road transport through fuel efficiency promotion, thus contributing to an increase of energy savings.

A communication released by the Commission (EC, 2013g) presented projections of 1,5 to 4 million tons of CO_2 savings per year in 2020 from more efficient tyres being purchased by costumers.

3.2.3. SUPPORT ACTIONS FOR ENERGY EFFICIENCY

In addition to the energy policy orientations developed at EU level that lead further on to legislative acts enforcing and stimulating EE, a set of support actions are developed and implemented by the EU in collaboration with Member States. These actions and support programmes drive evolution on specific sectors or issues aiming at a high level of EE improvements. A range of wide initiatives are presented (Table 3.6), as well as their aim and framework of operation.

Table 3.6 – EU initiatives supporting EE.

Programme	Target	Key objective	In operation	References
Sustainable Energy Europe Campaign	Energy policy promotion	Dissemination of know-how and sustainable energy technologies at the EU, through *Energy Days conferences* organized at Member States and the annual event *European Sustainable Energy Week.*	Since 2005	(EC, 2013l; EUSEW, 2013)
CONCERTO Initiative	High EE strategies and sustainability development	Focus on demonstrating the breadth of benefits from renewable energy sources and EE integration, mainly through a knowledge exchange platform for participating and interested communities.	Since 2005	(Concerto Initiative, 2013; EC, 2013m)
ManagEnergy	Training and EE education.	Provide tools for the work of local actors on EE and RES, through training, workshops and online education. Whilst providing multimedia content on EE and RES matters.	Since 2002	(EC, 2013n; ManagEnergy, 2013)
Intelligent Energy Europe (IEE) Programme	Funding scheme for projects on energy in the EU	Stimulate a more rational use of energy and increase the deployment of RES, through financing and cooperation support.	Since 2007	(EC, 2013o; IEE, 2013)
Eco-Innovation	Funding scheme for reducing ecological footprint of EU companies.	Support the entry and uptake of new green products, services and technologies, through financial incentives specially targeting small and medium enterprises (SMEs).	Since 2008	(EC, 2013p; Eco-Innovation, 2013)
Covenant of Mayors	Reduction of CO_2 emissions beyond 2020 20% target	Engage cities and towns on the development and execution of Sustainable Energy Action Plans (SEAP), to achieve a more eco-friendly and sustainable reality. Cities participating are monitored by the Commission and excluded from failure to comply with the SEAP	Since 2008	(Covenant of Mayors, 2013; EC, 2013q)
BUILD UP Initiative	Enhance buildings energy savings potential.	Increase awareness of all actors in the building chain on EE potential, by connecting building experts, local authorities and citizens through a web community platform for intelligence sharing across the EU.	Since 2009	(BUILD UP, 2013; EC, 2013r)

Support actions for EE represent efforts to tackle market barriers and accelerate the delivery of wide improvements on energy savings potential realization. From the set of programmes presented in the previous table, it is possible to identify actions boosting information sharing, training activities and financial support enabling a broader reach of the necessary evolution on practices and technologies across the EU that contribute to improvements on EE.

Other relevant actions towards EE include:

- EU ENERGY STAR Programme, for labelling energy efficient office equipment, based on an agreement between the USA government and the EU (EC, 2013s).
- GreenLight Programme, on engaging non-residential consumers on the installation of energy-efficient lighting technologies (EC, 2013t).
- GreenBuilding Programme, on engaging non-residential building owners to adopt energy efficient measures (EC, 2013u)

These initiatives consist of actions that besides driving EE development encompass strategies that combine measures to improve energy security and environmental quality, such as CO_2 emissions decrease and RES integration and deployment. These initiatives have the advantage to support the downsizing of the strategies for the future of energy in Europe through a diverse range of market actors (i.e.: local energy agencies, local governments, SMEs, associations on energy, national governments, etc), ensuring that the market is both being developed and that schemes to support this development exist.

3.3. EUROPEAN UNION SCHEME ON ENERGY EFFICIENCY

Understanding the EE structure from EU's perspective was the aim of this chapter, named – *top down perspective*. Through the breakdown of EE developments from the EU side it is possible to confirm that *Europe's 2020 Energy Strategy* (EC, 2011d) is part of a broader interconnected strategy towards an energy efficient Europe.

Developments in the EU strategy entail a long-term scheme for 2030 and 2050 (EC, 2011g, 2013h; EP, 2013), through the development of a low-carbon, resource efficient economy (EC, 2011h), securing a pathway of action beyond 2020.

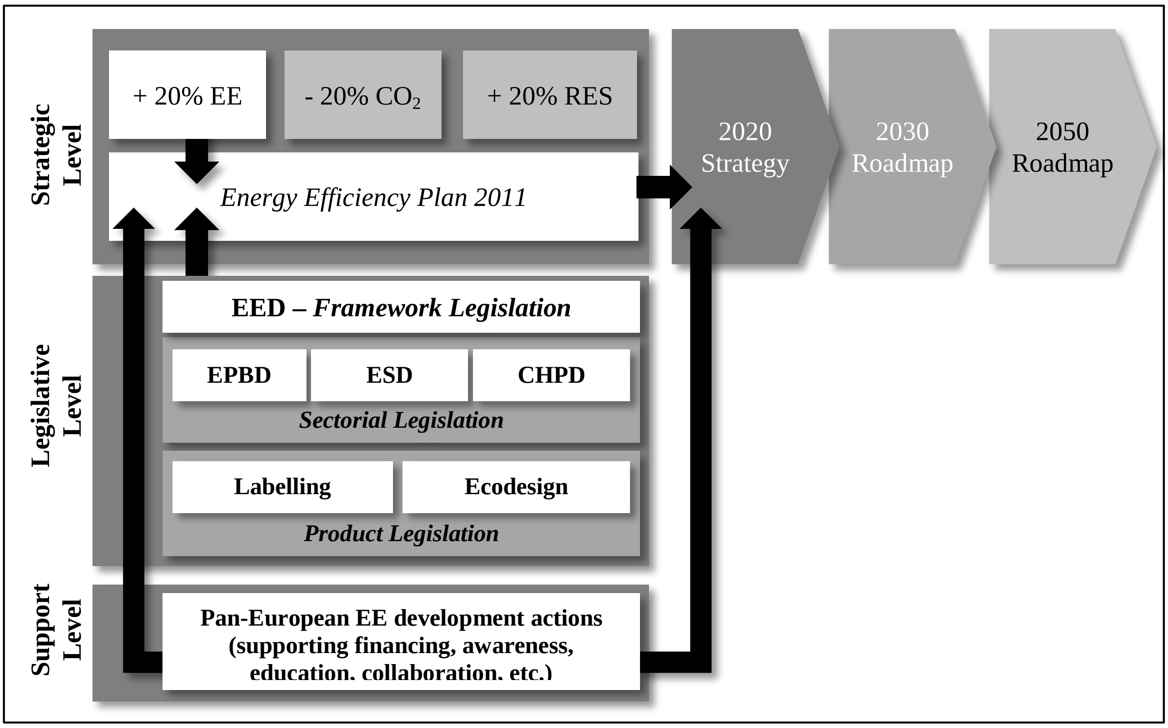


Figure 3.3 – European Union EE development scheme.

Figure 3.3 above illustrates the contributions of the different EU actions on energy and energy efficiency and how these combined represent an overarching effort to tap into energy savings in the mid-long term. Additionally, the matrix below describes the intertwined contributions between different levels of action from the EU on EE.

Table 3.7 – Contributions between actions on EE.

High scope of action

Strategic Level	Strategic roadmaps outline support actions to boost the expected results to ensure that targets and measures are reached (e.g.: Intelligent Energy Europe Programme).	The definition of new EE targets and frameworks requires the development of legislative acts to support their delivery and correct implementation. (e.g.: New EED supporting the *Energy Efficiency Plan 2011.)*	Strategies for the energy system ensure long-term energy security development, and sustainable evolution of technology and practices.(e.g.: Energy Strategy 2020, Low-Carbon Roadmap 2050)
Legislative Level	Existing or new legislative acts on EE benefit from support actions by ensuring communication, collaboration and structures for Member States to comply with the law (e.g.: EU Energy Star Programme).	Legislative acts in the EU (e.g.: directives, regulations, etc.), define binding measures and targets that must be transposed by Member States, creating frameworks and schemes across sectors to increase EE.	Implementing law on EE supports both the accomplishment of mid-long term strategies and the necessary Member States contributions for a sustainable energy future in the EU.
Support Level	Support actions and programmes ensure that efforts are made across the EU to tackle barriers to the implementation of EE strategies. In broader or targeted actions. (e.g.: GreenLight Programme.).	Through the development and implementation of Support Programmes insights arise to improve, amend or change legislation on EE. Ensuring that EE potential realized is maximised.	Support Level initiatives contribute to the definition or development of new and existing strategies for the energy system, through the insights that ascend from Member States realities.
	Support Level	**Legislative Level**	**Strategic Level**

Low scope of action

Low scope of action **High scope of action**

While developing this tool for comparison, two scopes of action were defined from the main characteristics of each level of action compared (i.e.: Support Level, Legislative Level and Strategic Level.), namely:

- **Low scope of action**: regarding measures that in most cases focus on specific issues or barriers, and are planned to ensure the development of a certain market within the EE vast market.
- **High scope of action**: regarding actions that in most cases include overarching measures and plans for EE or the energy system as a whole, outlining mid-long term roadmaps and expected results.

In Table 3.7 the grey shaded blocks present a brief description of the action at that level.

4. European Union – A bottom up perspective on energy efficiency

Increasing EE across the EU relies heavily on the ability of Member States to downsize the EU's streams of policy and measures into national activities. Developing national actions that cover the necessary obligations and go beyond the binding measures is thus the challenge for the EU Member States.

Throughout this chapter a complementary perspective is presented relatively to the previous *top down perspective* (Chapter 3).

The aim of this chapter is to analyse the current state and contributions of EU Member States to increase energy savings at national level. This methodological analysis is then defined as a *bottom up perspective* on EE given that the fact-finding methodology is focused on Member States actions rather than EU actions on EE (see Table B.1, Annex B for Member States acronym list).

Benchmarking Member States current efforts and progress on EE is a key priority given the reinforced regulatory framework for EE and the need to understand the contribution of each country. Furthermore, Enerdata (2013) states that the benchmarking of countries on their EE actions allows an understanding on the best case practices at the countries level, as well as the possibility to identify the most effective policy measures being implemented.

4.1. Methodology

The methodology used for the development of the *bottom up perspective* on EE across the EU, is based on the design, development and analysis of a matrix combining different quantitative and qualitative aspects of the EE progress at national level in EU countries.

The use of a matrix is based on the capability to aggregate different facts of the Member States scenarios and evolution, enabling a straightforward analysis and outlining of the trends and conclusions on their progress. The EU has used this concept in a range of studies for the assessment of energy policy targets evolution throughout Member States (EC, 2013a, 2013c, 2013g, 2013v).

The matrix developed, which is the foundation of the results presented through this chapter was based in the following methodology (Figure 4.1).

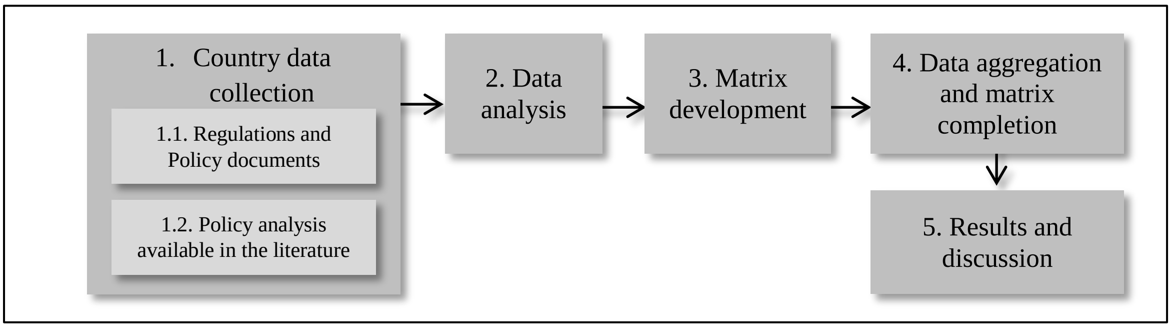


Figure 4.1 – EU – A bottom up perspective, development methodology.

The methodology designed includes the necessary steps to develop an analysis tool of EE in EU countries. This analysis includes data on EE from the Republic of Croatia when information regarding the criteria under analysis is available.

4.2. MEMBER STATES AND ENERGY EFFICIENCY

Given the extension of the matrix developed, and the aim to produce organized conclusions of the research conducted, the matrix will be analysed and presented in parts, regarding each specific aspect of analysis for the Member States and the conclusion from that analysis. Mainstream conclusions and consideration will be presented in the end of this chapter combining different aspects of the results obtained through this methodology.

Each presented analysis will generally be organized based on: (1) Criteria analysed and aim of the analysis, (2) main sources of information, (3) matrix developed and (4) key findings and considerations. Prior to the presentation of the benchmarking matrix results, a range of background evidence on EE across Member States is presented and analysed.

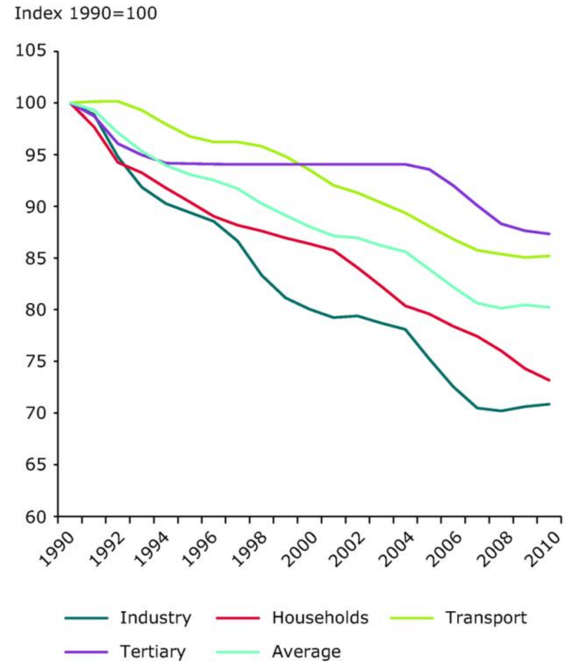
4.2.1. ENERGY EFFICIENCY DEVELOPMENT

The benchmarking of EE development from the Member States side must be based in the range of actions developed by each country and their capability to implement measures that meet and overcome EU obligations, as well as by considering the evolution and potential of a Member State, to deliver energy savings in the past and in the future. Member States have different realities that must be considered when analysing their status on EE in the EU. Therefore the potential on EE must be analysed.

Background information on Member States progress is presented and analysed, in addition with macro level data on EU EE evolution, providing the link between Member States actions and overall evolution of energy savings.

4.2.1.1. ENERGY EFFICIENCY PROGRESS

A study from the European Environmental Agency (EEA, 2013), based in the ODEX EE index[20], indicated an increase on EE (EU 27) of 20% between 1990 and 2010 (Graph 4.1) for final consumers. At an annual average of 1,1% per year, obtained through improvements in the industrial and households sectors, 1,7% and 1,6% per year respectively.



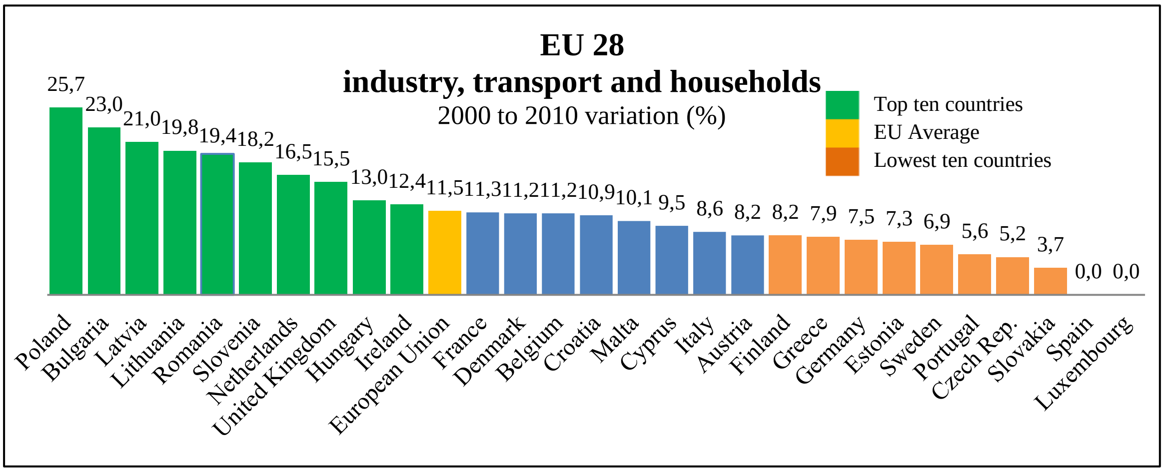
Graph 4.1 – Energy efficiency progress, ODEX Indicator 1990-2010. Source: (EEA, 2013)

The assessment also determined that the improvements verified on EE were achieved prior to 2007, given the slow down on improvements caused by the economic recession, causing an increase of 0,4% in 2009, resulting thus in a deterioration of EE of 0,4% relatively to 2008. Given the economic constraints, EE has improved at an average of 0,9% per year in the EU for the period 2005 to 2010.

For end-use sectors it is possible to outline the contribution of Member States for overall EE gains[21] (Graph 4.2) through ODYSEE[22] database.

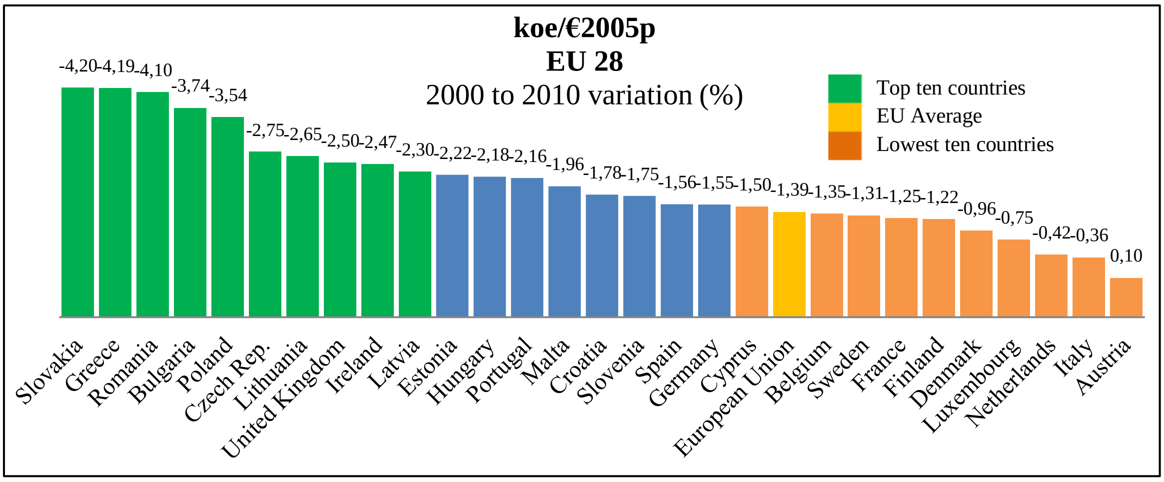
[20] ODEX Index is the energy savings indicator used by the ODYSEE-MURE Project (EEA, 2013; ENERDATA, 2010)

[21] "Energy efficiency gains are calculated from ODEX and reflects efficiency gains since 2000. ODEX by sector (industry, transport, households) is calculated from unit consumption trends by sub –sector (or end-use or mode of transport) by aggregation of unit consumption indices by sub-sector in one index for the sector on the basis of the current weight of each sub-sector in the sector's energy consumption. Service sector is excluded because of lack of reliable data to capture energy savings in this sector" (ENERDATA, 2013a).



Graph 4.2 – Overall EE gains per Member State in 2010, since 2000. Adapted from: (ODYSSEE, 2013a).

The top ten Member States on EE gains are: PL, BG, LV, RO, SI, NL, UK, HU and IE. Whilst the lowest ten countries are: FI, EL, DE, EE, SE, PT, CZ, SK, ES and LU.



Graph 4.3 – Final energy intensity per unit of GDP, variation in % 2000-2010. Adapted from: (ODYSSEE, 2013b).

In terms of climate corrected[23] final energy intensity variation in 2010 compared to 2000 (Graph 4.3). The outlook presents SK as the country with the highest evolution in intensity efficiency, whilst AT presents the lowest variation.

In terms of power production efficiency progress across the EU (ENERDATA, 2013b), an increase on efficiency of 0,6% was registered from 1990 to 2011 on average in the EU.

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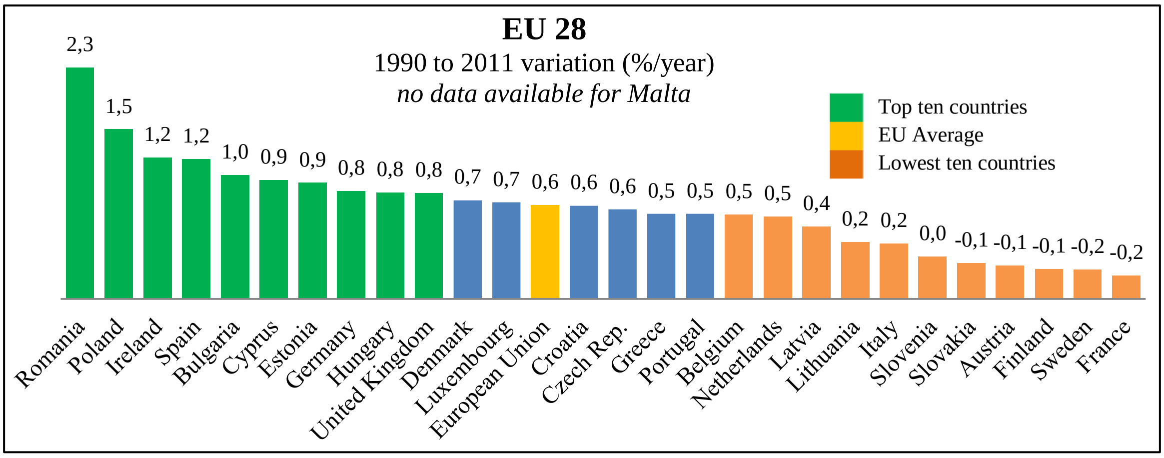
[22] ODYSEE MURE is a Project coordinated by ADEME (*Agence de l'Environnement et de la Maîtrise de l'Energie*), which gathers energy representatives from the 28 Member States and Norway aiming at monitoring energy efficiency trends and policy measures in Europe (ODYSSEE, 2013c).

