UNIVERSIDADE D
COIMBRA

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AN ASSESSMENT OF ENERGY EFFICIENCY OBLIGATIONS AS AN ENERGY POLICY INSTRUMENT AND A PERSPECTIVE FOR 2030

VOLUME 1

Dissertação no âmbito do Mestrado em Energia para a Sustentabilidade orientada pelo Professor Doutor Álvaro Filipe Peixoto Cardoso de Oliveira Gomes e Professor Doutor António Manuel Oliveira Gomes Martins e apresentada ao Departamento de Engenharia Mecânica da Faculdade de Ciências e Tecnologia da Universidade de Coimbra.

Outubro de 2021

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ABSTRACT

The Energy Efficiency Obligations are an instrument adopted by several countries worldwide, intending to improve energy efficiency indices, and consequently reduce energy consumption.

Based on Article 7 of the European Directive for Energy Efficiency, Member States (MS) are obliged to comply with the targets set for 2020, through the implementation of Energy Efficiency Obligations, or through Alternative Measures proposed by each State. In order to monitor the progress of the goals, MS are required to send annual reports to the European Commission (EC) where they present the main energy indicators and the savings achieved.

Portugal implemented Alternative Measures to comply with Article 7 of the Directive, and defined its target and savings measures in its National Action Plan for Energy Efficiency (PNAEE). This work analyses compliance with the Portuguese target from 2013 to 2018, based on reports sent to the EC. Between 2013 and 2016 there were significant savings in final energy consumption, however in 2017 and 2018 energy consumption increased, which could jeopardize the proposed targets for 2020. This study aims to assess Energy Efficiency Obligations in order to characterize the effectiveness of the Energy Efficiency targets for 2020, allowing a general reflection for a 2030 perspective.

The period from 2020 to 2030 will be challenging for MS, as an update of the Energy Efficiency Directive will be in place, which requires new plans and targets, and will imply new energy policies.

Keywords: Energy efficiency obligations, Energy Efficiency Directive, Annual Reports, Energy Savings, Alternative Measures.

RESUMO

As Obrigações de Eficiência Energética são um instrumento adotado por vários países a nível mundial, com o objetivo de melhorar os índices de eficiência energética, e consequentemente reduzir o consumo energético.

Com base no Artigo 7º da Diretiva Europeia para a Eficiência Energética, os Estados Membros (EM) são obrigados a cumprir com as metas definidas para 2020, através da implementação de Obrigações de Eficiência Energética, ou por Medidas Alternativas propostas por cada Estado. Por forma a vigiar o progresso das metas, é requerido aos EM o envio de relatórios anuais à Comissão Europeia (CE) onde apresentam os principais indicadores energéticos, e as poupanças alcançadas.

Portugal optou por implementar Medidas Alternativas para cumprir com o Artigo 7º da Diretiva, e definiu a sua meta e medidas de poupança no Plano Nacional de Ação para a Eficiência Energética (PNAEE). Neste trabalho, é feita uma análise ao cumprimento da meta Portuguesa desde 2013 até 2018, com base nos relatórios enviados à CE. Entre 2013 e 2016 verificaram-se poupanças significativas no consumo final de energia, no entanto em 2017 e 2018 o consumo de energia aumentou, podendo por em risco alcançar as metas propostas para 2020. Este estudo tem como objetivo avaliar as Obrigações de Eficiência Energética de forma a caracterizar a eficácia dos objetivos de Eficiência Energética para 2020, permitindo uma reflexão geral para uma perspetiva de 2030.

O período de 2020 a 2030 será desafiante para os EM, uma vez que estará em vigor uma atualização da Diretiva para a Eficiência Energética, que obriga a novos planos e metas, e irá implicar novas políticas energéticas.

Palavras-chave: Obrigações de Eficiência Energética, Diretiva para a Eficiência Energética, Relatórios Anuais, Poupanças Energéticas, Medidas Alternativas.