[23] The purpose of these climatic corrections is to leave out the influence of cold winter. This is particularly important when there are large climatic variations from one winter to the other. The climatic corrections are made only for the part of the final consumption corresponding to space heating. Climate corrections are only made in the residential and service sectors"(ENERDATA, 2013a).

The country with the higher increase was RO with 2,3% improvement, whilst FR deteriorated its power production efficiency by -0,2% (Graph 4.4).



Graph 4.4 – Efficiency progress of power production. Adapted from: (ENERDATA, 2013b)

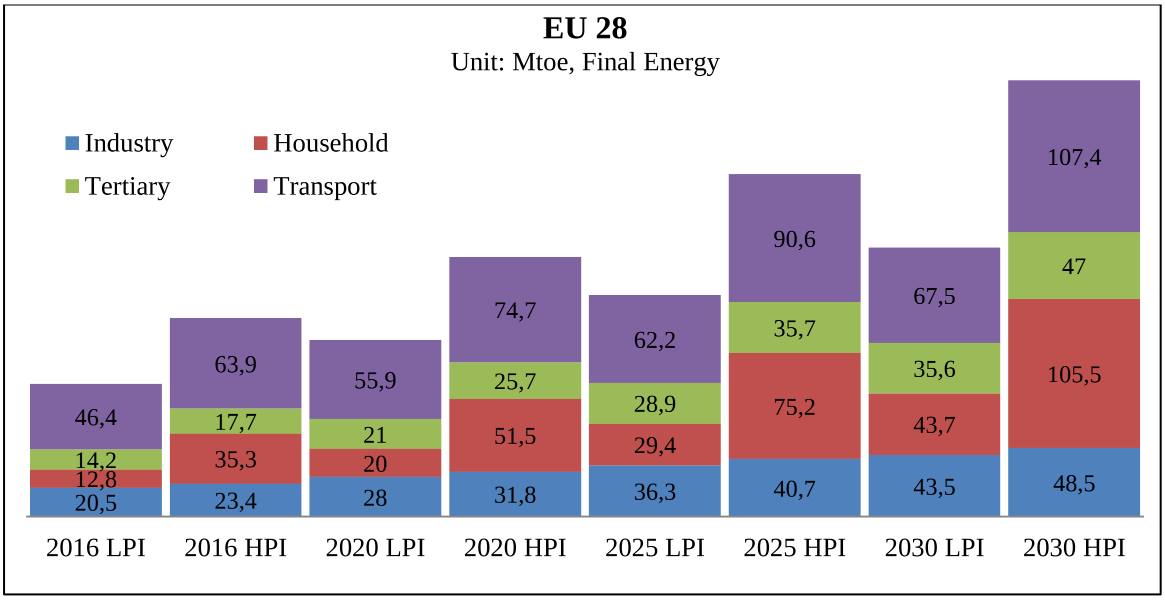
4.2.1.2. ENERGY EFFICIENCY POTENTIAL

Based on an analysis of end-use energy savings potential, calculated through the MURE (*Measures d'Utilisation Rationelle de l'Energie)*[24] simulation tool available through the EC (2013t). It is possible to see the potential savings deriving from (1) industry, (2) households, (3) tertiary and (4) transport sectors.

The potentials presented (Graph 4.5) are divided in two scenarios, Low Policy Intensity (LPI) and High Policy Intensity (HPI), alternative to an autonomous scenario (i.e.: business as usual). These scenarios are defined as (EC, 2013x):

- **Autonomous scenario** considers that technology diffusion occurs in an autonomous way. Including impacts of policies in place previous to the base year and changes in market energy prices.
- **Low Policy Intensity scenario**, in which additional technology diffusion of best available technologies beyond autonomous diffusion is only driven by increases in market energy prices, while market barriers and failures continue to persist.
- **High Policy Intensity scenario** considers the diffusion of best energy saving technologies to the maximum extent possible from an economic viewpoint. Cost effectiveness and removal of market barriers and failures are on the scope of the scenario.

[24] MURE is a simulation tool to evaluate energy Savings potentials at the demand side, through a rich technological structure for the defined energy demand sectors (i.e: Households, Transport, Industry and Services) (EC, 2013w).



Graph 4.5 – End use Energy savings potentials per sector of demand. Adapted from:(EC, 2013w)

Considering the savings potential for 2020 under a LPI and HPI scenarios, the contribution from the different sectors accounts for energy savings of 124,9 and 183,7 Mtoe correspondingly.

The new EED has a target of achieving a final energy consumption of 1086 Mtoe by 2020 including the accession of Croatia. The achievement of a HPI scenario guarantees the accomplishment of 17% of energy savings expected for 2020, whilst achieving a LPI scenario would account for 12% of 2020 projected energy savings. Considering the overarching scope of the EED and the potential for energy savings in generation and transmission in addition to end-use savings, the relevance of strong impetus from Member States side increases.

In 2020 for the HPI scenario, transport accounts for 40,66% of the potential savings, tertiary sector 13,98%, 28,03% for households and 17,33% for industry. Driving extraordinary attention to the relevance of actions that tap the potential energy savings from the transport sector.

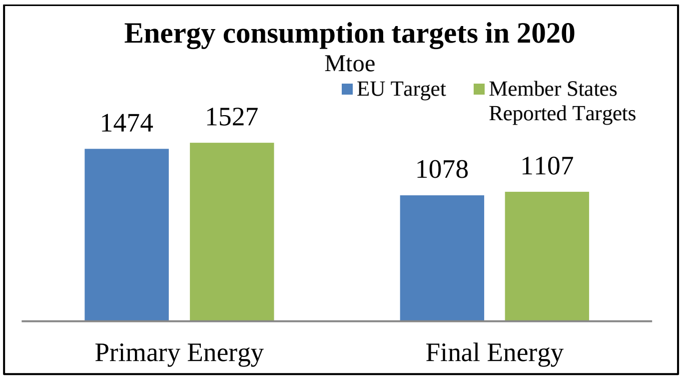
4.2.2. Benchmarking Member States

The analysis and discussions disclosed on this section are the result of the implementation of the methodology proposed for the development of the benchmarking matrix for EU Member States (see Figure 4.1),

4.2.2.1.EE GOALS FOR 2020

The success on achieving a scenario of high EE across Member States, is pending on the ability to deliver the 2020 20% energy savings target (EC, 2011d). The strategy to achieve this scenario was described in Chapter 3, now under the new EED; Member States had to report their EE targets[25] for 2020 final and primary energy consumption goal to meet the EU's goal of 1483 and 1086 Mtoe of primary and final energy consumption respectively. Analysing the already reported goals (Table 4.1[26]) is possible to outline a set of risks on achieving the planed savings.

Comparing the reported targets until November 2013, two Member States continue to lack targets on EE, namely: HR and SI, whilst LT has only reported its final energy consumption target. The reported targets relatively to the EED target present a gap (Graph 4.6).



Graph 4.6 – Energy consumption targets.

Table 4.1 – Member States EE targets reported. Adapted from: (EC, 2013d)

Absolute level of energy consumption in 2020 (Mtoe)		
Region	**Primary Energy**	**Final Energy**
EU	**1474**	**1078**
AT	31,5	26,3
BE	43,7	32,5
BG	15,8	9,16
HR	n.a.	n.a.
CY	2,8	2,2
CZ	39,6	24,4
DK	17,8	14,8
EE	6,5	2,8
FI	35,9	26,7
FR	236,3	131,4
DE	276,6	194,3
EL	27,1	20,5
HU	26,6	18,2
IE	13,9	11,7
IT	158	126
LV	5,37	4,47
LT	n.a.	5,4
LU	4,482	4,239
MT	0,825	0,493
NL	60,7	52,2
PL	96,4	70,4
PT	22,5	17,4
RO	42,99	30,32
SK	16,2	10,4
SI	n.a.	n.a.
ES	121,6	82,9
SE	45,9	30,3
UK	177,6	157,8

n.a.: information not available

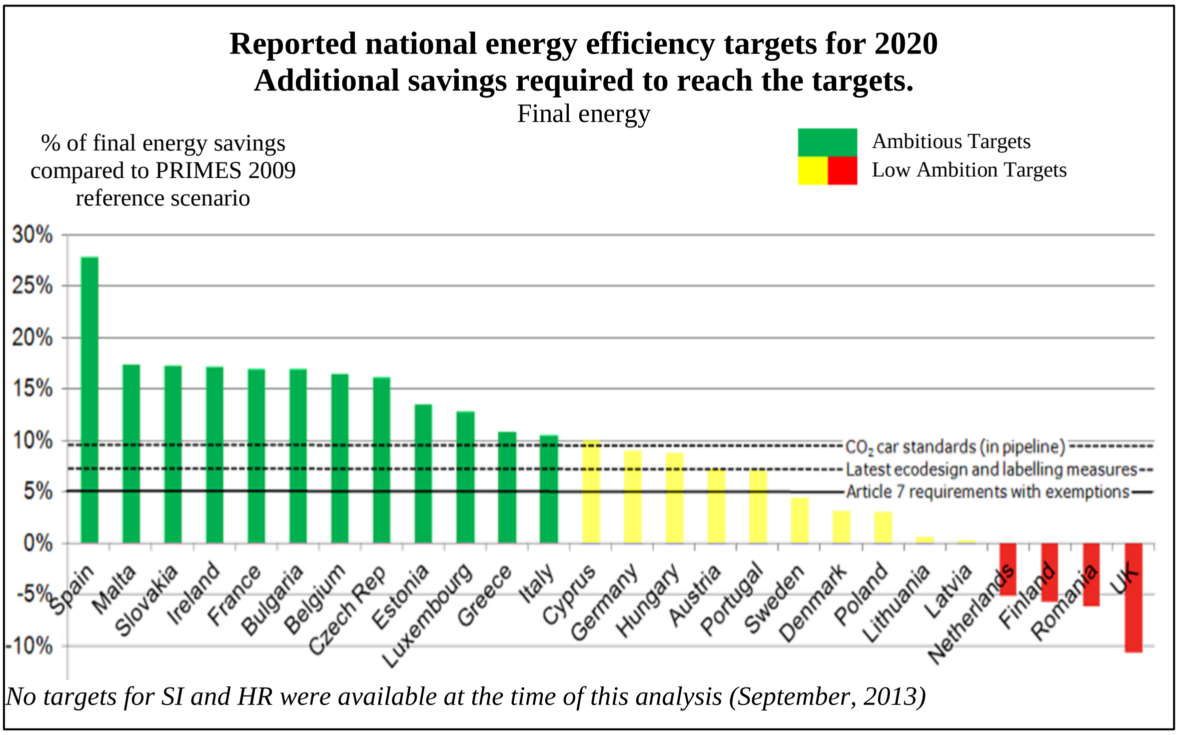
The gap on Primary Energy is of 53 Mtoe and 29 Mtoe on Final Energy consumption. These deviations represent 4% and 3% respectively, of the overall EU target for Primary and Final Energy consumption. From this comparison it is possible to outline that the ambition of the

[25] Member States had to present their targets in terms of primary and final energy consumption by April 30th, 2013 (EC, 2013a; EU, 2012a).

[26] For the analysis conducted on the reported targets the goals prior to Croatia's accession were used, given that no information on Croatia's target was available in November 2013.

overall reported targets is close to the EU ambition, as disclosed by the EC (2013a) but a final conclusion will only be possible when all countries have reported their targets and these have been analysed by the EC, as defined in the EED.

Although the EC assessment on reported targets has not been published, it has been publicly acknowledged that although the ambition is close to EU goals a gap exists (EC, 2013v: 7). A similar assessment to the EE reported targets from The Coalition for Energy Savings (2013) discloses the effort of the reported targets per country (Graph 4.7). Allowing to understand the targets with a low ambition which will be easily overachieved by implementing the binding measures of the EED and those who deliver considerable energy savings beyond the minimum EED requirements (i.e.: ambitious targets).



Graph 4.7 – Energy savings target analysis. Adapted from: (The Coalition for Energy Savings, 2013).

This study outlines a gap between EU goals and Member States reported targets of 68 Mtoe on Primary Energy consumption, already considering draft targets for HR and SI.

Combining the findings on the EE targets across Member States it is possible to sketch courses of action from the EC on the revision stage of the national targets, namely:

(1) Define and implement a contingency plan on mitigating the risk deriving from the existing gap between the EU goal and the aggregated countries ambition on energy consumption in 2020.

(2) Ensure that the effort across Member States is balanced in terms of ambition and capacity to deliver energy savings, sustaining a collaborative environment whilst securing the delivery of the energy savings planned.

4.2.2.2. NEEAPS (2ND ROUND) OUTLOOK

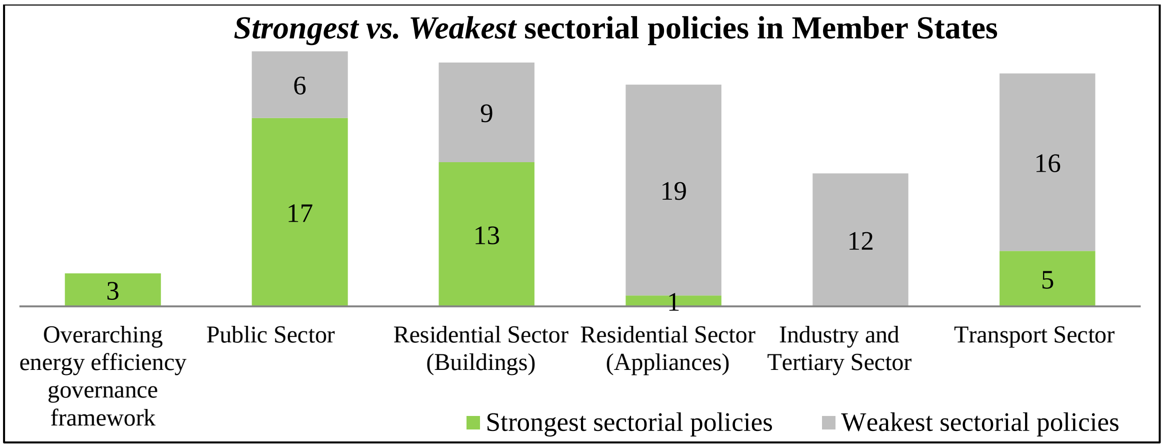
The aim of this analysis is to understand the national strengths and weaknesses of EE policies in Member States, based on the 2nd NEEAPs presented by Member States under the ESD, now repealed by the new EED.

The main source of information to conduct this analysis is an EU funded initiative, the Energy Efficiency Watch II Project (EEW), which was created to analyse the transparency and implementation of EE measures at Member States (EEW, 2013a). The EEW project disclosed 27 reports for the EU Member States presenting the results of the analysis of the 2nd NEEAPs presented by Member States. These will be analysed and compared to outline trends, risks and best case practices on developing and increasing energy savings (see comparison matrix in Table C.1, Annex C).

The results of the analysis are presented based on the sectors defined through the EEW Project (EEW, 2013a), specifically: (1) Overarching energy efficiency governance framework, (2) Public sector, (3) Residential sector – buildings, (4) Residential sector – appliances, (5) Industry and tertiary sector and (6) Transport sector.

An analysis outlining the *strongest* and *weakest* quality sectorial policies at Member States was developed from the gathered data for EU 27. Sectorial policies considered *strong* are well structured, with set goals and mechanisms in place for the delivery of the planned outcomes. Whilst policies considered *weak* are those lacking structure, goals and ambition to deliver energy savings as presented throughout EEW outputs.

Transport, Industry and Residential appliances as the most common sectors with the weakest potential to achieve energy savings, whilst the public and residential buildings sector present the most common policies with higher quality and potential to deliver EE improvements, thus stronger policies. Graph 4.8 presents the number of Member States for each sectorial policy package considered *weaker* and *stronger*. (e.g.: 3 Member States were considered to have a high quality governance framework for EE development).



Graph 4.8 – Strongest vs. Weakest sectorial policies across Member States. Source: Analysis of Annex C.

For an understanding on the EE policy quality, Table 4.2 presents for each policy sector the *strongest* and *weakest* Member States.

Table 4.2 – Policy analysis, per sector, per Member State. Source: Analysis of Annex C

Policy Sector	***Weakest* performing Member States**	***Strongest* performing Member States**
Overarching energy efficiency governance framework	n.i.	CZ, DK, LU
Public Sector	HU, IT, LV, SK, ES, SE	AT, BE, CY, CZ, DK, FI, FR, DE, EL, LT, MT, NL. PL, PT, RO, SI, UK
Residential Sector (Buildings)	BE, CY, FI, EL, LT, PT, SI, SE, UK	AT, BG, DK, EE, FR, DE, IE, IT, LV, LU, MT, NL, PL
Residential Sector (Appliances)	AT, BE, BG, CY, CZ, DK, EE, FR, DE, EL, HU, LT, MT, PL, RO, SI, ES, SE, UK	SK
Industry and Tertiary Sector	BG, EE, FI, FR, IE, IT, LU, MT, NL, PL, RO, SK	n.i.
Transport Sector	AT, BE, BG, CY, CZ, DK, EE, DE, IE, IT, LV, LU, NL, PT, RO, SK	FI, HU, SI, ES, SE

n.i.: information not identified.

The analysis reveals areas for action in terms of EE policy development at Member States, In terms of transport being the sector with highest potential to support energy savings increase (see Graph 4.5, page 46), it is necessary to develop national strategies to foster knowledge sharing and stronger ambition and efforts to promote energy savings on this sector. A geographical representation of the *strongest* and *weakest* sectorial policies is presented in Figure 4.2 and Figure 4.3.

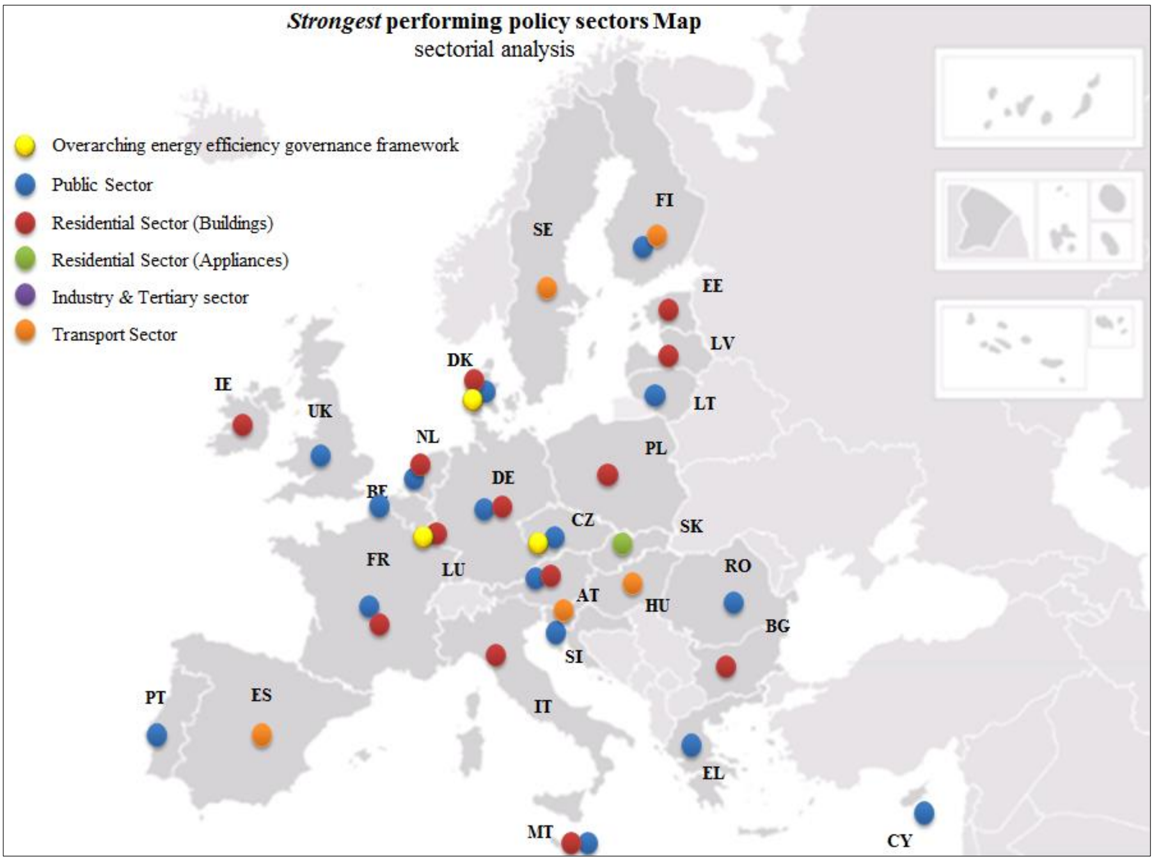


Figure 4.2 – *Strongest* sectorial policies geographical distribution, base map from EU (2013b).

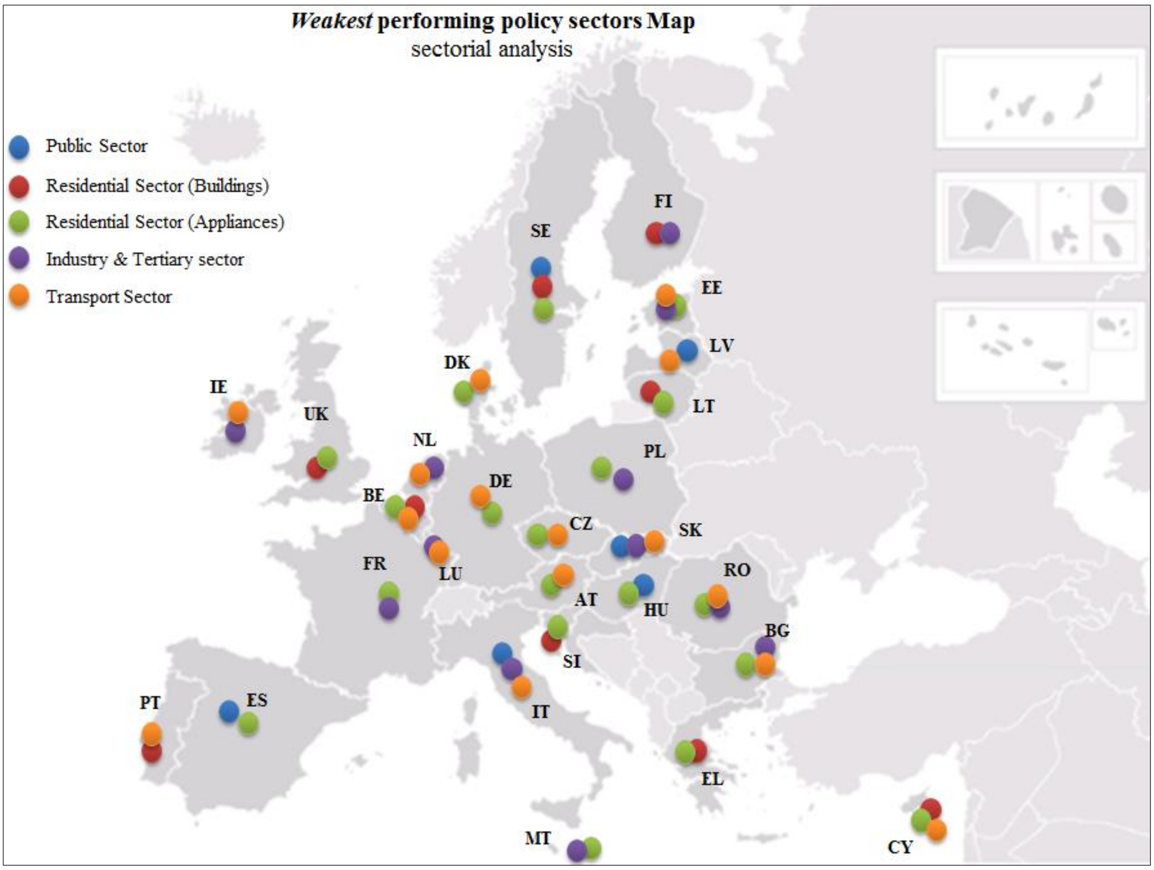


Figure 4.3 – Weakest sectorial policies geographical distribution, base map from EU (2013b).

In terms of national Best Case Practices (BCPs) Slovenia (EEW, 2013b) is highlighted in terms of EE in transport, namely by addressing all transport modes through investments and incentives, integrated mobility planning to ensuring competitive public transportation. Also awareness campaigns are organized as well as educational activities. The policy package is balanced in terms of actors addressed; potentials are taken into account as well as barriers for development. An example of a specific good practice is the public subsidies to public transport providers being linked to kilometers (Km) travelled by passengers, instead of Km travelled on the road. Further details on BCPs from Member States can be found on Annex C and in Figure 4.4 below.

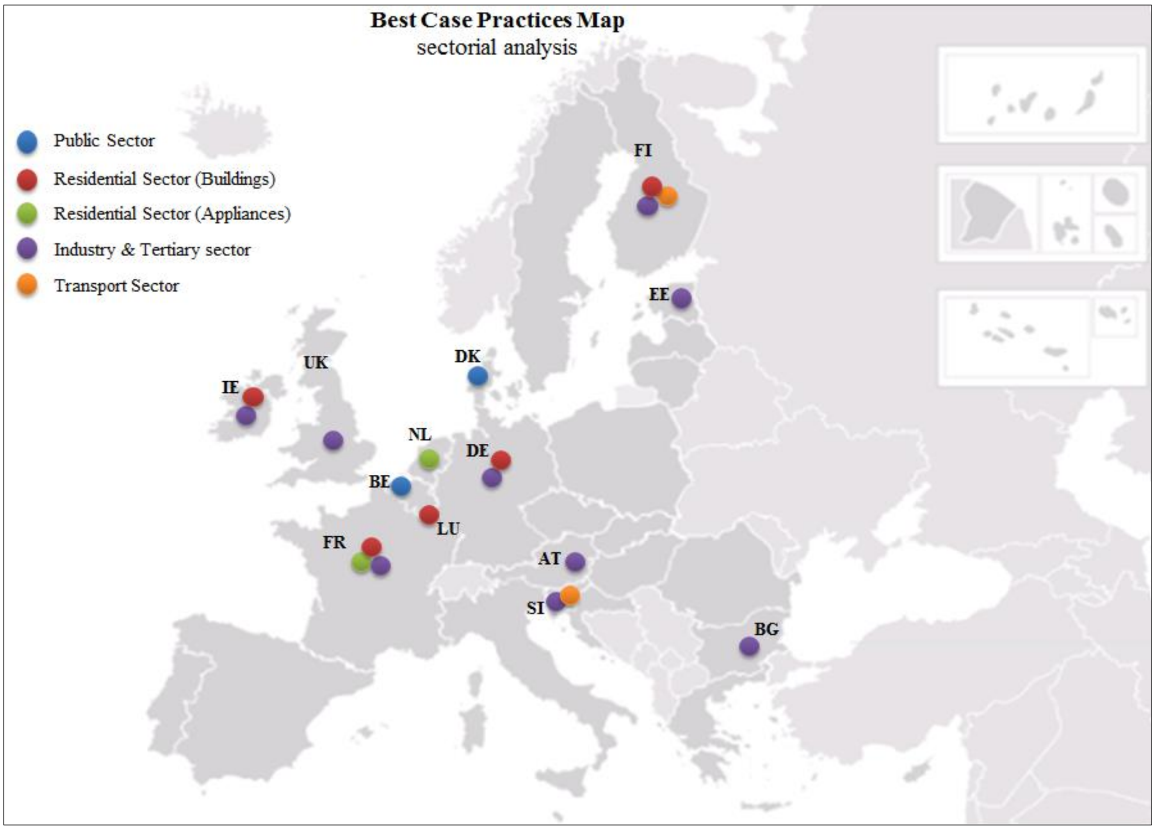


Figure 4.4 – BCPs geographical distribution, base map from EU (2013b).

From the analysis and comparisons carried out based on the data from EEW project, it is possible to outline key priority areas for the Member States actions on EE:

(1) The definition of national governance strategies that are aligned with the EU plans and ambitions, ensuring a balanced collaboration of actors at national level towards the delivery of energy savings across sectors. Only three Member States were presented as holding BCPs on EE governance, their knowledge must be analysed and shared across Member states.

(2) Industry and transport represent high contribution potentials to increase EE although on the 2nd round of NEEAPs. These were the sectors that presented more Member States on a *weak* sectorial policy situation, increasing the risk of achieving the 20% energy savings goal for 2020, as well as the development of the necessary path towards 2050 low carbon reality.

(3) Given the existing range of BCPs in each Member State and the importance of this knowledge to be transferred to other countries lacking measures and ambition for higher energy savings. An effort must derive both from the EC and by national actors (e.g.: energy agencies, national and local governments, etc.) to promote the dialogue and the access to this knowledge that will support information barrier removal from the market, fostering EE development and the range of associated direct and indirect benefits.

4.2.2.3. GOVERNANCE FRAMEWORK

EE governance consists in the "use of political authority, institutions and resources by decision makers and implementers to achieve improved energy efficiency" (Pierre, 2000 and Rhodes 2000 *apud* Jollands & Ellis, 2009a).

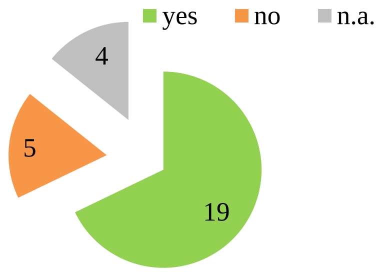
IEA and the European Council for Energy Efficient Economy (ECEEE) have stressed the priority of EE governance, to ensure that the necessary instruments exist and support the development of energy saving measures (IEA, 2010b; Jollands & Ellis, 2009b). The previous chapter outlined the overarching EE framework at the EU level by providing a *top down perspective*. This section presents the analysis of a limited set of indicators outlining the EE governance scenario across Member States.

This analysis is based in the dimensions for governance, defined by Jollands & Ellis (2009b): (1) institutional structures, (2) people and financial resources, (3) human capacity[27] and (4) political support. The data for the analysis was extracted from the World Energy Council Energy Efficiency and Policies database (WEC, 2013). The information for the analysis conducted is presented in Table D.1, Annex D.

(1) **Institutional Structures**, for this dimension of EE governance, the existence of entities that focus on EE and its development was the aim of the analysis.

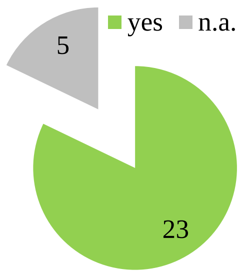
[27] People resources and human capacity are analysed as one dimension alone, from the perspective of employees working on energy related organisations at local, regional and national level (i.e.: energy agencies and ministries).

	Member States
yes	CY, CZ, EE, LV, SI, UK, FR, IT, HR, DE, AT, BG, MT, IE, DK, PT, FI, LT, PL
no	BE, EL, HU, LU
n.a.	RO, NL, ES, SK, SE

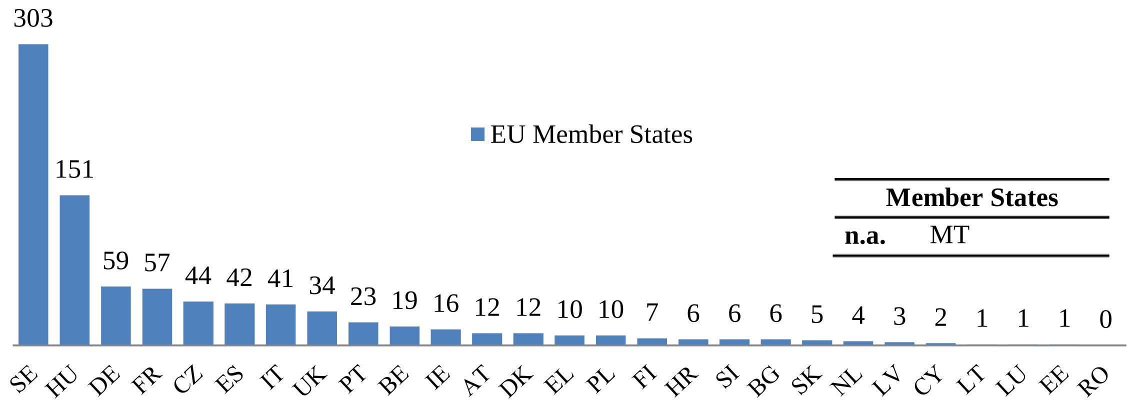


Graph 4.9 – Existing Ministry departments for EE at Member States. Source: Analysis of Annex D.

	Member States
yes	AT, BG, CY, DE, DK, EE, EL, ES, FI, FR, HR, HU, IE, IT, LT, LU, MT, NL, PL, PT, SE, SK, UK
n.a.	BE, CZ, LV, RO, SI



Graph 4.10 – Existing National energy agencies for EE at Member States. Source: Analysis of Annex D.

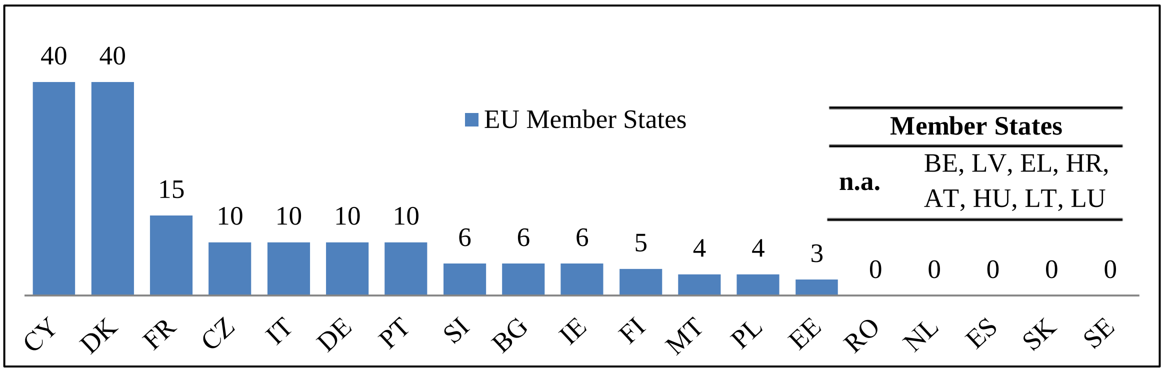


	Member States
n.a.	MT

Graph 4.11 – Existing Regional/Local energy agencies at Member States. Source: Analysis of Annex D

Graph 4.9, Graph 4.10 and Graph 4.11 disaggregate the distribution of existing entities working on EE at Member States with different levels of influence (i.e.: ministries, national agencies and regional/local agencies).

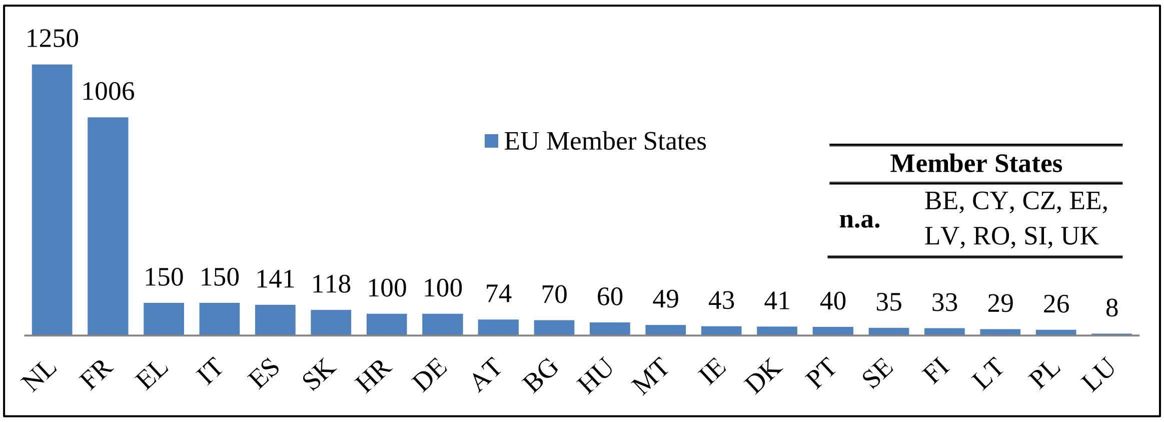
(2) **People resources / human capacity**, the data analysed is associated with the institutional structures presented previously, specifically, the staff working in these organizations, as an indicator of people resources dedicated to EE at the Member States. A comparison between Member States is outlined through Graph 4.12 and Graph 4.13.



Member States	
n.a.	BE, LV, EL, HR, AT, HU, LT, LU

Graph 4.12 – Employed staff at Ministry departments for EE. Source: Analysis of Annex D.

Regarding the employed staff at Ministry's departments on EE, the graph above does not include data for the UK, although it was available. Nevertheless, the staff count provided was for the entire Department of Energy and Climate Change (DECC) and accounted for 1600 employees (DECC, 2013; WEC, 2013), not entirely dedicated to EE issues.

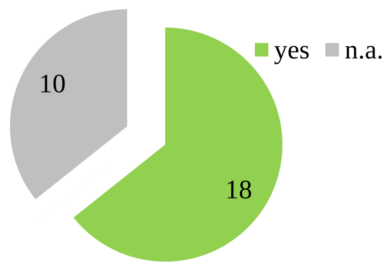


Member States	
n.a.	BE, CY, CZ, EE, LV, RO, SI, UK

Graph 4.13 – Employed staff at National Energy Agencies. Source: Analysis of Annex D.

(3) **Financial resources,** on the scope of this dimension the availability of dedicated EE funds was the main goal of the analysis, presented through Graph 4.14.

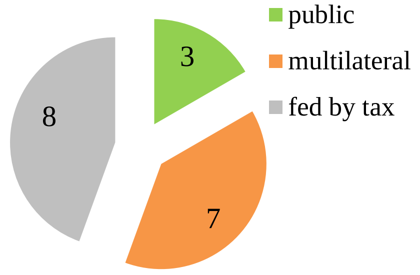
Member States	
yes	AT, HR, ES, BG, CZ, HU, IT, NL, RO, SK, CY, DK, DE, LT, PL, PT, SI, UK
n.a.	BE, EE, FI, FR, EL, IE, LV, LU, MT, SE



Graph 4.14 – Member States with dedicated EE funding. Source: Analysis of Annex D.

For the countries which present dedicated EE funding instruments, Graph 4.15 disaggregates the sources of funding.

	Member States
public	AT, HR, ES
multilateral	BG, CZ, HU, IT, NL, RO, SK
fed by tax	CY, DK, DE, LT, PL, PT, SI, UK

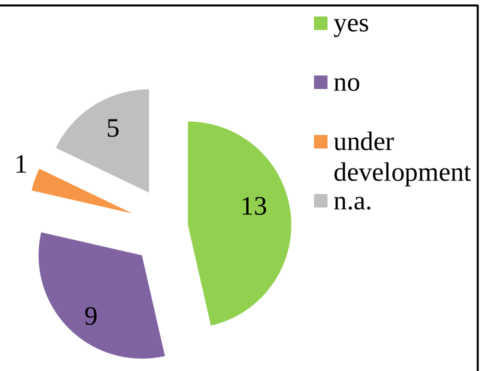


Graph 4.15 – Source of funding of Member States with EE dedicated funds. Source: Analysis of Annex D.

As for the sources of funding for EE, these are classified as: (1) public when the fund is planned on the public spending budget; (2) multilateral, when the fund is based on different financial streams; (3) fed by tax, when the fund is sourced only through a specific tax.

(4) **Political support,** the aim of the analysis was on the understanding of the existing political and legal acts that enable and foster EE, such as enacted laws and Member States compliance with EU directives and recommendations.

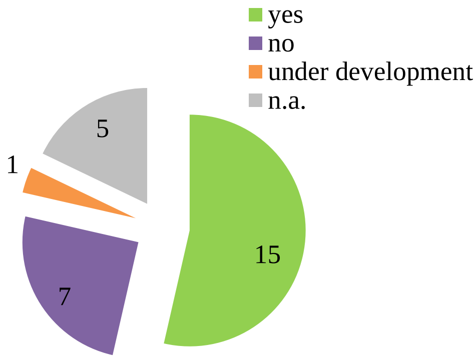
	Member States
yes	HR, CY, EE, FR, HU, IE, IT, PL, PT, SK, SI, SE, UK
no	AT, BG, CZ, DK, FI, DE, LV, LT, RO
under development	ES
n.a.	BE, EL, LU, MT, NL



Graph 4.16 – Energy law with EE targets. Source: Analysis of Annex D.

From the analysis of Graph 4.16 only 46% of the EU's countries have defined specific EE targets on their energy legislation. This situation may improve under the new EED obligations presented previously, as of the EE target for 2020 that after analysed by the EC may be approved or requested to be strengthened.

	Member States
yes	BG, HR, CY, CZ, DK, FR, DE, IE, IT, LV, MT, PL, PT, RO, SK
no	AT, EE, FI, HU, LT, SI, SE
under development	ES
n.a.	BE, EL, LU, NL, UK



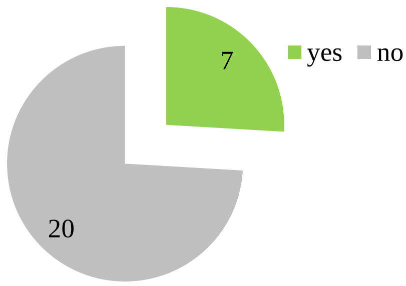
Graph 4.17 – Dedicated EE law. Source: Analysis of Annex D.

The scenario on existing EE law is similar to the situation on targets for EE. Through Graph 4.17 is possible to see that only 54% of the Member States have dedicated EE law.

National cost-optimal calculation on minimum energy performance requirements of buildings to EC

situation in 30th of April, 2013

	Member States
yes	DK, FR, HU, IE, LT, NL, SE
no	AT, BE, BG, CY, CZ, EE, FI, DE, EL, IT, LV, LU, MT, PL, PT, RO, SK, SI, ES, UK

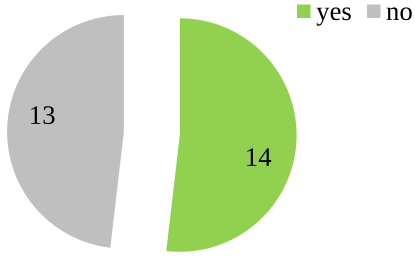


Graph 4.18 – Buildings performance cost-optimal calculations report to EC. Source: Analysis of Annex D.

National Nearly Zero Energy Buildings (NZEB) Report to EC

situation in 30th of April, 2013

	Member States
yes	BE, BG, CY, DK, FI, FR, DE, HU, IE, LT, NL, SK, SE, UK
no	AT, CZ, EE, EL, IT, LV, LU, MT, PL, PT, RO, SI, ES

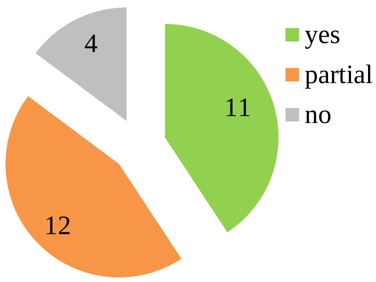


Graph 4.19 – NZEB report to EC. Source: Analysis of Annex D.

Graph 4.18 and Graph 4.19 are based on whether the reports were delivered or not, as the EC is still analysing the quality of those Member States that delivered the reports.

National Transposition of EPBD
due 9th of July, 2012
situation in 30th of April, 2013

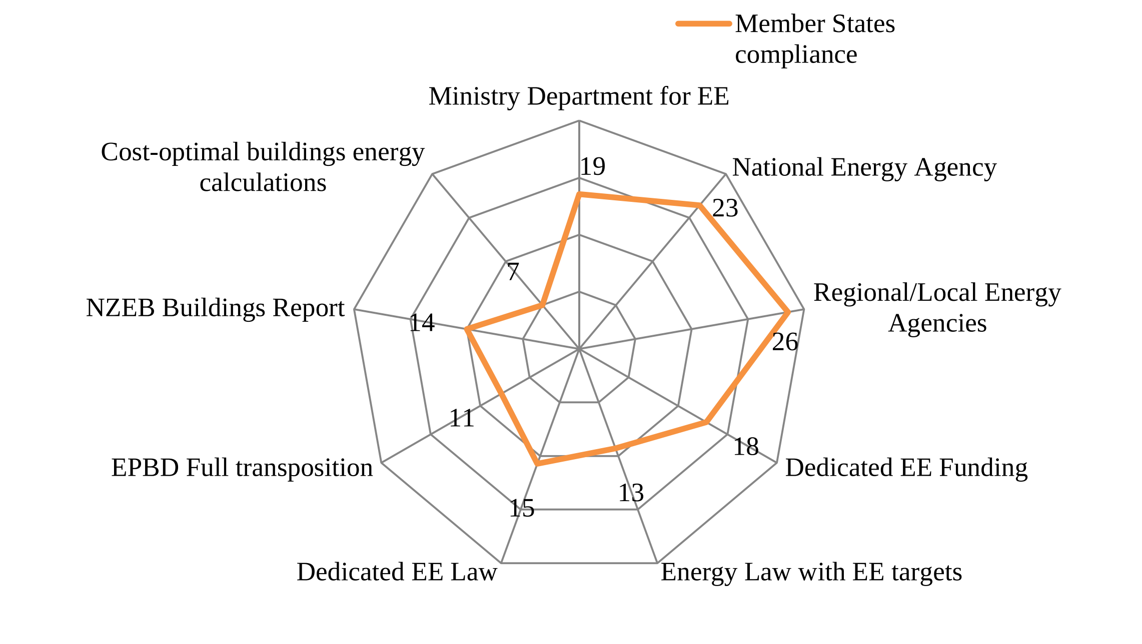
	Member States
yes	CY, CZ, DK, EL, HU, IE, LT, MT, SK, SE, UK
partial	AT, BE, BG, EE, FI, FR, DE, LV, LU, NL, PL, RO
no	IT, PT, SI, ES



Graph 4.20 – National transposition of EU's EPBD. Source: Analysis of Annex D.