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LIST OF ABBREVIATIONS

ADENE: Agência para a Energia (Energy Agency in English)

CIE: Energy - Intensive Premises

CDM (Clean Development Mechanism)

DGEG: General for Energy and Geology

DSM: Demand Side Management

EAFRD: European Agricultural Fund for Rural Development

Eco.AP: Programa de Eficiência Energética na Administração Pública (Energy-Efficient Public Administration Programme in English)

EED: Energy Efficiency Directive

EEO: Energy Efficiency Obligations

EEOS: Energy Efficiency Obligation Scheme

EMFF: European Maritime and Fisheries Fund

ERDF: European Regional Development Fund

ERSE: Entidade Reguladora dos Serviços Energéticos (Regulatory Body for Energy Services in English)

ESCO(s): Energy Service Company

ESE(s): Energy Services Enterprises

ESF: European Social Fund

eSPap: Entidade de Serviços Partilhados da Administração Pública, I.P. (Entity for Shared Services of Public Administration in English)

EU: European Union

EV: Electric Vehicles

FAI: Fundo de Apoio à Inovação (Innovation Support Fund in English)

IMT: Instituto da Mobilidade e dos Transportes (Institute for Mobility and Transport in English)

Instituto da Mobilidade e dos Transportes, I.P. (Institute for Mobility and Transport, public enterprise

ISV: Imposto Sobre Veículos (vehicle tax in English)

IUC: Imposto Único de Circulação (Circulation Unique Tax ~~total road tax~~ in English)

NEEAP: National Energy Efficiency Action Plan

NZEB(s): Nearly Zero-Energy Building(s)
OLMC: Logistics Operator for Change of Supplier
PDIRD-E: Plano de Desenvolvimento e Investimento na Rede de Distribuição (Plan for Development and Investment in the Electricity Transmission Network in English)
PDIRD-GN: Plano de Desenvolvimento e Investimento da Rede de Distribuição de Gás Natural (Plan for Development and Investment in the National Transmission Network in English)
PDIRGN: Plano de Desenvolvimento e Investimento da Rede de Gás Natural (Plan for Development and Investment in the National Transmission Network, Storage Infrastructure and LNG Terminals in English)
PDIRT-E: Plano de Desenvolvimento e Investimento da Rede de Transporte de Electricidade (Plan for Development and Investment in the Electricity Transmission Network in English)
PNEC: Plano Nacional de Energia e Clima (National Energy and Climate Plan in English)
PO SEUR: Programa Operacional Sustentabilidade e Eficiência no Uso dos Recursos (Operational Programme for Sustainability and Efficient Use of Resources in English)
PPEC: Plan for Promoting Efficient Energy Consumption
PRIMES: Price-Induced Market Equilibrium System
RGCEST: Regulation on Energy Consumption Management for the Transport Sector
RND: Rede Nacional De Distribuição (National Distribution Network in English)
RNDGN: Rede Nacional de Distribuição de Gás Natural (National Natural Gas Distribution Network in English)
RNT: Rede Nacional de transporte (National Transmission Network in English)
RNTGN: Rede Nacional de Transporte de Gás Natural (National Natural Gas Transmission Network in English)
SCE: Sistema de Certificação Energética dos Edifícios (Energy Certification System for Buildings in English)
SDGs: Sustainable Development Goals
SEEF: Sistema de Etiquetagem Energética de Frotas (Energy Labelling System for Fleets in English)
SEEP: Sistema de Etiquetagem Energética de Produtos (Product Energy Labelling System in English)

SGCIE: Sistema de Gestão dos Consumos Intensivos de Energia (Intensive Energy Consumption Management System in English)

SIIE: Sistema Integrado de Informação Escutista (State Property Information System

SMEs: Small and Medium-sized Enterprises

VEET: Victorian Energy Efficiency Target

1. INTRODUCTION

Relevant improvements in energy efficiency are occurring worldwide. Energy efficiency policies are delivering results in terms of reducing consumption, safeguarding security of supply, reducing CO2 emissions, creating jobs and saving money for consumers. All this brings monetary and non-monetary benefits to industry and consumers, including those experiencing energy poverty. As discussed in a variety of literature sources on ‘sustainable growth´, energy efficiency can counter the adverse effects of economic downturn and lead to economic growth (European Commission, 2015). Therefore, reduction of total energy consumption not only evokes an environmental interest but also promotes the long-term energy security and the competitiveness of the European market (Bányai & Fodor, 2014).

The European Union (EU) claims to have successfully managed to decouple energy demand and economic growth. In short, this means reduction in energy use is not linked to a reduction in the economic or industrial activity. The economy can now grow while energy is being saved (European Commission, 2015).

1.1 Contribution

This study aims to conduct a critical analysis of the different types of approaches to achieve the objectives set for energy efficiency. It performs a retrospective analysis up to 2020, and a prospective analysis for the period 2020-2030.

1.2 Objectives and research questions

General Objective

An assessment of Energy Efficiency Obligations in order to characterize the effectiveness of the Energy Efficiency targets for 2020, allowing a general reflection for a 2030 perspective.