Graph 4.20 is also based on the reporting status of the transposition of the EPBD at national level, as the EC verifies the reported transposition measures (EC, 2013c). The classification is based on: (1) yes, when all the requirements were communicated to the EC; (2) partial, when part of the requirements were communicated to the commission and (3) no, when none of the requirements were duly communicated to the EC.

From the set of indicators on EE governance at the Member States, and by applying the framework defined by the IEA (2010b) and Jollands & Ellis (2009b) (see Figure D.1, Annex D for the theoretical EE governance framework) is possible to present the current governance framework outlook by aggregating comparable data into a radial graph, enabling to understand the state of play of different governance dimensions.



Graph 4.21 – Governance framework outlook.

For a clear representation of the governance scenario only comparable information was included on the scope of the outlook presented in Graph 4.21, therefore the dimensions included are associated with institutional, financial and political resources availability only (e.g.: the number of Member States that have Ministry departments for EE is 19). As no comparable indicator was defined for the human resources data available this was not included in this aggregated analysis. The graph is designed for EU 28.

Through the analysis of the aggregated information it is possible to outline the areas of higher performance on EE governance and those which need more attention on developing the necessary framework to foster energy savings. In this scenario although the Member States have the national, regional/local structures to ensure that EE is being developed, as well as financial instruments dedicated to EE, it is important to act on the development of the political support structure.

The current risk on the energy efficiency agenda increases when considering that only 39% of the Member States have fully transposed the EPBD, which was due in July 9^{th}, 2012. Thus, the main priority must be to ensure that the national legal systems are in line with the EU strategy, whilst considering local complexities to enable the benefits of the overarching ambition for an energy efficient low carbon economy.

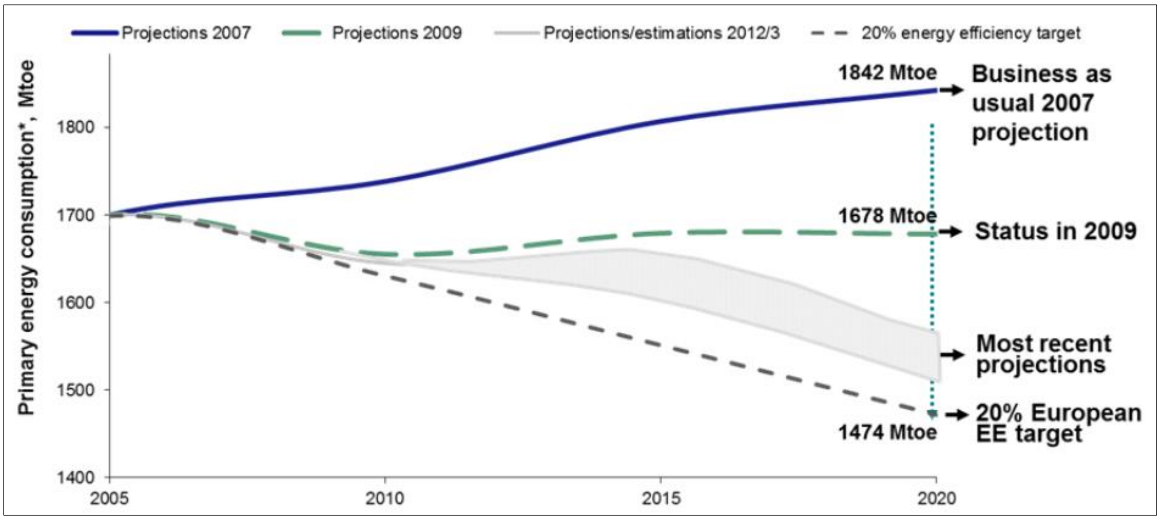
These risks must be prioritized at national level as well as at EU level, given their potential negative impacts on the planned strategies.

4.3. BRIDGING PERSPECTIVES ON ENERGY EFFICIENCY

Throughout this chapter, the situation on EE was described on the perspective of the Member States reality and their contributions. This approach was entitled as *bottom up perspective* due to the fact-finding analysis being focused on Member States progress, providing the necessary insights to define the European EE roadmap, having as a starting point each country and its performance in different EE areas analysed.

The analysis setting was aided by a comparison matrix, as described in the methodology section. Given the extension of the matrix the relevant excerpts are presented in Annex C and D, the most relevant conclusions of the analysis were included in this chapter. From the different comparisons and analysis conducted, the following aspects must be emphasized, given their potential impact on the EU agenda for EE improvements, and the overall benefits that achieving the planned agenda will deliver.

(1) **EE targets for 2020**, under the new EED Member States had to define targets to comply with the EE agenda for 20% reductions. The already presented targets overcome the global consumption planned, although by a small percentage. A contingency plan including cross-cutting collaboration between Member States and the EC must be a priority. Based on the most recent projection a gap is still present on the ability to deliver the 2020 EE target (see Graph 4.22), although lower than the gap acknowledged by the EC in 2011 (EC, 2011c) (see Graph 3.4, page 28, for the EE target gap projection presented in 2011).



Graph 4.22 – Projections on EU's primary energy use by 2020, most recent projection. Source: (EC, 2013v).

The expectation for the removal of the existing gap is dependent on the report from the EC due in June 2014 (EC, 2013b), analysing the most recent progress on the EE agenda and defining action steps on existing issues. A plan that tackles the gap is thus anticipated to be revealed in this document.

(2) **NEEAPs outlook**, the analysis conducted was based in plans designed under the ESD (Directive 2006/32/EC), which focused on EE at end-uses. This paradigm is now changed through the new EED, through which Member States must redefine their national strategies to overcome challenges and deliver EE improvements throughout the entire energy system (i.e.: generation, transmission and end-uses).

The most relevant findings of the analysis rely on the fact that the areas which were more times identified as *weak* sectorial policies across Member States, are those with the most relevant potential to contribute for EE improvements, namely: industry, which was the sector where EE increased the most in the past (see Graph 4.1, page 43) and transport, which represents the higher potential to increase energy savings in the future (see Graph 4.5, page 46).

Given that these NEEAPs analysed through the reports presented by EEW were developed prior to the new EE framework at European level, evolutions are expected in the sectors previously stated, as well as measures for energy generation and transport.

(3) **Governance framework**, presents an unstable scenario across the analysed dimensions. The higher risk is associated with the political support for EE, which instead of sustaining EE development are backlashing Member States performance given the continuous infringements to the EU directives, blocking EE improvements, whilst bringing legal and financial burdens to Member States in infringement situation (EC, 2013y).

The contribution aimed from this chapter was firstly to complement the *top down perspective* provided in Chapter 3 through a fact-finding analysis on Member States, resulting in the *bottom up perspective* disclosed. The combination of these perspectives allows the outlining of strategies that combine both national and European level insights, aiming at a stronger, faster, more collaborative effort to deliver energy savings and removal of existing barriers and risks.

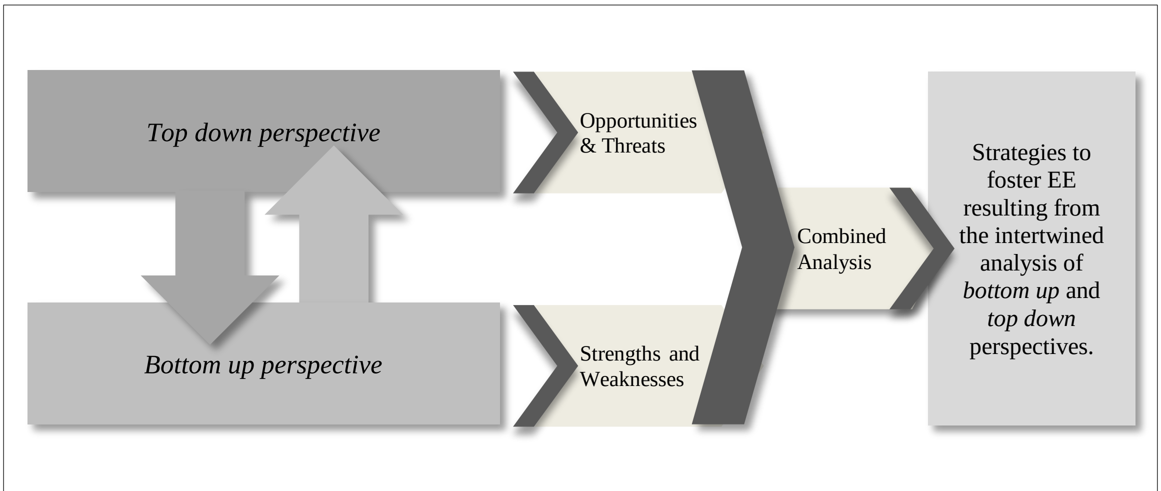


Figure 4.5 – Scheme to define EE strategies combining *top down* and *bottom up* viewpoints.

The previous scheme (Figure 4.5), presents a proposal on how to derive strategies by bridging the two developed perspectives on EE. On this proposal the SWOT analysis is the aiding mechanism to combine the perspectives to extract the strategies that combine Strengths, Weaknesses, Opportunities and Threats (SWOT) to foster energy savings throughout the EU.

The SWOT analysis derives from business administration techniques on evaluating the strategic position of a company on a straightforward manner (Hill & Westbrook, 1997). Its application on energy research and sustainable energy development has been presented in different projects and studies (BalticClimate, 2013; Dinya, 2013; EC, 2005b), proving its ability to outline relevant courses of action to foster a sustainable energy system.

Applying the SWOT analysis method to outline strategies through the proposed scheme in Figure 4.5, allows the combination of the external situation, based on: Opportunities (O) and Threats (T), of the *top down perspective* regarding the European level strategies, laws and support actions for EE. With the internal (i.e.: national) situation, based on: Strengths (S) and Weaknesses (W), of the *bottom up perspective* regarding the national actions and efforts for EE.

Given the differences at each Member State it is recommended to follow a country-by-country analysis using a matrix similar to the presented bellow (Table 4.3) to list the strengths, weaknesses opportunities and threats and then combine them in the quadrants presented (i.e.: SO, WO, ST and WT). As stated by Markovska *et al.* (2009) the strategies deriving from the SWOT analysis must: (1) develop strengths, (2) remove weaknesses, (3) explore opportunities and (4) mitigate external threats.

Table 4.3 – EE SWOT analysis framework. Adapted from: (Dinya, 2013).

	Internal situation (*bottom up perspective)* →	Strengths	Weaknesses
External situation (*top down perspective)* ↓	**EE SWOT Analysis**	• List Strengths	• List Weaknesses
Opportunities	• List Opportunities	**SO Strategies** *to explore opportunities based on internal strengths*	**WO Strategies** *to remove internal weaknesses through external opportunities.*
Threats	• List Threats	**ST Strategies** *to avoid threats based on internal strengths*	**WT Strategies** *to avoid threats and eliminate internal weaknesses.*

The proposed scheme for bridging perspectives can be compared to the work carried out successfully through an EU funded project, named *RESGen*, on building energy self-sufficiency. The project ran from 2009 to 2012, focusing on building strategic road-maps and joint action plans for renewable energy in the UK, FI, HU and ES (RESGen, 2013).

Although *RESGen* was focused on renewable energy, its success on driving joint action to develop regional strategies, combining different perspectives and realities present a valid argument for a similar scheme for EE to be pursued as soon as possible.

Considering the proposed scheme to define EE strategies combining *top down* and *bottom up* viewpoints presented in Figure 4.5, and the SWOT analysis framework disclosed through Table 4.3, the following table (Table 4.4) aggregates the necessary inputs to define EE strategies.

Table 4.4 – SWOT analysis inputs aggregation.

	Member States - internal situation (*bottom up perspective*) – General
Strengths	• 2nd round NEEAPs developed to ensure EE progress; • Public sector EE policies; • 13 Member States considered as BCPs regarding EE policies; • 23 Member States with operating EE agencies; • 18 Member States with dedicated EE funding instruments: • 15 Member States with EE legal instruments.
Weaknesses	• 13 Member States with legislated EE targets; • Lack of Member State's ambition on the preliminary EE targets for 2020, defined on the scope of the new EED; • 11 Member States with the EPBD transposed; • Industrial sector EE policies; • Residential appliances EE policies.
	EU – external situation (*top down perspective)*
Opportunities	• Structured EE action framework, based on strategies, laws and support initiatives; • New EED; • End-use EE potentials identified; • 2020 20% EE headline target; • 2030 framework for 40% reduction on GHG emissions; • 2030 roadmap for 80-95% reduction on GHG emissions; • Cross-country collaboration potential; • Funding opportunities (e.g.: IEE, Eco-Innovation); • Financial crisis, as a motivation to increase EE; • Resource efficiency flagship initiative; • High unemployment rates;
Threats	• Track record of difficulties on delivering EE targets; • Authority to impose binding targets; • Price of imported energy: • Current identified gap on the overall EU EE target for 2020; • Economic crisis, which may reduce the priority of EE improvement actions.

Considering the aggregated inputs, outlined above (Table 4.4), it is possible to perform a SWOT analysis, combining the internal and external dimension of EE to define strategies according to the method presented on Table 4.3.

The following EE strategies (Table 4.5) are possible coursed of action formulated as a result of the application of the SWOT analysis.

Table 4.5 – Strategies proposed from SWOT analysis.

SO Strategies	• Ensure that Member States develop their 3rd NEEAP considering available BCPs on EE policies, through knowledge transfer and cross-country collaboration; • Increase awareness of financial benefits possible through EE improvements, focusing on the public sector as a major energy consumer; • Develop national EE strategies aligned beyond 2020, considering the 2030 and 2050 EU roadmaps.
WO Strategies	• Develop contingency actions for Member States to tackle the lack of ambition on the proposed EE targets for 2020 on the scope of the new EED; • Roll-out of EE measures targeting the Industrial and Residential appliances sectors, supported by tailored financial support schemes and measures implementation assistance; • Explore existing funding programmes available at EU level to foster EE improvements, and foster indirect benefits such as employment creation;
ST Strategies	• Create an accessible and detailed knowledge centre for Member States to share their EE BCPs and support other countries on overcoming barriers and challenges, contributing to reduce the ambition gap of EE improvements targets; • Make the most of the public sector engagement on implementing EE improvement measures to develop the EU ESCO market, increasing the availability of funding opportunities and the validation of innovative business models for energy performance contracting; • Develop awareness campaigns through national energy agencies to disseminate the contribution of EE for socio-economic development, which is decisive to improve Europe's economic performance.
WT Strategies	• Ensure a balanced contribution for the delivery of EE improvements planned by Member States and the EU as a whole, reducing the risk of demanding unrealistic goals, and increasing countries impetus to deliver the defined strategies; • Develop support mechanisms to ensure that the EU Directives are aligned with Member States EE improvement capacity, and assist on their timely and correct transposition; • Analyse the reasons for late transposition of EE related laws and define a framework to reduce the irregularities on EU law enactment across Member States.

The application of the scheme proposed should be acknowledged as an initial contribution to the current practices on developing EE strategies. This analysis requires a detailed and up-to-date understanding of each Member State situation, as well as of the EU as a whole, in order to design realistic and appropriate strategies.

5. ENERGY EFFICIENCY AND JOB IMPACTS

Within the perspectives outlined on EE throughout Europe, a wide spectrum of indicators were presented and aggregated on Chapter 4, combined with the strategic analysis developed on Chapter 3. These have been ultimately driven by the EU ambition for a more competitive, sustainable and secure energy system by 2020 (EC, 2011d), in line with the wide-action strategy – *Europe 2020*, for smart sustainable and inclusive growth (EC, 2010a).

On the scope of the efforts towards sustainable and inclusive growth, job creation and skills development have also been defined as a priority in Europe. Employment thus is one of the actions embraced by Europe's 2020 strategy, and its supporting flagship initiative fostering new skills and jobs (EC, 2010b). The Committee of the Regions stated that actions on energy, resource efficiency and pathways for new skills are part of the "new engines for boosting growth and jobs" (EU, 2012a).

The EC through the initiative on new skills and jobs defined that (EC, 2010b):

> A skilled workforce is an essential asset to develop a competitive, sustainable and innovative economy in line with Europe 2020 goals. In times of budgetary constraints and unprecedented global competitive pressures, EU employment and skills policies that help shape the transition to a green, smart and innovative economy must be a matter of priority.

The aim of this chapter is hence to link EE and its ability to create new jobs, providing an overview on green jobs and the most relevant EE and job creation studies available in the literature. Given the scarcity of studies focusing on employment impacts of EE, the studies presented are not limited to EU studies only, also being presented the most relevant studies from the USA. The diagram below (Figure 5.1) represents the connection between the previous chapters on EE progress in Europe and the focus on job creation of the subsequent chapters, linking *sustainability* and *inclusiveness*.

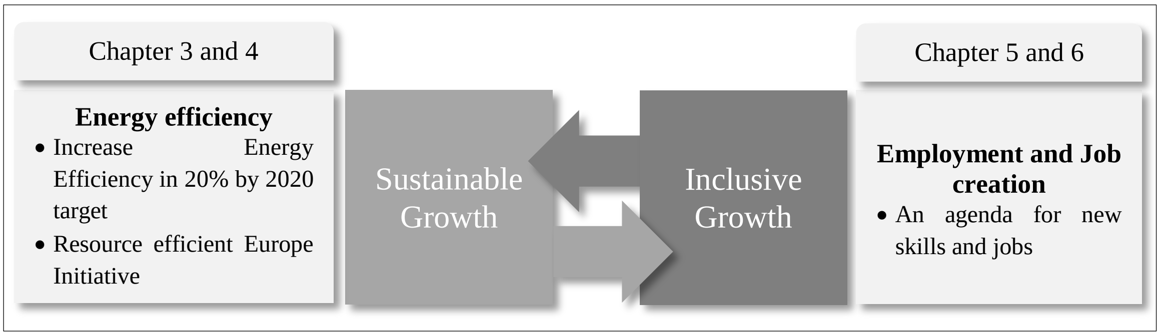


Figure 5.1 – Connecting energy efficiency improvements and its employment impacts. Adapted from: (EU, 2012a).

Furthermore this chapter sets the foundations for the experimental study results showcased in Chapter 6 on employment impacts of EE in Portugal. In addition to the literature review on job creation through energy efficiency, concepts and methodologies for EE job creation assessment are defined and discussed.

5.1. UNDERSTANDING THE CONNECTION

As presented in Table 2.3, page 18 of Chapter 2, job creation is one of the indirect benefits associated with the development of EE initiatives (IEA, 2012b; Neves *et al.*, 2008). A report from the Organisation for Economic Co-operation and Development (OECD, 2003) also presented employment as an indirect benefit of EE measures and policies.

Furthermore, ECEEE (2013) places energy efficiency improvements as a critical step for increased competitiveness, whilst being the only proven pathway to secure existing jobs and create new ones on the scope of more efficient products, contributing also to the development of more efficient industries.

Understanding the connection between energy efficiency and its impacts on jobs requires a blended knowledge regarding green jobs, job measurement definitions and assessment methodologies, which are further explored in this section.

5.1.1. GREEN JOBS

Green jobs consist on the jobs deriving from the clean energy economy (Engel & Kammen, 2009). In this sense investing on EE improvements will reallocate financial streams that would be otherwise used on energy related costs. A study by Sorrell & Speirs (2010) complements the previous by highlighting these as the jobs deriving from the transition to a low carbon economy.

The definition of *green jobs* is far from being universal (Silva *et al*, 2012), different authors and climate protection organizations present their view and contribution on what shall be the best way to define this broad job category. The United Nations (UNEP, 2008) defines green jobs as "[…] work in agricultural, manufacturing, R&D, administrative and service activities that contribute substantially to preventing or restoring environmental quality […] this includes jobs that help to protect ecosystems and biodiversity, reduce energy, materials and water consumptions through high efficiency strategies; […]".

Jobs within EE are logically within the scope of a green job, nevertheless according to Pearce & Stilwell (2008) a problem remains unsolved on the current range of available definitions in the literature, which challenges the extension to what a certain job can be categorised as a *green-job*, making it harder to know what jobs are included (Sorrell & Speirs, 2010). In line with this standpoint the Worldwatch Institute states that:

> Defining the energy efficiency sector is a vexing problem, since most of the relevant forms of employment are embedded in a broad range of existing industries such as vehicle manufacturing, construction, lighting, heating and cooling equipment, electronics, appliances […] (Worldwatch Institute, 2008 *apud* Pearce & Stilwell, 2008)

On understanding the current range of available *green jobs* definitions, some concepts focus on the occupations and skills, whilst others on employment in industries or projects (Silva *et al.*, 2012).

The previously presented UNEP concept provides a value-chain approach on defining green-jobs, stating the different stages that a good or service goes through. This supports the complexity of accounting the range of green jobs within the EE industry. Nonetheless Wei *et al* (2010) reinforce the viewpoint of *green jobs* as those referring to the reduction of environmental impacts of companies and economic sectors, stating that on the scope of EE these are not strictly *green jobs*, but rather employment opportunities that would not have existed without the EE measures or programmes.

The American Council for an Energy Efficiency Economy (ACEEE, 2012), reporting on job creation provides a baseline on what are the potential job opportunities deriving from EE, namely: work for electricians, heating & air conditioning technicians, carpenters and construction site workers, roofers, insulation installers, building inspectors, computer software engineers. The previous list is not exhaustive; any job may be to one extent considered as a *green job* if contributing to the promotion of a healthier environment through EE improvement.

5.1.2. JOB CONCEPTS AND DEFINITIONS

Job analysis reports on EE or clean energy are frequently associated with concepts that provide a more specific understanding on what are the measures of the analysis and the real impact of a specific programme on EE.

The impacts on employment creation or destruction associated with EE developments are presented on a disaggregated form, composed by a range of categories (Gross *et al.*, 2012). These categories are presented in most studies available in the literature, providing the necessary information for non-accustomed readers. The table below (Table 5.1) addresses the most common terms and definitions used in job impact analysis resulting from different reports available in the literature.

Table 5.1 – Most common concepts and definitions used in job analysis

Concept	Definition	References
Job, Job-years	Is the full-time equivalent (FTE) of one person for one year, also equivalent to person-year, or the employment of 2 persons for 6 months each, or 4 persons for 3 months each.	(ACEEE, 2012a, 2012b; Wei *et al.*, 2010)
Gross Jobs	The total amount of jobs existing at an industry and its supply chain.	(ACEEE, 2012b)
Direct Jobs	Consist on jobs that are directly supported through a shift in spending, deriving from an expenditure or effort (e.g.: construction jobs for a building retrofit). Namely jobs directly associated with a certain EE measure or project and its design, development, control and maintenance actions.	(ACEEE, 2012a, 2012b; Lambert & Silva, 2012; Wei *et al.*, 2010)
Indirect Jobs	Are those deriving from the supply chain and support industries of the industry which is directly associated with expenditures on EE. (e.g.: manufacturing the insulation materials to renovate a building), presented as the *multiplier effect* or *supplier effect*.	(ACEEE, 2012a, 2012b; Association of Energy Conservation, 2000; Gross *et al.*, 2012; Lambert & Silva, 2012)
Induced Jobs	Are those generated by the expenditure of received income from the created direct and indirect jobs.	(ACEEE, 2012a, 2012b; Gross *et al.*, 2012; Lambert & Silva, 2012; Sorrell & Speirs, 2010; Wei *et al.*, 2010)
Net Jobs	Is the number of direct and indirect jobs created in an industry, obtained by considering both positive and negative impacts on employment.	(ACEEE, 2012b; Lambert & Silva, 2012)
Displaced Jobs	Refer to the jobs destroyed from the shifting of economic activity from one economic sector to another.	(Gross *et al.*, 2012)
Labour Intensity	Consists on the number of jobs required to support the expenditure necessary to produce products and services.	(ACEEE, 2012b; Association of Energy Conservation, 2000)

The UK's Association of Energy Conservation (2000) through the concept of labour intensity presented above, highlighted the capacity of EE to create new jobs. An example of this is the manufacturing, installation and maintenance related to EE measures in buildings which are more labour intensive in comparison to energy supply.

5.1.3. JOB IMPACT ASSESSMENT METHODOLOGIES

The calculation and assessment of job impacts of EE can be conducted using different methodologies. This section presents a brief description of assessment methods, which will be useful on understanding the review of existing studies presented in Section 5.2.

Table 5.2 showcases the most commonly used methodologies for assessing employment impacts.

Table 5.2 – Most common methodologies on assessing employment impacts. Adapted from: (Breitschopf, Nathani, & Resch, 2011; Gross *et al.*, 2012; IRENA, 2011; Wei *et al.*, 2010).

Methodology	Description
Employment factors	Based on estimation of the average number of job unit of energy saved and then multiplied for the total energy savings potential. The use of employment factors is specific to technologies and stages in the value chain, useful for direct job estimations.
Supply chain approach	Consists on mapping the range of details of the supply chain for a certain technology and estimating the material and labour costs, as well as profit margins. The supply chain methodology is useful on analysing direct and indirect job impacts.
Input-Output economic Model	Serves for macroeconomic outcome predictions, based on tracing linkages across the whole economy. The Input-Output model methodology is useful on analysing direct, indirect and induced job impacts across sectors.
Direct Surveys	Provide real data on employment from companies actively operating in the EE field. Through a survey it is possible to obtain the real characteristics of the industry. It is more resource intensive than the previous methodologies described, the value of the information must thus be analysed for a cost-effective study. The use of surveys is useful on analysing the direct jobs, usually expressed as FTE jobs.

Wei *et al.* (2010) categorises the available methods in the literature regarding job creation in the clean energy industry in two types, namely: (1) Top-down methods: As those using Input-Output economic models, and (2) Bottom-up methods: As those based on analytical, case study/survey collected data.

Each type of methodology has differences on their usage and obtained outcome, some providing wider results, whilst other focusing on specific projects or supply chain links. The choice of a model must thus be based on the goals of the research project and the resources available (i.e.: time, money and people), ensuring cost-effectiveness and results quality.

5.2. REVIEW OF EXISTING STUDIES

The existing literature on EE and its impacts in jobs is varied in measures, results and methodologies used. Much of the available analysis was conducted by non-profit organizations (NPOs) and private consulting firms, whilst the journal approved papers represent a smaller share of existing studies and reports. The review of existing studies on EE jobs impacts aimed to outline a comprehensive background on the state-of-the-art, their extension in terms of sectors, projects and their geographical reach, as well as the methods used on achieving the results presented.

The following table (Table 5.3) aggregates the main findings of the review, which enables to compare different studies and their scope of analysis.

Table 5.3 – Review of existing studies on EE jobs impacts.

No.	Author	Research type	Sample size	Year	Region	Scope	Method	Jobs	Direct Jobs	Indirect Jobs	Induced Jobs	Notes
1	(Janssen & Staniaszek, 2012)	NPO report	35 studies analysed from 20 sources.	2012	EU and USA	EE in Buildings	Analysis of existing reports and studies.	-	19 jobs per 1M€ invested	n.a.	n.a.	The results showcased are focused on EU potential for jobs through investments in improved EE of the building stock. The direct jobs number is an average of the conducted analysis.
2	(Burr & Garrett-peltier, 2012)	NPO report	n.a. (*Input-Output table*)	2012	USA	EE in multifamily residential and commercial buildings.	Input-Output Model	-	6,92 jobs per 1M$USD invested	4,32 jobs per 1M$USD invested	4,50 jobs per 1M$USD invested	These results derive form the employment through operational improvements in the building stock. Detailed data per specific measure is disclosed on the study report.
3	(Bezdek, 2009)	NPO report	n.a.	2007	USA	General EE Industry	n.a.	8 jobs per 1M$USD in revenue	-	-	-	The study presents definitions for EE and renewable energy (RE) jobs and a comprehensive analysis of the current and future outlook of jobs created. The value is an average of 3 scenarios.
4	(The Blue Green Alliance, 2010)	Private company report for NPO Association	n.a. (*Input-Output table*)	2010	USA	EE jobs from: Building retrofits, mass transit and smart grids.	Input-Output Model	-	12,2 jobs per 1M$USD invested	-	-	The report estimates job impacts from the American Clean Energy and Security Act of 2009. The jobs figure derives from an average of results on building retrofits, mass transit and smart grids job impacts.
5	(Association of Energy Conservation, 2000)	NPO report	EE programme analysis	1991-1996	UK	EE scheme for improvements in low-income domestic sector.	Programme impacts analysis (case study).	-	24 jobs per 1M£ invested	61 jobs per 1M£ invested	-	The report analyses the UK's Home Energy Efficiency Scheme (HEES), period from 1991 to 1996.
6	(Association of Energy Conservation, 2000)	NPO report	EE programme analysis	1996	UK	EE project for housing improvements and skill development	Programme impacts analysis (case study).	-	58 jobs per 1 M£ invested	-	-	The report analyses Heatwise project impacts which focused on housing improvement, energy advice and escalating awareness and dissemination. Focusing on data from 1996 for these results

No.	Author	Research type	Sample size	Year	Region	Scope	Method	Jobs	Direct Jobs	Indirect Jobs	Induced Jobs	Notes
7	(Association of Energy Conservation, 2000)	NPO report	EE programme analysis	1998	UK	EE standards of performance for heating and insulation in housing.	Programme impacts analysis (case study).	-	11,4 jobs per 1M£ invested	87 jobs per 1M£ invested	-	Analysis of Standards of Performance impacts on job creation from 1994 to 1998.
8	(Association of Energy Conservation, 2000)	NPO report	EE programme analysis	1997-1998	UK	EE in appliances	Programme impacts analysis (case study).	-	75 jobs per 1M£ invested	10,2 jobs per 1M£ invested	-	Analysis of Fridgesavers programme in the UK, which had as main goal to replace fridges for mere energy efficient ones on low-income households.
9	(Association of Energy Conservation, 2000)	NPO report	EE programme analysis	1993	UK	EE demand side management initiative	Programme impacts analysis (case study).	-	20,6 jobs per 1M£ invested	-	-	Analysis of Manweb programme in the UK, to reduce peak demand in Holy Island, North Wales.
10	(Association of Energy Conservation, 2000)	NPO report	EE programme analysis	1994-1997	UK	EE demand side management initiative	Programme impacts analysis (case study).	-	19 jobs per 1M£ invested	-	-	Analysis of Shetland Integrated Resource Planning programme in the UK, to manage electricity consumption and increase EE.
11	(Association of Energy Conservation, 2000)	NPO report	EE programme analysis	1996-1997	UK	EE building regulations	Programme impacts analysis (case study).	-	29,8 jobs per 1M£ invested	70 jobs per 1M£ invested	-	The presented job figures derive from an analysis on implemented regulations for EE in buildings, based on efficiency ratings of building stock.
12	(Navigant Consulting, 2009)	Private company report for NPO Association	Connecticut, USA EE industry	2009	USA	EE in residential, small business and new constructions and retrofitting actions.	Expert interviews	-	9,1 jobs per 1M$USD invested	14,6 indirect & induced jobs per 1M$USD invested		The figures result from an analysis to Connecticut's EE industry. The direct jobs are an average of 3 fields of EE. Indirect and Induced jobs result from the use of an economic multiplier of 1.6.

No.	Author	Research type	Sample size	Year	Region	Scope	Method	Jobs	Direct Jobs	Indirect Jobs	Induced Jobs	Notes
13	(Navigant Consulting, 2009)	Private company report for NPO Association	Connecticut, USA EE industry	2009	USA	EE in residential, small business and new constructions and retrofitting actions.	Expert interviews	-	14,1 jobs per 1M$USD invested, subsidy adjusted.	22,6 indirect & induced jobs per 1M$USD invested, subsidy adjusted.		These figures are based on the previous assumptions, but adjusted for the consideration of State subsidies and their impact on EE jobs. Indirect and Induced jobs also result from the use of an economic multiplier of 1.6.
14	(Jaccard & Sims, 1991)	Journal Article	British Columbia, Canada EE Programme	1991	CA	EE demand side management initiative	Input-Output Model	13,5 jobs per 1M$USD invested	-	-	-	Analysis of 17 demand side management initiatives comprising residential, commercial, industrial and lighting actions.
15	(Goldman *et al.*, 2010)	NPO report	n.a.	2008	USA	EE cross-sectorial analysis	Expert interviews and Self-reported data	6,6 jobs per 1M$USD invested	-	-	-	Estimation of workforce on EE industry in the USA. The figure is the average of 5 sectors (i.e.: ratepayer-funded activity, low-income weatherization, ESCOs, insulation, government EE staff.
16	(Engel & Kammen, 2009)	NPO report	n.a.	2009	USA	Cross-technology assessment of electricity EE.	n.a.	0,38 jobs per saved GWh	-	-	-	US calculations (available in: http://rael.berkeley.edu/greenjobs). Figures from: (Wei *et al.*, 2010: 922)
17	(International Council for Local Environment Initiatives, 2001)	NPO report	City of Heidelberg EE actions	2001	DE	EE in buildings	Programme impacts analysis (case study).	10 jobs per 1M€ invested	-	-	-	The results derive from the expectation of building renovations at a yearly rate of 3%,

No.	Author	Research type	Sample size	Year	Region	Scope	Method	Jobs	Direct Jobs	Indirect Jobs	Induced Jobs	Notes
18	(EC, 2011q)	EC report	EU 27	2010-2020	EU	EED Impact Assessment	n.a.	4,4 jobs per 1M€ invested	-	-	-	Additional energy related investments – Option C2a (i.e.: cost-optimal levels).
								2 jobs per 1M€ invested	-	-	-	Additional energy related investments – Option C2b (i.e.: nearly zero energy level.)
								4,5 jobs per 1M€ invested	-	-	-	Total energy related investments – Option C2a (i.e.: cost-optimal levels).
								2,3 jobs per 1M€ invested	-	-	-	Total energy related investments – Option C2b (i.e.: nearly zero energy level.)
19	(ACEEE, 2012b)	NPO report	n.a.	2012	USA	General EE industry	DEEPER - ACEEE Methodology	20 jobs per 1M$USD invested	-	-	-	Calculations based on DEEPER model from ACEEE. (Available in: http://aceee.org/fact-sheet/deeper-methodology).
20	(CECODHAS, 2009)	NPO report	28 000 housing cooperatives	2010-2020	EU	EE through buildings retrofits	n.a.	21,25 jobs per 1M€ invested	-	-	-	Results from a project on directing EE improvements to social housing buildings in Europe.
21	(Ürge-vorsatz *et al.*, 2010)	NPO report	n.a. (*Input-Output table*)	2020	HU	EE through buildings retrofits	Input-Output Model / Up scaling of case studies	37 jobs per 1M€ invested	-	-	-	Projections for future employment impacts of deep renovations in Hungary.

No.	Author	Research type	Sample size	Year	Region	Scope	Method	Jobs	Direct Jobs	Indirect Jobs	Induced Jobs	Notes
22	(Sundquist, 2009)	NPO report	n.a.	2009	USA	EE through buildings retrofits	Expert interviews and Self-reported data	4,3 jobs per 1M$USD invested	-	-	-	For EE in large commercial buildings
								7,4 jobs per 1M$USD invested	-	-	-	For EE in multifamily residential buildings
								9,1, jobs per 1M$USD invested	-	-	-	For EE in single family residential buildings
23	(Economidou *et al.*, 2011)	NPO report	EU 27, Switzerland and Norway	2011	EU	EE in buildings	Input-Output Models, National statistics and Case studies.	17 jobs per 1M€ invested	-	-	-	Average of a range of studies spanning case studies and national statistics analysis. Focusing on building retrofits throughout Europe.
24	(Lund-Larsen, *et al.*, 2009)	NPO report	n.a.	2009	DK	General EE industry	n.a.	7,3 jobs per 1M€ invested	-	-	-	The report outlines key proposal for high EE in Denmark for a more sustainable future. Figure results from the average of 3 outlooks.

The previous review (Table 5.3), is based on the analysis framework presented by Janssen & Staniaszek, (2012) for comparing different studies. Encompassing results from different EE improvement actions, as well as different methodologies of analysis and projections of job impacts.

Often, when authors refer their conclusions as *jobs per 1M€ invested*, it is difficult to understand if the figure presented is for *Net Jobs* creation, or *Direct Jobs*. This increases the uncertainty of the expected impacts on employment of an action towards EE improvements.

The analysis conducted is based on 24 studies that result from 17 authors, covering 7 different countries/regions, namely: CA, DE, DK, EU, HU, and USA. The documents analysed can be categorised as: (1) NPO reports, (2) EC reports, (3) Journal articles and (4) private company reports contracted by NPOs.

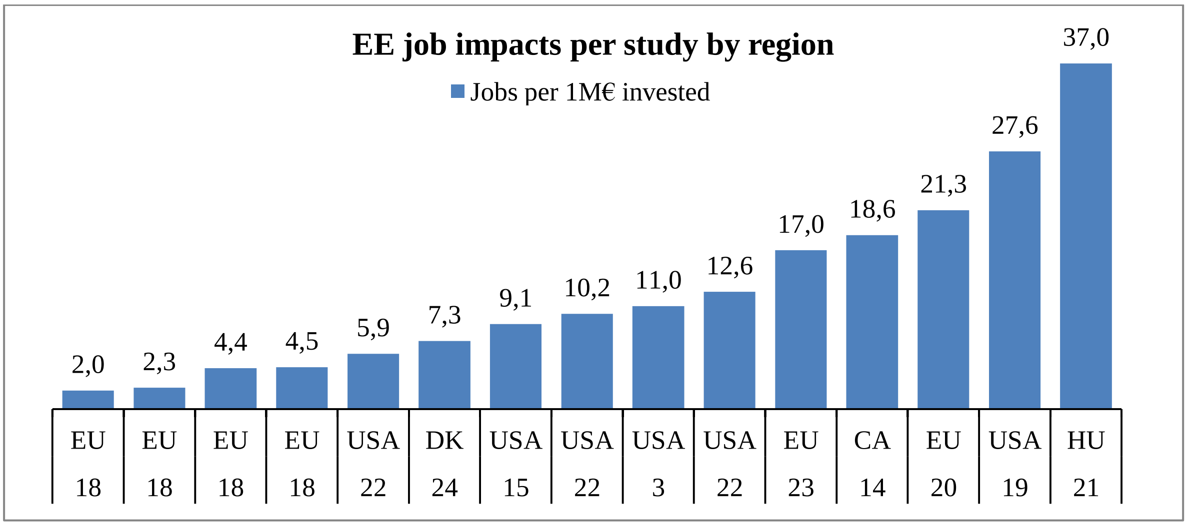
The data gathered on Table 5.3 is not sufficient to outline individual impacts for the different sectors within EE (i.e.: building retrofits, lighting, household appliances, etc.), rather provides a background on a range of job impacts and their variability across regions and scope of the studies showcased. The table below (Table 5.4) outlines some indicators resulting from the review.

Table 5.4 – Indicators from studies review

Studies review indicators	
Average Jobs per 1M€ invested	12,7 FTE
Minimum Jobs per 1M€ invested	2,0 FTE
Maximum Jobs per 1M€ invested	37,0 FTE
Average Direct Jobs per 1M€ invested	24,1 FTE
Minimum Direct Jobs per 1M€ invested	9,5 FTE
Maximum Direct Jobs per 1M€ invested	63,2 FTE

The indicators above were calculated for the criteria with more available information, namely: (1) Jobs and (2) Direct Jobs, *per 1M€ invested*. Although when calculating the indicators associated with *Jobs per 1M€ invested* some uncertainty remains on assuring if these are net, direct or gross jobs. Furthermore, some studies present their figures based on different EE industry sectors (see: (ACEEE, 2012b; Engel & Kammen, 2009; Sundquist, 2009)), different scenarios (see: (Bezdek, 2009; Lund-Larsen *et al.*, 2009)) or a combination of these (see: (Burr & Garrett-peltier, 2012; EC, 2011q)). This wide span of approaches also contributes to an uncertain baseline when projecting job impacts of an investment for EE improvement.

The results per study, for *Jobs per 1M€ invested* organized by region are presented in the following graph (Graph 5.1).



Graph 5.1 – EE impacts on jobs, existing studies review synthesis of Jobs per 1M€ invested.

Each result presented on Graph 5.1 corresponds to a study reviewed on Table 5.3 – Review of existing studies on EE jobs impacts., the number below each region is the number (No.) given to each study on the review.

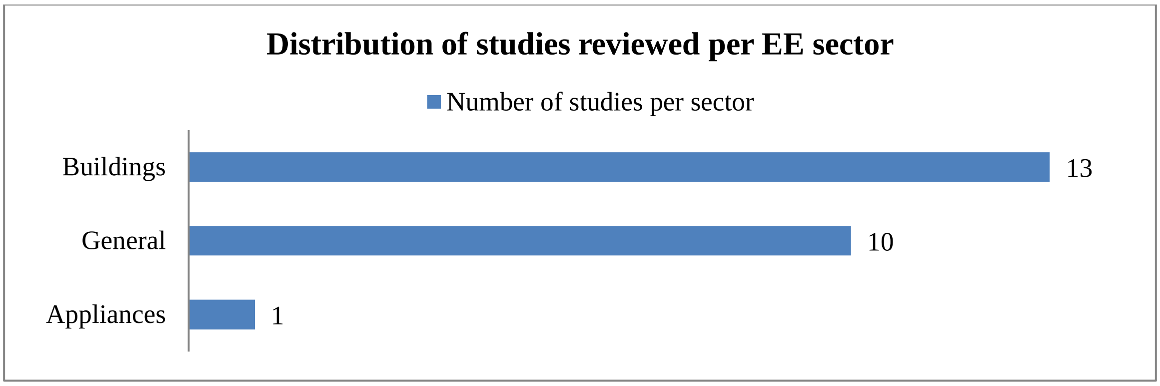
Study No. 21 from Hungary on EE job impacts of buildings retrofits is the case analysed with the highest job creation for 1M€ invested, whilst the scenarios presented by the EU on study no. 18 present the lowest job creation capacity. As the review included studies from North-America (i.e.: CA and USA), and Europe (i.e.: DE, DK and HU) the table below (Table 5.5) compares the difference between 1M€ invested in the USA and in Europe and the job creation expected.

Table 5.5 – Comparison of EE job impacts per 1M€ invested.

Region	Average jobs per 1M€ invested	Studies included on calculation (Study No.)
North America	13,6 FTE	22, 24, 15. 22, 3, 22, 23, 14, 20, 19
Europe	12,0 FTE	18, 22, 24, 15, 22, 3, 22, 23, 14, 20, 19, 21

Nevertheless the particularities from each study, the results obtained for the two regions on the impact of investing 1M€ on EE are similar, as indicated in Table 5.5.

On the scope of the analysis performed, the sectors within the EE industry included on the review are also important. From the 24 studies reviewed, 13 had as scope EE in Buildings, 10 focused on EE in general, and 1 regarded EE in appliances, as presented in Graph 5.2 – EE sectors of studies reviewed..



Graph 5.2 – EE sectors of studies reviewed.

The review of existing studies included EE impact assessments on job creation from 1991 to projections up until 2020. The results yielded impacts from 2 to 37 jobs per 1M€ invested on EE improvements.

Therefore the conclusions and analysis presented must be acknowledged as the result of a fact-finding desk-based research process, which presents a considerable amount of impacts deriving from EE in buildings and EE industry in general. Presenting a high range of variability but providing an understanding on the type of reports and their outcomes, which are present in the literature and which should be taken into consideration when building new models and analysing the job impacts of specific EE improvement actions. The analysis resulted on an estimate that investing 1M€ on EE leads to 12,7 FTE jobs having as background the set of 24 case studies and reports analysed.

5.3. FUTURE OUTLOOK ON JOB CREATION

Investing on EE delivers between 2,5 to 4 times the jobs yielded by the same amount of investment on producing energy from conventional sources (i.e.: fossil fuels), as stated by EC (2012c), thus the importance of shifting towards a *low carbon economy*, creating new jobs whilst improving environmental protection and living standards.

This section provides a complementary vision to the previous review of existing studies, bridging current impacts with future outlooks for *green jobs* creation through EE, at a Global and European level.

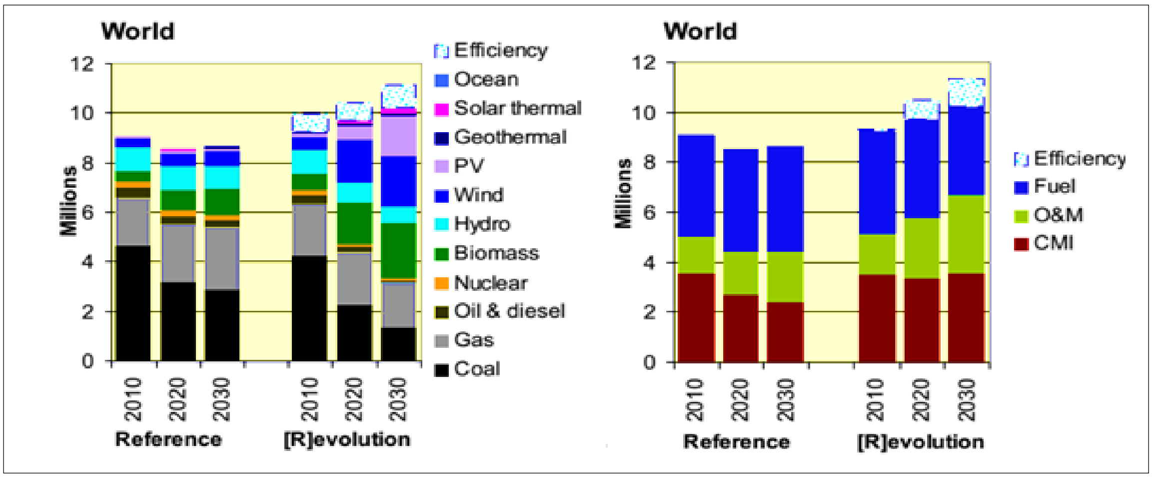
5.3.1. GLOBAL OUTLOOK

The United Nations (UNEP, 2008) highlighted the job creation opportunities reliant on fostering new building standards, which would also revolutionise the construction industry whilst boosting new jobs, alongside with opportunities in more energy efficient transportation and agriculture sectors. Through the correct economic stimulus to boost new clean technologies for a more energy efficient world, the UN states that "The numbers of additional green jobs that could be generated through such path breaking measures is unknown, but obviously enormous." (UNEP, 2008). The future *green jobs* potential of the different sectors within the EE industry are presented on the table below (Table 5.6), based on a qualitative scale.

Table 5.6 – Green Jobs potentials for EE related activities. Adapted from: (UNEP, 2008).

Industry	Sector	Greening Potential	Green Job Progress to-date	Long-term Green Job Potential
Energy Efficient related activities	Fuel-efficient cars	Fair to Good	Limited	Good
	Mass transit	Excellent	Limited	Excellent
	Rail	Excellent	Negative	Excellent
	Aviation	Limited	Limited	Limited
	Green Buildings	Excellent	Limited	Excellent
	Retrofitting	Excellent	Limited	Excellent
	Lighting	Excellent	Good	Excellent

By comparing the assessment of the *green job progress to-date* with the *long-term green job potential* a gap between these two stages is evident. This enhances the importance of the implementation of instruments that foster EE, contributing to a *greener economy* and to the achievement of the long-term potential on jobs created through EE related activities.



Graph 5.3 – World jobs by technology (graph on the left) and type (graph on the right). Source: (Rutovitz & Atherton, 2009)

Complementing the qualitative classifications presented on Table 5.6, Rutovitz & Atherton (2009) reveal a systematic analysis on global job impacts of shifting to a low carbon energy future. The results are for direct job impacts only to avoid the uncertainty associated with estimating the multipliers for indirect job impacts. Graph 5.3 outlines the projected evolution, on two scenarios: (1) reference scenario and (2) [R]evolution scenario. Presenting the job impacts evolution across technologies and types of jobs for 2010, 2020 and 2030.

From the data provided with the analysis, Rutovitz & Atherton (2009) estimate that EE on the *[R]evolution scenario* will create up to 1,3 million direct jobs over the normal jobs that the EE industry would deliver until 2030, baseline scenario figures are not disclosed on the study. The authors also present an estimate of 0,19 jobs created per Giga Watt hours (GWh) saved through EE.

The previous estimate is relatively lower in terms of job creation potential than the one presented by Engel & Kammen (2009) and Wei *et al.* (2010), which stated that 0,38 jobs could be created per GWh saved through EE improvements.

5.3.2. EUROPEAN UNION OUTLOOK

As previously presented the EU has developed an intertwined action towards *green jobs* and an overarching framework for EE improvements given the complementary initiatives on: (1) new skills and jobs and (2) resource efficiency including energy (EC, 2012c) alongside with the EU strategy for 2020 (EC, 2010a) that drives action towards these challenges.

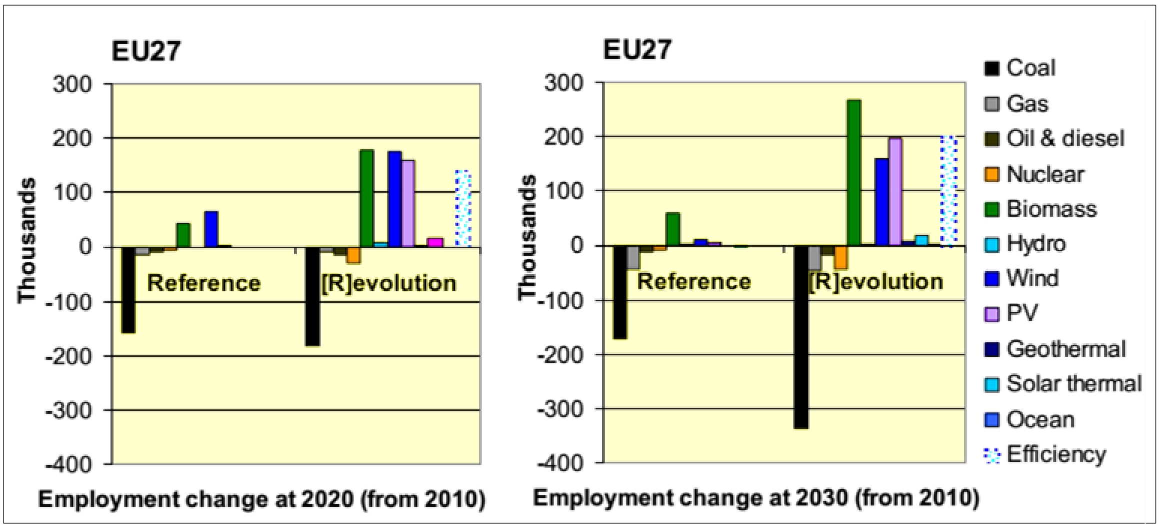
This impetus for job creation through EE is also present in the main legal instrument to foster efficiency in energy, the EED, which states:

> Shifting to a more energy-efficient economy should also accelerate the spread of innovative technological solutions and improve the competitiveness of industry in the Union, boosting economic growth and creating high quality jobs in several sectors related to energy efficiency. (EU, 2012b)

In line with this driver, employment potential revealed by the EC, identifies EE measures as the pathway to deliver 2 million jobs by 2020 (EC, 2012a, 2012b, 2013e; Rademaekers et al., 2012). Exploring the *green jobs* potential of EE in Europe according to the EED impact assessment (EC, 2011q) represents the opportunity to create: 400 000 jobs in the construction sector, 526 000 jobs through the resource efficiency flagship initiative and 650 000 jobs through sustainable land transportation (EC, 2012d).

The impacts on job creation through EE, are the result of a broader action towards a sustainable energy system in Europe, which is expected to create 5 million jobs by 2020 (EC, 2012b, 2012f, 2013h), leading to an inclusive low carbon economy.

Rutovitz & Atherton (2009) on their energy sector jobs analysis, also present a perspective for EU-27 on EE job creation, the graph below outlines the evolution expected (for the two scenarios as presented previously on the *Global outlook*), on job creation across technologies, demonstrating the positive evolution of EE jobs both in 2020 and 2030, compared to 2010.



Graph 5.4 – Employment change in 2020 and 2030, compared to 2010 levels. Source: (Rutovitz & Atherton, 2009)

Although the reference scenario job figures are not presented by the authors, the positive evolution between 2010 and 2020 is visible, reducing its pace on the period from 2020 to 2030. Notwithstanding the quality of the quantitative data on the analysis, Graph 5.4 provides useful information to compare with the expected evolution by the EC.

Regarding the skills required for a sustainable transition to a low carbon economy, the EC and the European Centre for the Development of Vocational Training (CEDEFOP) outlined the necessary actions to ensure that *green jobs* from EE are created to match expectations with the required quality, namely (CEDEFOP, 2010; EC, 2012e):

- The potential for new jobs through EE is evident, although the effort on skills development must accompany and support this impetus for the creation of a qualified workforce;
- A concerted action from the policymakers' side is necessary to ensure that the required workforce exists to deliver the planned investments on infrastructure and low carbon innovation.

Apart from the necessary skills, the overall structure has to exist and be oriented for the same goals towards a low carbon economy. Providing the means for the development of resource efficiency, including the necessary financial support, otherwise the EE job impacts foreseen will remain untapped.

The EU has the challenge of employment and job creation intrinsically present in both its overarching European strategy for 2020, and also through its strategy for a more sustainable energy system towards 2050. Thereby, although the uncertainty on the exact number of jobs that 1M€ invested will create or a GWh saved, the necessary framework for a low carbon development boosting efficiency and job creation is in place.

The key challenge remaining is to ensure a collaborative approach throughout Member States to ensure that targets are met and difficulties surpassed to deliver the results and unlock the planned benefits for the society, economy and environment. Alongside with the necessary availability of skills, funding and people to work towards the EU 2020 and 2050 goals.

5.4. SYNTHESIS

Connecting EE and its impacts on job creation requires a blended understanding on both employment economics and EE dynamics. The role of this chapter was to outline the foundations on links between these two fields.

The presented definitions and brief descriptions on methodologies provide an understanding on the main terminology used in most studies focusing on employment effects of EE investments for a certain action or programme. Although it is often difficult to be certain of the type of job impact that an author is presenting results for (i.e.: direct, indirect or induced jobs), given the ambiguity of the metric used to present job creation data.

In addition the review on existing studies regarding impacts on job creation across the EE industry, encompassing a range of 6 countries, gave an outlook on the state-of-the-art for this growing body of literature. The analysis resulted on an estimate of 12,7 FTE jobs resulting from 1M€ investment on EE improvements. This estimation should be carefully applied on a calculation given the uncertainty incorporated, resulting from the wide-range of methodologies used by authors on computing the employment impacts of EE investments (see: Table 5.3). It should also be taken into account that 54% of the studies reviewed were based on data from EE in buildings (see: Graph 5.2), which may cause a bias if these estimate is applied to another EE industry sector (e.g.: lighting, transport, industrial appliances).

Alongside with the range of employment impact assessment methodologies described, and those used on the studies reviewed, authors have different metrics for expressing the final results obtained.

Some authors present their results solely as jobs per 1M€ invested (see: (Bezdek, 2009; Goldman *et al.*, 2010) without clarifying the type of jobs (i.e.: direct, indirect, net, gross, induced), which causes uncertainty on the extent of the impact presented. Whilst other studies present their conclusions clearly identified, as direct jobs (see: (Association of Energy Conservation, 2000; The Blue Green Alliance, 2010)), indirect jobs (see: (Burr & Garrett-peltier, 2012)) and some present direct and induced jobs as one single figure (see: (Navigant Consulting, 2009)). Additionally, to the usual metric of job creation per 1M€ invested, some authors present the job impact of EE on a metric based on the amount of energy saved as jobs per GWh saved (see: (Engel & Kammen, 2009; Wei *et al.*, 2010). These different metrics in combination with the different methodologies used are the main concern regarding the uncertainty of the estimations for job impacts of EE related activities.

Nonetheless, the potential for job creation through EE improvements is evident, although assessing the real extent of this impact is proving to be a challenging task, given the concerns presented above, and the lack of a systematic data collection methodology for job impacts, as stated by the EC (2012d).

In spite of the uncertainty and concerns outlined, the motivation to move forward towards a low carbon economy, creating new and *green* jobs is clear. In this scenario the next steps must include the development of common methodologies and metrics that enable comparison and a common assessment framework for job impacts (e.g.: an EU standard that would enable comparison across the 28 Member States, which could be also implemented by other regions in the world), This would tackle the uncertainty on data benefiting the shift to a *greener* economy. Consequently, driving investments and providing good quality information, establishing a clear link between planned potentials and real outcomes on job creation across-sectors and regions from EE improvements.

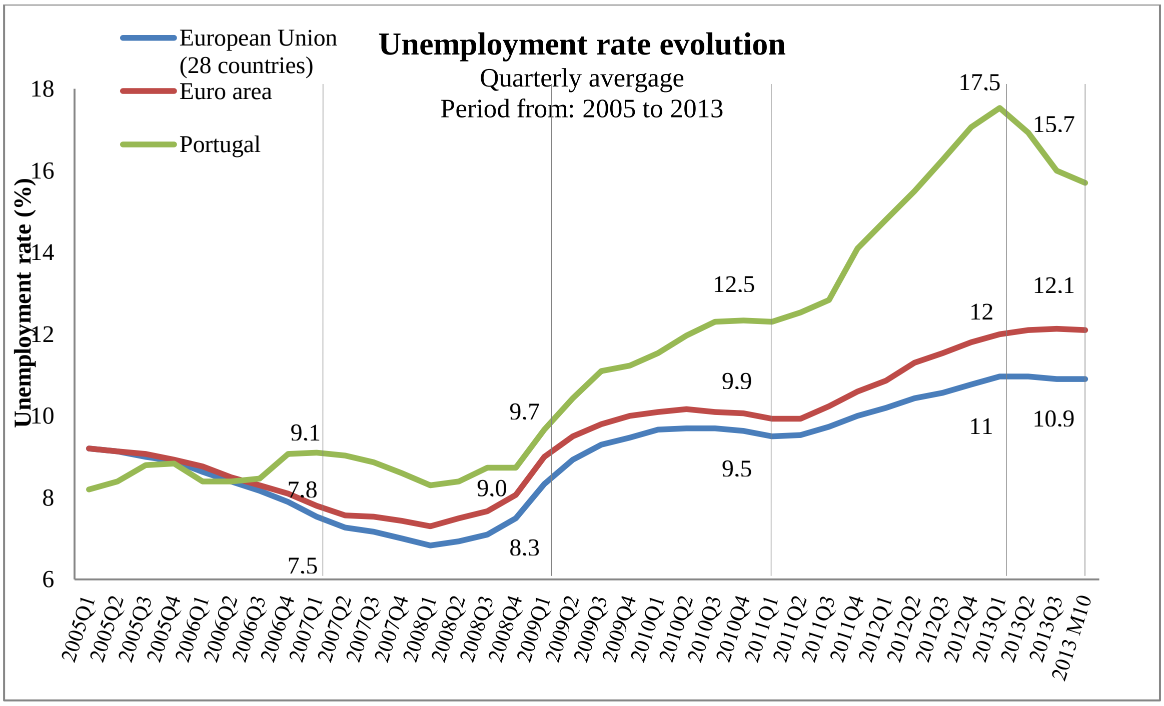
6. MEASURING ENERGY EFFICIENCY JOB IMPACTS – AN EXPERIMENTAL STUDY IN PORTUGAL

In a period where decreasing unemployment is a challenge throughout the EU, understanding the EE contribution for job creation is relevant for the validation of the presented outlook in the literature described throughout Chapter 5. These evidences on potential for job creation if properly validated will support a higher impetus towards EE investment, unlocking benefits for the environment, economy and society.

This chapter presents the methodology and key results of an experimental study conducted in Portugal, for the assessment of the employment impacts of Energy Efficiency and Renewable Energy. The experiment was conducted in collaboration with the Energy for Sustainability Master Student Mr Nikola Šahović, whose research project focuses on the job impacts of Renewable Energy.

6.1. STUDY BACKGROUND

The rising unemployment rate, since the start of the economic recession in 2007, has had stronger impacts in Portugal than in the rest of Europe; Graph 6.1 presents the evolution of the unemployment rate from 2005 to 2013, per quarter (see full data set on Table E.1, Annex E).



Graph 6.1 – Unemployment rate evolution from 2005 to 2013. Data from: (EUROSTAT, 2013).

The highest unemployment rate[28] since 2005 for Portugal was registered in Quarter 1 of 2013, reaching 17,5%. On the same period, the EU also registered its highest unemployment rate since 2005, reaching 11%. For the Euro Area, Quarter 2 of 2013 was the period with highest unemployment, at a rate of 12,1%. In spite of the most recent decreases in unemployment for Portugal, data from Eurostat (see Graph 6.1) presents a rate of 15,7% for October 2013. Despite this positive evolution the country remains well above the EU average with a 4,8% higher unemployment rate.

In the framework of the Portuguese EE legislation[29] the recast of the EE policy instrument for Portugal (i.e.: the Portuguese NEEAP), enacted on April 2013 also acknowledges the EE job creation potential. The Portuguese NEEAP states that indirect benefits are not included in the plan, such as employment, as these are of complex quantification given the current lack of data, indicators and of an adequate methodology for their measurement (PT, 2013).

Therefore the enhanced unemployment reduction challenge for Portugal and the acknowledged potential of EE improvements to contribute to job creation are the main background drivers for the development of this study, which will create a tool to fill the gap identified regarding available data and methodologies for Portugal, which were also acknowledged by the EC for the quantification of employment impacts of EE across Europe (EC, 2012a).

The development of this experimental study was steered in a collaborative setting encompassing efforts from:

- Masters Students of the Energy for Sustainability Initiative (EfS) of the University of Coimbra: Mr Guillermo Pereira and Mr Nikola Šahović;
- Faculty of Economics and EfS Faculty Member at the University of Coimbra: Professor Patrícia Pereira da Silva Ph. D;
- INESC Coimbra Researcher and Faculty Member at IPC-ISCAC: Professor Carla Oliveira Henriques Ph. D.;

[28] The term unemployment rate as presented in EUROSTAT datasets should be acknowledged as: "The unemployed persons as a percentage of the labour force based on International labour Office (ILO) definition. The labour force is the total number of people employed and unemployed. Unemployed persons comprise persons aged 15 to 74 who: (1) are without work during the reference week; (2) are available to start work within the next two weeks; (3) and have been actively seeking work in the past four weeks or had already found a job to start within the next three months. " (EUROSTAT, 2013).

[29] A review of Portuguese EE strategy, programmes, plans and laws is outlined by Cera (2012), which is relevant on the scope of the experimental study conducted.

- The Portuguese Renewable Energy Association (APREN) Collaboration: Ms Lara Ferreira M. Sc.;

As described, the experimental study encompasses two different focuses, namely job impacts from EE and from RE, the figure below (Figure 6.1) outlines the structure of the experiment developed.

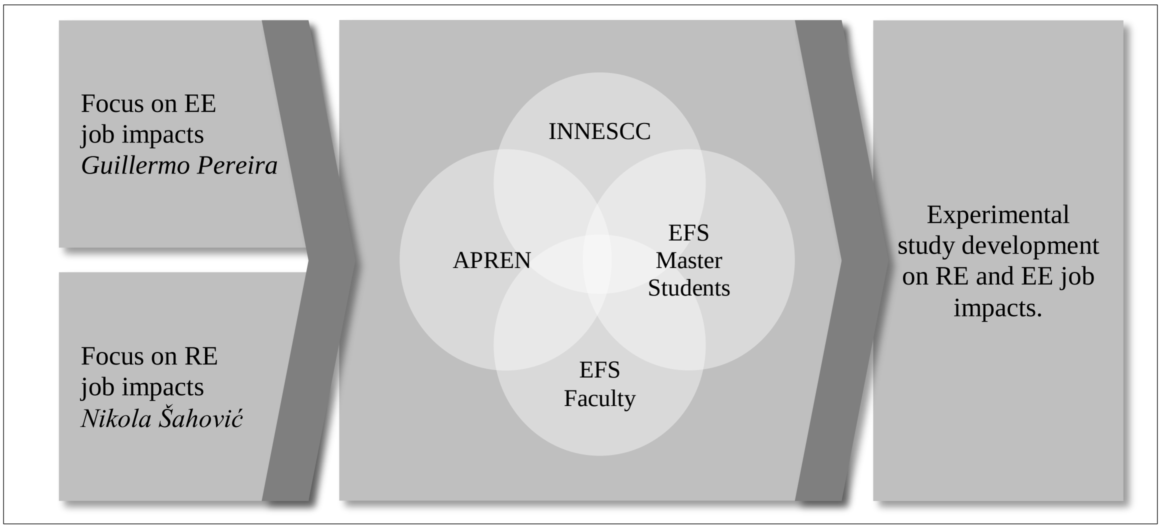


Figure 6.1 – Experimental study structure.

The motivation to combine two different research focuses on the scope of the study was based on the possibility to obtain synergies from the contribution of different entities on the scope of the study. On the methodology section, responsibilities are further divided providing a clear view of the collaborative framework designed. On the results section the obtained data is presented and discussed regarding EE job impacts.

6.2. METHODOLOGY

The goal of the experimental study aimed to measure the EE job impacts in Portugal over the past years and to obtaining intelligence for an outlook of the future expectations in terms of job creation through EE improvements. On the scope of the collaborative framework obtained for the development of the study, the methodology defined consisted on gathering real information from the EE industry[30] through the use of a direct survey. This method is presented in the literature as resource intensive when compared to other methods (see other methods in Table 5.2) (Breitschopf *et al.*, 2011; Gross *et al.*, 2012; Silva *et al.*, 2012), but it also provides more detailed information beyond real

[30] The term *industry* throughout the experimental study is used as an overarching concept, including the production of services and goods within the Portuguese economy related with EE across sectors.

employment data that is essential for characterizing the EE industry in Portugal (e.g.: financial data, skills data, operating sectors, etc.).

In Europe the survey method has already been used for measuring energy sector job impacts in Austria for the gas and electricity sectors (Astrov *et al.*, 2010), in Sweden for EE in the foundry sector (Rohdin *et al.*, 2006), in Germany and the United Kingdom for RE deployment (see Lehr *et al.* (2011) and Department of Trade and Industry (2004) respectively). On a cross-country approach a pan European study was conducted using the survey method to assess wind energy job impacts (Arapogianni *et al.*, 2012).

In Portugal the survey method was used to develop a study on *green jobs* in Portugal, focusing more on RE job impacts (Dias *et al.*, 2009).

The energy job impact related surveys conducted in Europe and in Portugal serve as the necessary baseline for the development of the questionnaire on the scope of this experimental study.

The main steps of the experimental study development are described through this section, as: (1) survey development process and (2) survey deployment.

6.2.1. Survey development process

The survey used in the study was developed following the procedure described below:

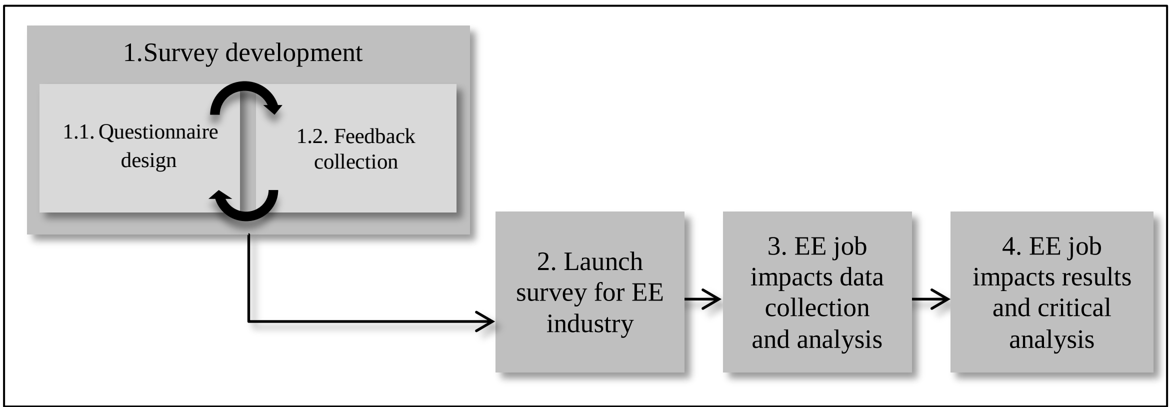


Figure 6.2 – Survey development methodology.

Given that part of the methodology above (Figure 6.2) was used for the development of the entire survey to assess both EE and RE job impacts the period when each task was conducted, as well as the responsible author within the collaborative framework presented previously for the development of the study are outlined in detail on Table E.2, Annex E.

The survey development process started in June 2013 alongside with the preparation of the Applied Research Project delivered in July 2013.

The conclusion of Task no. 1 results on the complete survey for the experimental study (see Annex G.1. for the complete survey in Portuguese). The survey was designed to enable any organization operating on: (1) EE industry, (2) RE industry or (3) both (i.e.: EE and RE industries) to contribute to the measurement of job impacts. Therefore, to enable this possibility, the survey is based on a modular structure. Through the designed structure organizations answer a set of general questions and then are directed to a specific questionnaire regarding their operational industry scope.

Figure 6.3 below outlines the modular structure of the survey, as well as the industries and organizations targeted on the scope of the study.

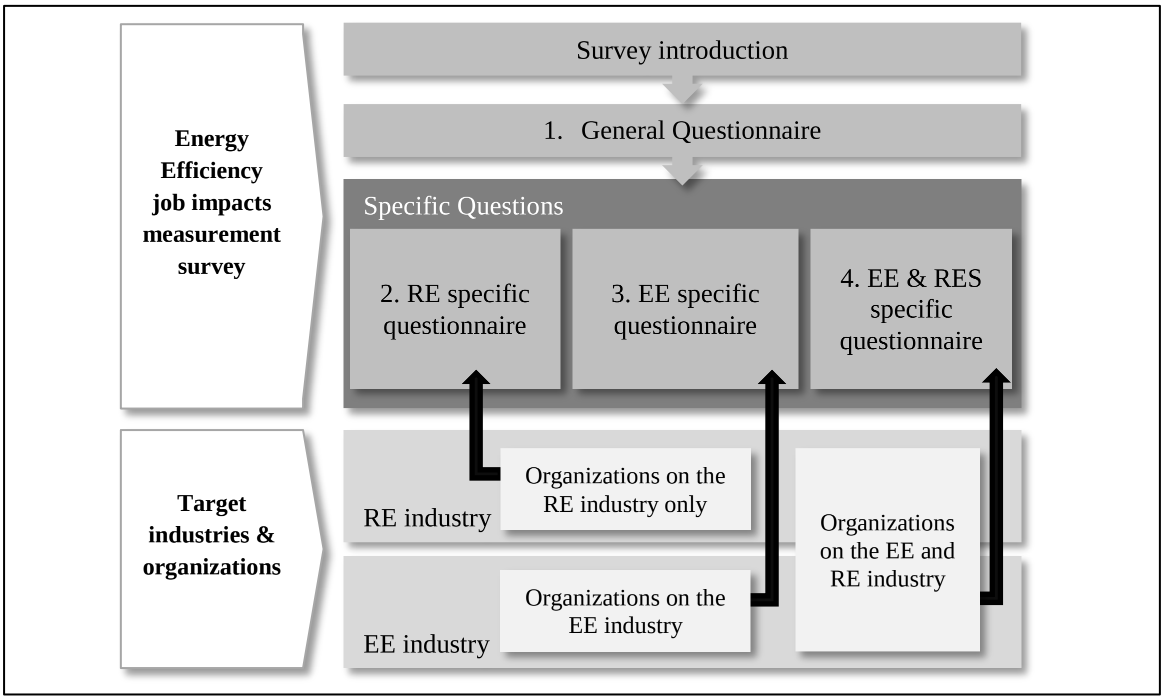


Figure 6.3 – Survey structure, target sectors and organizations.

Based on the survey design above a range of common questions are asked to all organisations within the specified sectors (i.e.: module *1. General Questionnaire*), and then they follow a specific questionnaire for the measurement of the job impacts of their business sector (i.e.: module 2, or module 3 or module 4). On the scope of this dissertation, the data analysed and the results presented derive from the information related to EE job impacts, specifically: (1) General questionnaire section, *module 1*, (2) EE specific questionnaire section, *module 3* and (3) EE & RE specific questionnaire section, *module 4*.

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6.2.2. SURVEY DEPLOYMENT PROCESS

The survey deployment process is the main result of Task no. 2, *Launch survey for EE industry* (see Figure 6.2) conducted on October 2013. Launching the survey involved three main stages:

6.2.2.1. SURVEY DISSEMINATION PLATFORM

The methodology is based on the electronic dissemination of the survey, through email contacts. For this purpose the survey designed was built online in Qualtrics® platform[31] for online survey design, deployment and management.

6.2.2.2. DISSEMINATION LIST DEVELOPMENT

During September 2013 the list of organizations to which the survey was sent was created. Given the wide spectrum of activities on the scope of the EE industry an effort was made to include different types of organizations for a better measurement of EE job impacts in Portugal across the industry. The dissemination list consisted on a group of 374 organisations.

Table 6.1 – Organizations for survey dissemination.

Type	Description	No. of Organizations
Cluster Agency	Key competitiveness cluster for the Portuguese Energy field organizations[32], the cluster disseminated the survey via email and on their website (see Figure F.1, Annex F).	1
Energy Agencies	Local Agencies and National Agency on energy and environment. Besides their contribution these organizations were asked to forward the survey to their Associate Members.	27
ESCOs	Organization accredited by the Portuguese Directorate for Energy and Geology (DGEG) as ESCOs (see: (DGEG, 2013a, 2013b)	113
EfS external council	Energy related companies that are part of the EfS external council group.	17
Portuguese Energy Agency (ADENE) registered companies	Organizations registered at the Portuguese Energy Agency (ADENE), as focusing on more energy efficient windows, systems and glass production.	142
Other companies on the Energy / EE industry	Other contacts that were gathered from online databases, recommended by APREN, and EfS Faculty.	74

[31] Qualtrics® surveys (see http://www.qualtrics.com/) was selected based on cost, possibility for multiple users to work on a survey online and the capabilities to build a modular survey as presented in Figure 6.1.
[32] The cluster contacted on the scope of the study is EnergyIN – Portuguese Cluster of Energy Technology and Competitiveness (see http://www.energyin.com.pt/).

Table 6.1 specifies the type and number of organization selected for dissemination, serving as a characterization of the sample, given that the Cluster agency and Energy Agencies were requested to disseminate the study through their contacts the total reach of the survey is unknown.

6.2.2.3. SURVEY LAUNCH

As part of the study development process the project aggregating the complete study, survey, data analysis and results dissemination was named as - *Project RES3E – Renewable Energy Systems and Energy Efficiency Employment* (see Annex G for outputs of the experimental study).

The survey was launched online on October 10th, 2013 and was active until October 31st, 2013. Three contacts were made to each selected organization, organised as: 1st contact, survey invitation; 2nd contact, reminder of invitation and 3rd contact, final reminder. The survey was closed for answers on October 31st, 2013.

During the survey launch process of the 374 initial sample of organizations contacted, 30 failed to receive the invitation[33] (i.e.: 7,75% of the initial sample, reducing the sample to 344). Table 6.2 and Table 6.3 below show the accumulated response rate evolution and final survey response analysis.

Table 6.2 – Accumulated survey response rate evolution.

	Contact stages		
	1st Contact, on October 10th, 2013	**2nd Contact,** on October 16th, 2013	**3rd contact,** on October 23rd, 2013.
No. replies	33	72	100
% of final sample after failures (344)	9,59%	20,93%	29,07%

Table 6.3 – Final survey replies analysis.

	Survey Response type		
	Blank Surveys	**Surveys within study scope** (i.e.: EE industry)	**Surveys out of study scope**
No. replies	38	34	28
% of final sample after failures (344)	11,05%	9,88%	8,14%
% of final survey responses (100)	38,00%	34,00%	26,00%

[33] The failures were mainly due to incorrect email contacts or organizations out of business.

The approach used for dissemination consisting on reminders proved to be effective, as the response rate continuously grew over time (see Table 6.2), doubling from 1st to 2nd contact and reaching 100 replies after the 3rd contact accounting to a good response rate of 29,07%. Of the total of replies obtained only 8,14% were from organizations outside the scope of the study (i.e.: organizations not involved on any EE related activity), which validates the adequacy of the sample selected to the survey scope.

After analysing the final number of replies and removing those outside the scope of the study and the responses saved in blank, the final response rate achieved is of 9,88%., which does not provide an acceptable amount of data for statistical analysis, although serving to outline conclusions on EE job impacts and future trends on employment and financial development of the Portuguese EE industry.

6.2.2.4. DATA COLLECTION AND ANALYSIS

The useful data for analysis was, as stated, insufficient for statistical analysis, due to the fact that only 34 replies were within the scope of the study. Given this the results were aggregated and main trends outlined using Microsoft Excel® software and its data analysis features instead of the initially planned analysis using IBM SPSS Suite® software.

On the scope of the low number of replies per question on the survey, the main conclusions derive from arithmetic means calculation (i.e.: averages) and the respective evolution of the observations within the data available for the different years collected.

6.3. RESULTS ANALYSIS

The experimental study – *Project RES3E*, consisted on a collaborative effort on collecting, measuring and analysing the job impacts of the EE and RE industry for Portugal. Developed from June to December 2013 the following results were obtained providing a detailed overview on the evolution of the EE industry in terms of job impacts within the participating organizations, which provides a perspective on the general job impacts in the Portuguese EE industry.

In addition to the data related to job impacts it was also possible to obtain data regarding financial evolution and potential trends for the future.

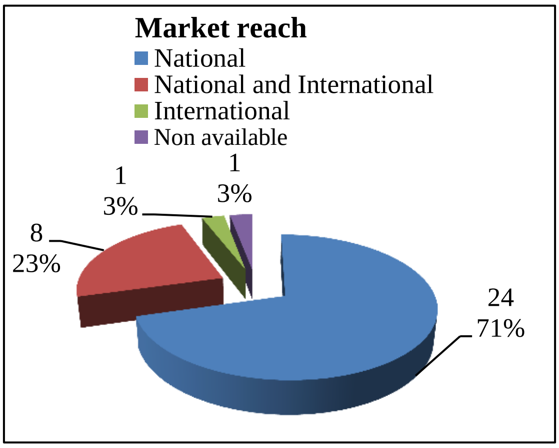
The survey structure as described in Figure 6.3 included a general questionnaire and specific questions for: (1) companies on the RE industry only, (2) companies on the EE industry only and (2) companies on the RE and EE industry. On the scope of the results analysis presented, only those on (1) EE industry and (2) RE and EE industry are presented in this section. These represent a sample of 34, corresponding to a response rate on the scope of these results of 9,88%, of the initial 344 organisations sample.

On the scope of the data collected and analysed, results are presented for the questions with the highest number of observations, increasing the quality and robustness of the outlined findings, the results are grouped as: (1) Industry characterisation, based on the General questionnaire; (2) Evolution on employment and future trends of jobs on the EE industry, based on the specific questionnaire. Only the most relevant results are presented through this section, additional data on job impacts evolution is available on Table G.1, Annex G.

6.3.1. INDUSTRY CHARACTERIZATION

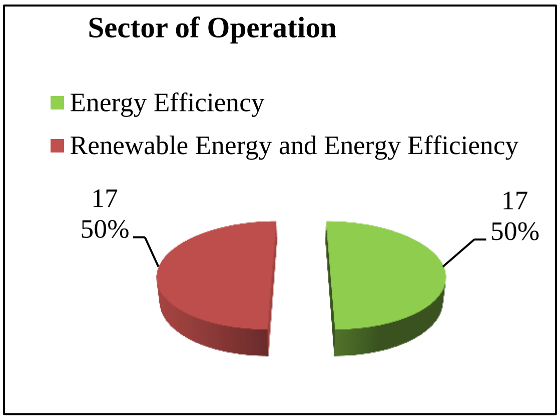
The organizations which participated on the study of EE job impacts have business in the sectors and markets outlined in the following graphs[34].

Of the 34 organizations contributing to the study working either on (1) EE or (2) RE and EE their regional reach is stronger in Portugal with 71% of the entities operating only in the national market (see Graph 6.2).



Graph 6.2 – Market reach of organisations

The industry of operation is equally distributed by organization on (1) EE and (2) RE and EE, with 17 observations for each sector of operation (see Graph 6.3).

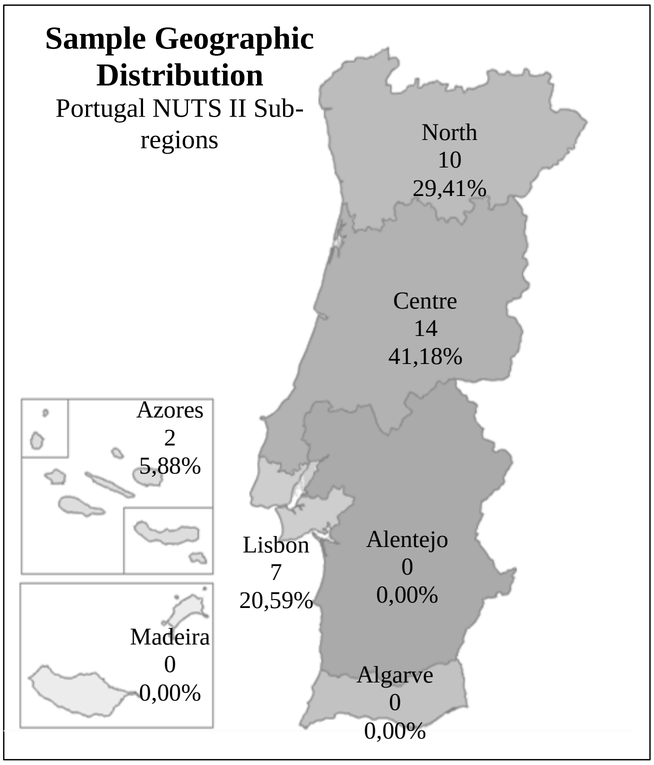


Graph 6.3 – Sector of operation

[34] Each graph on the results analysis, presents the number of observations and the percentage that those correspond to in the total of 34 surveys within the scope of the results presented.

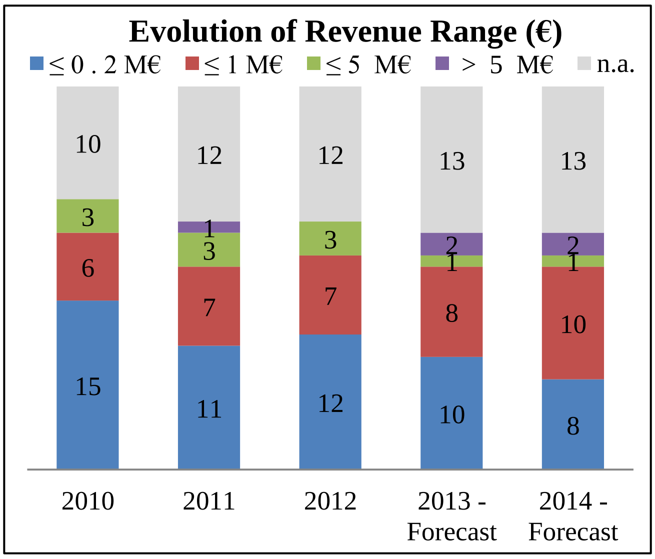
A higher share of companies operating in Portugal only, as presented in Graph 6.2, represents a better opportunity to obtain relevant data on job impacts and on the Portuguese EE industry.

Based on the Nomenclature of Territorial Units for Statistics (NUTS) II[35] of Portuguese sub-regions, the highest share of observations is from the Centre (41,18%) and North (29,41%) as demonstrated in Graph 6.4[36].



Graph 6.4 – Portuguese NUTS II study observations distribution, base map from: (Infopedia, 2013)

In terms of financial performance the study requested revenue data for 2010, 2011, 2012, and a forecast for 2013 and 2014 in M€. Despite the confidentiality and anonymity of the survey the organizations provided a small amount of exact data, rather preferring stating their revenue range for the requested periods, although with significant lack of replies, as the question was left in blank by approximately one third of the observations obtained.



Graph 6.5 – Evolution of revenue range.

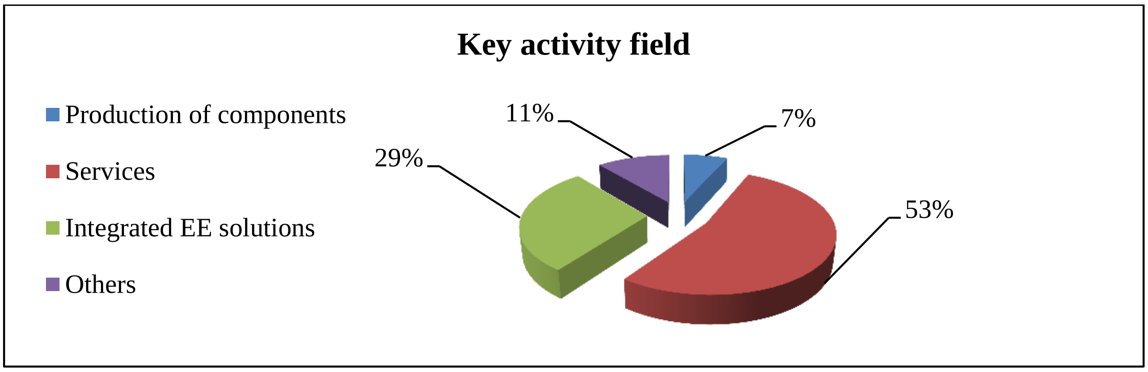
Nonetheless Graph 6.5 outlines the trend on growth of revenue, with organisations shifting from a revenue range equal or lower than 0,2M€ to a revenue range equal or

[35] Consisting on the territory statistical sub-regions throughout EU Member States, for Portugal these are: (1) North, (2) Centre, (3) Lisbon, (4) Alentejo, (5) Algarve, (6) Madeira Autonomous Regions and (7) Azores Autonomous Region (EU, 2003).
[36] Of the total observations, one organization did not provide its headquarters region, thereof Graph 6.4 represent 33 observations which provided the data.

lower than 1M€ and greater than 0,2M€, the trend is visible over the 5 year period of data collected.

In terms of sector of operation, the industry is based on services, with 53% of the organizations acting as EE service providers.

Graph 6.6 represents the study results for key activity field of organisations operating on the EE industry, the study provided three main categories: (1) Production of components, for organisations on the secondary sector, (2) services for those on the tertiary sector, and an overarching (3) Integrated EE solutions category for companies which provide equipment and O&M services. The previous accounts for 29% of the sample.



Graph 6.6 – Energy efficiency organizations activity field.

6.3.2. Evolution of jobs in energy efficiency

As part of the data requested from the study participants for the evaluation of the EE job impacts, the survey requested employment data at different levels of detail, from broader figures to specific per sector and per qualification figures, although the lack of response to the data with higher level of detail diminished the potential to understand different aspects of the job dynamics on the EE industry for Portugal.

Therefore only broader results are presented on the scope of EE job impacts measurement for the period from 2010 to 2012. For a detailed understanding on the evolution of jobs the results are presented in three different categories:

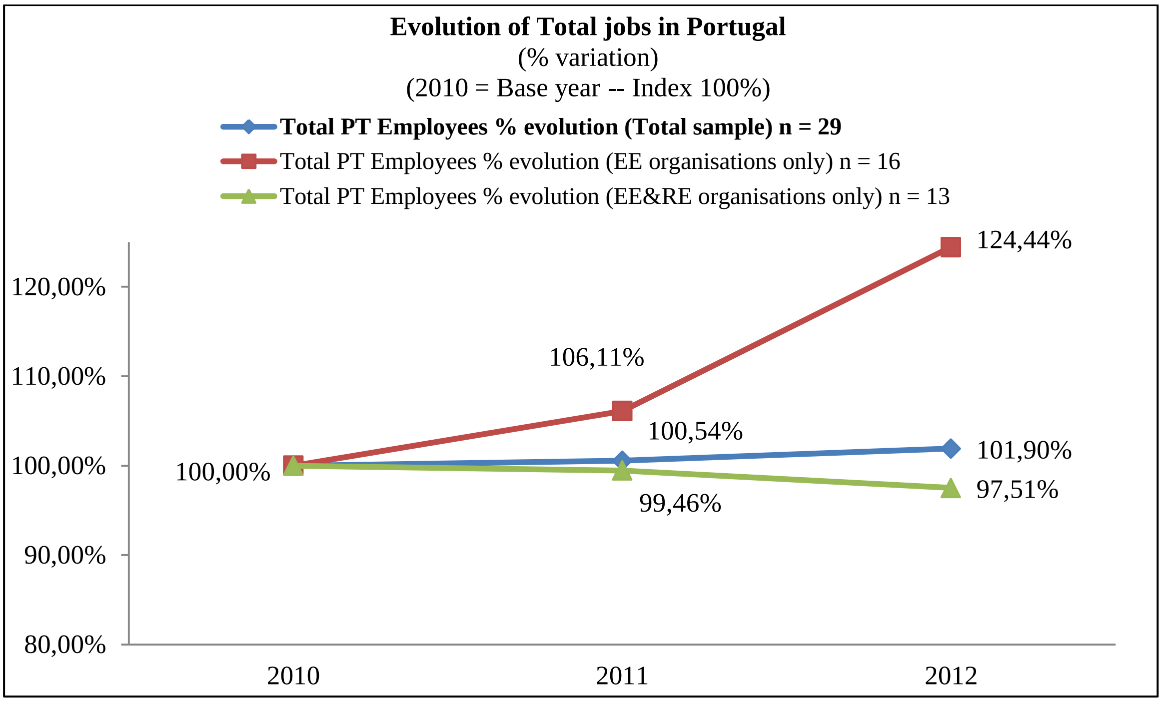
(1) Total sample results, as aggregated results of the entire sample for total jobs and EE jobs evolution;

(2) EE only organisations results, consisting on the specific organizations acting in the EE industry and their data on total and EE jobs evolution;

(3) EE & RE organisation results, consisting on the specific organisations acting on both EE and RE and their data total and EE on jobs evolution.

For the measurement of job impacts, and to consider that companies may have activities beyond EE and EE & RE, the requested information was to provide their total employees count working in Portugal, and then specify those working on EE related activities.

The results of the total jobs evolution for the three categories defined previously are presented in the following graph[37].



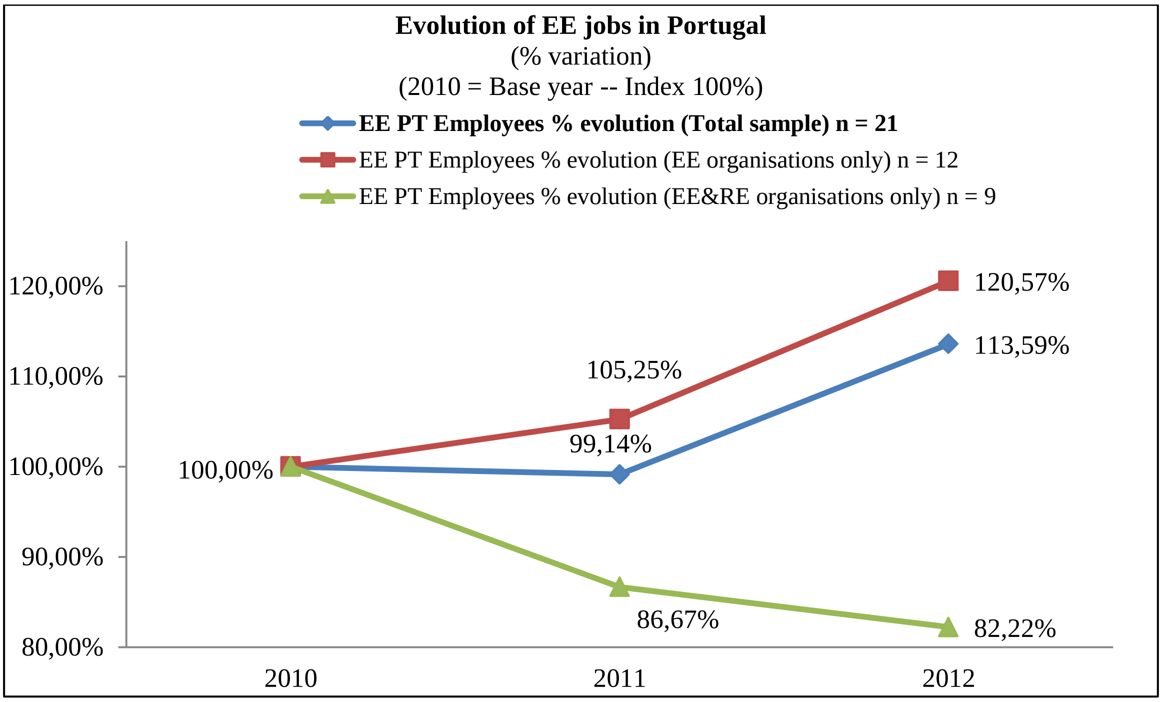
Graph 6.7 – Evolution of total jobs in Portugal (% variation).

In terms of total job data for the total sample of the EE industry minor changes on a positive path of development are visible, as represented on Graph 6.7. The total jobs for the complete sample over the 3 year presents a positive growth of 1,9% in 2012 comparatively to 2010 levels.

In spite of the positive development, the disparity between the two types of organizations included on the study to measure EE job impacts is visible. The evolution in terms of total jobs for organisation on the EE industry only, is positive, reaching a 24,44% growth rate in 2012 compared to 2010 figures. On the other hand, companies operating on EE and RE industries show a decrease on jobs, representing a loss of 2,49% of the jobs in 2012 compared to 2010 figures.

[37] Each series of data on the graphs presented states the number of observations in which the calculations were based as *n = number of observations, e.g.: n = 10*, meaning the series is based on 10 observations.

The data on total jobs evolution for Portugal is further complemented by the specific figures obtained from the organisations regarding their jobs directly related to EE activities. Graph 6.8 outlines the evolution trends for the same period for EE jobs only within the same categories used on Graph 6.7.



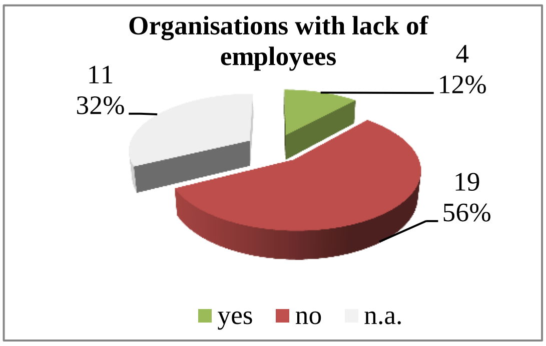
Graph 6.8 – Evolution of EE jobs in Portugal (% variation).

The evolution of EE jobs differs based on the business focus of the organisations. For those operating on the EE industry only, the evolution presents a growth rate of 20,57% on EE jobs in 2012, compared to 2010 levels. Although for companies operating both on EE and RE industries, a significant loss is registered in 2012 of 17,78% compared to 2010 levels.

The presented results highlight the contribution of EE for job creation compared to the case of RE, which presented losses over the period 2010 to 2012 for total jobs and for EE dedicated jobs as presented in Graph 6.7 and Graph 6.8. Although providing clear job evolution trends of the EE industry, the conclusions presented must be used and analysed carefully, given the reduced size of the sample obtained through the survey.

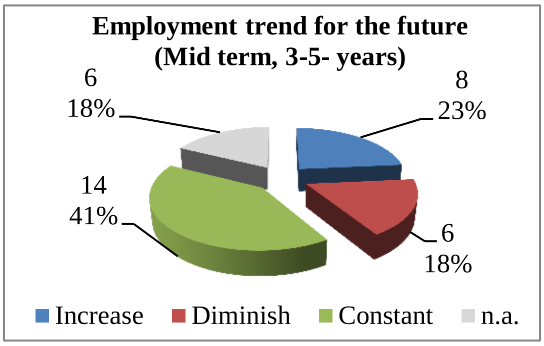
6.3.3. FUTURE TRENDS IN JOBS ON ENERGY EFFICIENCY

A range of questions presented on the survey gathered data on future perspectives and trends from the EE industry on jobs and potential evolution. In this logic, the collected data reveals that 56% of the organisations are not lacking employees on their EE activities (see Graph 6.10), contrasting with 12% which assume to be lacking workforce on their EE operations.



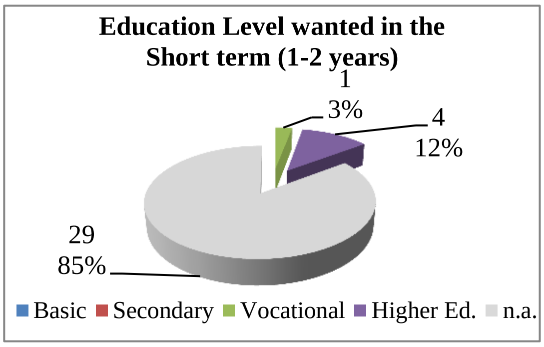
Graph 6.10 – Organisations with lack of employees.

In line with the previous finding, 41% of the participating organisations stated the aim to maintain constant the level of employment for the future, comparatively to 23% looking to increase their workforce as demonstrated through Graph 6.9.



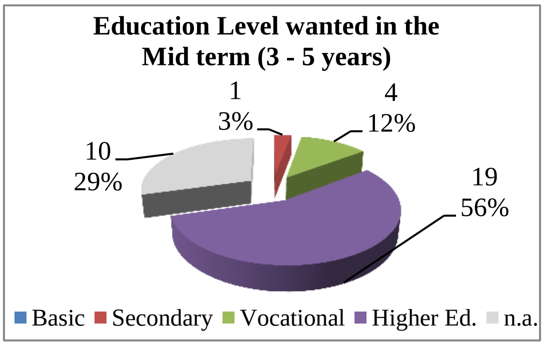
Graph 6.9 – Future employment trends (Mid-term, 3 – 5 years).

Data regarding the qualification level was included on the survey, although being one of the items with fewer observations, making the conclusions uncertain. Nonetheless, for the collected information the organisations are looking to hire employees with higher education more than any other qualification level for both short and mid-term.



Graph 6.11 – Short-term education level wanted.

In the short-term (Graph 6.11), 4 organisations out of 5 stated to be looking for higher education level employees. The low response rate for short-term is possibly caused by the fact that most organisations are not lacking employees (see Graph 6.10).



Graph 6.12 – Mid-term education level wanted.

Supplementing the short-term data, with a higher response rate, Graph 6.12 outlines the mid-term education level wanted by organisations for their EE employees. Higher education is again the skill level with the biggest share corresponding to 56% of the sample.

6.3.4. SYNTHESIS

The Portuguese EE industry is mainly focused on the national market, providing services and integrated EE solutions. Through the main results presented and analysed a positive evolution on EE jobs for organisations working on the EE industry was identified, whilst the evolution for companies working on both EE and RE was negative, presenting job losses from 2010 to 2012. Despite of the small dimension of the obtained sample, regional and sectorial distribution was balanced providing insights from a diverse set of organisations with operations on the Portuguese EE industry.

In spite of the positive evolution registered for EE jobs in total (see Graph 6.8), EE industry is most likely to stabilize in the forthcoming years as most organisations stated a sufficient workforce for their level of activity at the present (see Graph 6.10). As for the qualification for EE jobs Higher education represents the top priority when considering employees skills for both short and mid-term. In terms of financial performance the industry trend outlines an ambition for business growth, which given the trend on stabilization of job growth, may be based on obtaining returns on investments carried out in the past years.

6.4. CRITICAL ANALYSIS

The development of the study based on a survey, included a range of risks and advantages. As advantages the most relevant were:

- Collection of real data from organisations operating on the EE industry;
- Contacting with entities that may be interested in further collaborations on the scope of the survey and the analysis of the data obtained, as well as to support trends definition.
- Gathering complementary information besides data regarding jobs, such as financial information, sectors of operation within the industry, geographic reach and future ambition in terms of growth, and required skills for the EE workforce;
- Possibility to collect quantitative and qualitative data.

In terms of risks, those identified as most relevant on the scope of the study include:

- Lack of reply from the selected organisations to participate on the survey;
- Reliability of data provided by participating entities;
- Difficulty on obtaining employment and financial data given the sensitiveness of this information for organisations in general;
- Survey launch time of year (October 2013), when some organisations depending on their size and activity, undergo internal audits to prepare end-of-year financial statements and reporting.

After completing the data analysis and the overall process of development and deployment of the survey, the major barrier encountered relies on obtaining replies from the initial selected sample of organisations of 374 entities, which given incorrect contact information, was reduced to 344 entities successfully contacted. Of these only 34 replied and were considered within the scope defined for measuring EE job impacts in Portugal.

Resulting on a response rate lower than 10% of the initially selected sample of organisations, although providing new data not available so far in the literature, it includes uncertainty when considering the results and trends presented as general realistic trends for the EE industry in Portugal. Some of the potential causes identified for the low response rate are:

(1) Length of the survey, throughout the development process the main goal was to keep the survey simple and of straightforward answer. Although given the number of questions on jobs per sector, per qualification level, and per gender may have had a negative impact on the final response rate.

Piloting efforts in organisations were made before launching the survey without success, thereof the approach and questions asked could have been better adjusted, which could have positively influenced the data acquired.

(2) Lack of awareness of contacted entities for the importance of understanding job impacts as an indirect EE benefit to drive investment and foster development of the industry and business growth.

(3) The contacted person within the organisation has no access and/or knowledge on the requested data, which may have caused organisations to discard the study participation invitation or leave it on hold without reply.

(4) Developed as a voluntary survey, the study invitation to the selected organisation was sent as a research project developed by the collaborative group of University of Coimbra, EfS Initiative, INESC Coimbra and with the support of APREN. Although of the quality of the work and reputation of the involved organisations, the fact that it was an academic initiative may have reduced the priority given to the participation of the contacted entities, rather than a government mandatory collaboration (e.g.: launched by DGEG, ADENE or the Portuguese Institute of National Statistics (INE)).

Regardless of the low response rate, a detailed framework and tools were designed and developed, consisting on a step forward on measurement tools of EE job impacts, namely:

(1) A collaboration framework was successfully developed, supporting the design and development process through feedback and guidance;

(2) A detailed database of contact information of organizations identified as relevant for assessing the EE industry across sectors throughout Portugal was created, which can be further developed and updated for future research projects and studies.

(3) A complete survey was developed with detailed questions to gather data on financial development, employment, and skills evolution within the EE industry. Designed in line with the NEEAP for Portugal and its key action areas. This tool may be upgraded and used by other entities on the scope of their activity at national and/or regional level. Also serving as an example to other Member States as a tool to measure job impacts directly from the industry.

On the scope of the study, participating organisations were asked to confirm their availability for further collaboration. The request resulted in 20 organisations accepting the future collaboration invitation, which provided their contacts and responsible person for the collaboration representing 59% of the 34 organisations on the sample.

The group of organisations for future collaboration represents new opportunities on further developing studies on EE job impacts and other indirect benefits of EE improvements through surveys and/or qualitative interviews.

Besides the identified obstacles, the study was successfully developed, with a detailed methodology and structure, even though lacking industry engagement to significant levels. Hence improvements must be implemented to the survey to achieve an easier to answer questionnaire to increase response rate. Successfully engaging organisations across the EE industry will contribute to understanding the real job impacts and future outlook.

7. CONCLUSION

The research project presented, had as main goal to outline an EU EE outlook. Particularly by connecting EE progress across the EU with the job creation potential of increasing EE. The relevance of the intertwined research framework is based on the fact that EE improvements are not an independent effort, but rather a mean to contribute to sustainable development that has impacts on society, environment and economy. Therefore, having impacts in jobs, a critical issue in Europe and Portugal given the high unemployment rates registered since 2007.

In order to achieve this goal two main strategies were defined: (1) an analysis of EE progress in the EU and (2) an analysis of EE job impacts. These strategies led to the definition of the main research questions, specifically:

(4) Is the EU on track to deliver the complete range of benefits dependant on the EE target by 2020?

(5) What is missing in terms of Member States action?

(6) Is job creation through EE evolving as expected by 2020?

This chapter aggregates the main findings and results of the Dissertation providing the insights for the above stated questions. Furthermore suggests a range of future work, whilst outlining the main limitations faced through the development of the research project.

7.1. KEY OUTCOMES

On its effort to ensure a blended strategy for growth across Member States, having EE as a driver for that goal, the EU has developed a major interlinked framework to boost EE and *green jobs*.

Actions at strategic, legislative and support level ensure that Member States develop their national economies having EE as a priority and a valuable resource, rather than an obligation.

Over the past years EE grew in the EU having as main driver the industrial and household sectors. Although when analysing the latest NEEAPs the measures implemented to boost EE in industry were the weakest alongside with measures for households. This disparity must be taken into account when shaping the EE strategy across the EU.

On its effort to ensure that the EE is on track, the EU enacted the new EED, bringing a new horizon on EE and strengthening Member States obligations towards this issue, including new measures and national binding targets by 2020. The analysis performed revealed a lack of ambition across Member States, which puts at risk the goals of 20% increase on EE. At the time of the analysis the EC must ensure that Member States are in line with the EU ambition and are realising their improvement potential.

In spite of the existing framework and strategies, the level of implementation of the EE measures across Member States presents disparities, especially for the building sector were only 11 Member States had the EPBD fully transposed at the time of the analysis. This impacts the pace of EE improvements, and consequently the jobs delivered through the defined measures and targets. Taking into account that the EC forecasted that 2 million jobs would be created through EE by 2020, 400 000 of these from the construction sector (EC, 2012d), it is essential to ensure that efforts across the EU are being developed to meet the standards, and unlock the potential benefits.

Apart from contributing directly to a more sustainable energy system and a low carbon economy as ambitioned by the EC beyond 2020 and by 2050 through the Europe Energy 2050 Roadmap (EC, 2011g), EE creates jobs. The analysis performed showed that when investing 1M€ on average 12 FTE jobs were created. This figure results only from EU studies only, mainly from the building sector.

The experimental study on measuring EE job impacts in Portugal reveals a positive evolution of EE jobs at organisations working on the EE industry only, whilst a negative evolution is visible for companies that are operating in EE and RE industries. In terms of future trends the industry revealed to have a sufficient workforce for the short-term (i.e.: 1 to 2 years) regarding the current level of activity and reveals that the forthcoming jobs will require higher education level workers.

In general the EU is delivering both EE direct benefits by lowering energy demand growth, whilst fostering indirect benefits, such as the one herein analysed of job creation. Despite of the positive evolution and the existing framework to increase EE, the situation at Member States must be strengthened and the gaps at national level reduced. The rollout of the new binding measures through the enacted EED are an opportunity to ensure that the EE goals are on track, although embodying a challenge to ensure that measures, targets and ambition are aligned across the EU.

The EU as a whole, and Member States in their national context, must recognise the future benefits of EE on ensuring the development of local, regional and national economies. Embracing EE towards a low-carbon scenario is not optional. The environment and people rely on this evolution of energy use to continue to have access to resources. Actions must be driven from governmental entities, companies and educational institutions to guarantee that the existing mechanisms are deployed to their full potential, ensuring the delivery of the claimed benefits that energy efficiency entails for Europe.

The structures developed are essential, now the step forward is to ensure the uptake of these structures and to engage the stakeholders on acting towards the long-range 2050 agenda. The ability of Europe to perform accordingly by 2020 is critical to ensure the necessary pathway to develop the low carbon energy system ambitioned by 2050.

Europe's leading role on moving efforts and resources towards EE increase is part of the required impetus, which must be further complemented by Member States strengthened action.

The newest framework programme for research and innovation – *Horizon 2020*, represents a key opportunity for Member States to build collaborative initiatives and boost the solutions for the energy efficiency challenge.

Through *Horizon 2020*, the EU has an 80 B€ budget, of which 15 351 M€ are dedicated to actions that can boost EE, particularly: (1) smart, clean and efficient energy with 5 931 M€; (2) smart, green and integrated transport with 6 339 M€ and (3) climate action, environment resource efficiency and raw materials with 3 081 M€ (EC, 2013z). These actions, supporting EE improvements, correspond to 19,93% of the overall programme budget, which enhances the relevance of moving forward in actions targeting EE improvements.

The EU has focused so far on developing the necessary structure for EE measures to be implemented across countries, which is positive but clearly insufficient to deliver the ambitious goals defined. Given this the forthcoming efforts must focus on driving specific actions that may boost EE at Member States level. Moreover, national ambition must be enhanced and awareness created to the range of impacts deriving from EE investments. The Portuguese study served as proof of this positive impact of the EE industry, in years when unemployment rates reached the highest thresholds, the evolution of jobs on organisations operating on the EE industry was positive, representing a 20,57% growth in 2012 compared to 2010 levels.

The EU, across each Member State action and effort has the right tools, knowledge and framework to work on this priority. The future of the EE agenda in Europe depends on the ability to merge efforts, visions and resources to use energy in a more efficient way, as these actions will ensure that growth and jobs are created through the development of resource efficiency across Europe.

7.1. LIMITATIONS

The development of this research process included the analysis of both progress of EE across Member States and the analysis of one of the key indirect benefits, namely job creation, with the goal to create a blended outlook of EE across Europe. Through this process various obstacles and barriers appeared along the research project development, those with higher impact on the final outcome are:

(1) The research project was planned for EU 27 nevertheless after the accession of the Republic of Croatia; the plan was adapted to include data from the 28 Member States. Despite the efforts, sometimes there was no data from Croatia available for analysis leaving some information gaps in the data presented, as it can be seen mainly in Chapter 4, on the *bottom-up perspective* analysis.

(2) The key aim of this Dissertation was to provide a blended outlook on EE progress and on the job creation potential for Europe. The research strategies were designed for this purpose, although when developing the EE job impacts study review (See Chapter 5) studies from the USA were included given the scarce sources available in the literature on this subject. Including these studies almost doubled the sample of studies reviewed thus contributing to a more consistent outcome.

(3) When developing the experimental study for measuring EE job impacts in Portugal, the biggest limitation was the low rate of observations obtained, not reaching 10% of the successfully initially contacted sample of 344 organisations. Despite the new data collected and the outlined trends, the results may not reflect the real impact of EE in jobs for Portugal, which limits the applicability of the obtained results.

(4) APREN's collaboration was useful when designing the experimental study, but could not support the dissemination and deployment of the study, given that the EE

industry is outside their scope of action, as they focus on RE. This limited the ability to reach a higher audience for the study.

Notwithstanding the limitations described, the Dissertation document represents the final outcome of an organised and structured research process. It brings to light a new perspective on EE across the EU, whilst providing suggestions on future courses of action to ensure that the EU is on track to deliver both the EE targets and their benefits.

7.2. FUTURE WORK

Through the development of this research project, different opportunities for future work were identified, which would increase the quality and impact of the current research and expand its scope and the applicability of the results, namely:

(1) Widen the scope of the current outlook that analysed only the indirect benefit associated with job creation, to include a wider range of benefits (see Table 2.3, page 18).

(2) Develop a benchmarking database including direct and indirect EE impacts and their evolution over time for the EU and individually for each Member State. Such tool would enable a greater control of EE progress and value delivered by the achieved improvements, whilst contributing to the removal of information barriers.

(3) Further validate and implement the SWOT analysis scheme proposed on Chapter 4 to define EE strategies, starting from individual SWOTs for each Member State and aggregation the individual contributions into an global EU strategic roadmap.

(4) Recast the experimental study to measure EE job impacts in Portugal in partnership with an organisation of stronger capacity, such as The Portuguese Energy Agency (ADENE), the Portuguese Directorate-General for Energy and Geology (DGEG), or the Portuguese Industry Association (AIP) which have a wider industry networks, resulting on a higher potential of collaboration from organisations operating on EE.

(5) Develop a Delphi study with the group of 20 organisations that accepted to contribute on further understanding the job impacts of the EE industry. This study has the potential to validate the data obtained through the survey launched, and

outline future trends, as well as courses of action towards understanding and assessing EE impacts for Portugal.

(6) Pilot the survey developed for the experimental study (see Annex G.1) in organisations across Europe to validate its effectiveness and adequacy, as well as to obtain feedback and improve its structure and potential to be implemented internationally.

These suggestions aim to contribute to the development of the necessary methods and strategies to understand the real benefits of EE, consequently making this knowledge and findings available to the diverse group of stakeholders that can contribute to EE improvements across sectors and regions.

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