Specific Objectives

- Analysis of the Energy Efficiency Directive, with the objectives/targets to be achieved by 2020.
- Analysis of alternative measures to energy efficiency obligations.
- Analysis of the different energy efficiency schemes, besides energy efficiency obligations.
- Analysis of the progress made by Portugal to achieve the proposed targets for 2020.
- Analysis of the perspective on energy efficiency targets for 2030.

Research Questions

1. Which are the types of alternative measures to EEO schemes? Which countries have adopted a combination of EEO schemes and alternative measures?
2. What are the possible expectations regarding the alternative measures?
3. According to the scheme followed by Portugal, what is the expectation of meeting the proposed goals?
4. How valid is the approach for the 2030 period, according to the new regulations, namely the recast of the Energy Efficiency Directive?

1.3 Research Outlines

In the next sections of this thesis, six chapters including the introductory chapter are presented:

In chapter 2, a characterization of the concept of energy efficiency obligations is presented, using the context of energy policies in the frame work of sustainable development. The different options for energy efficiency obligation schemes in various geographies are also presented. Finally, the European energy efficiency directive is characterized, as well as the plan followed by Portugal.

In chapter 3, Article 7 of the European Energy Efficiency Directive is presented in detail. In addition, energy efficiency obligation schemes in some Member States are presented. The chapter includes an analysis of alternative policies to the energy efficiency obligations.

Chapter 4 presents the options adopted by Portugal on energy efficiency obligations. The measures planned to be implemented, what was promised, and what was achieved are also characterized.

In chapter 5, a reflection is made for 2030 according to the guidelines of the most recent update of the European energy efficiency Directive, and of the most recent national energy and climate plan (PNEC) in Portugal.

Chapter 6 provides the final conclusions, and makes recommendations for the next energy efficiency plans and objectives.

2. LEGISLATION AND RULINGS

2.1 Energy Efficiency Obligations Concept

2.1.1 General Concept

"Energy Efficiency Obligations (EEO) are a regulatory mechanism that requires obligated parties to meet quantitative energy savings targets by delivering or procuring eligible energy savings produced by implementing approved end-use energy efficiency measures" (Joshi, 2012). EEO schemes in general share three key features: a) a quantitative target for energy efficiency improvement; b) identification of the obligated parties that must meet the target; and c) a system that defines the energy-saving activities that can be implemented to meet the target, measures, verifies, and reports the energy savings achieved through these activities, and confirms that the activities actually took place (Bányai & Fodor, 2014).

The imposition of saving targets defined in the Energy Efficiency Directive (EED) (EED, 2012) requires the mandatory participation of utilities in the promotion of Energy Efficiency measures, through Demand Side Management programs. Under the EEO, some part of the company has an obligation to achieve energy savings in end-use customers premises or homes. Financial penalties will be incurred if the company fails to deliver those savings.

Governments set the overall targets for the EEO and the scheme administrator (a government department, energy agency or energy regulator) shares out the target among the obligated companies. The target for any particular energy company is related to its market share, quantified trough the volume of energy supplied or distributed by it. The EEO administrator is also responsible for approving the energy companies' actions or schemes on energy efficiency (including any product specification requirements); determining the energy savings at the completion of each action/scheme; verifying the claimed energy savings are valid and accurate; and taking enforcement action to ensure compliance with the EEO statutory order.

In most EEO Schemes, energy companies are not restricted to saving energy from their own customers; they can deliver energy saving actions to any eligible end-use consumer. The key steps are to set energy savings target, rules for determining the energy savings and procedures for

monitoring and verifying that those measures have in fact been adopted. Governments may also highlight or restrict any particular social or technological issue to which it wishes to give priority.

EEO can be coupled with various trading options: trading of certified energy savings, trading of eligible measures without formal certification or trading of obligations. There is increasing innovation on how these schemes are developed and a growing body of best practice examples available globally to accelerate the development and deployment process.

EEO have evolved from operating within vertically integrated electricity monopolies to operating in fully liberalised energy markets.

EEO offer a number of advantages beyond designating responsibility for ensuring efficiency actions are undertaken, including:

- Satisfying the "polluter pays" principle, as end users ultimately pay for the costs of the EEO to energy companies;
- Remaining independent of public expenditure, since financing comes ultimately from end users;
- Providing a more stable outlook that is not subject to changing government budgetary decisions;
- Creating a transformative effect on the market for energy services if the EEO design ensures that there is no abuse of market power by energy companies and that the market is open to third parties other than the obligated energy companies to participate;
- Being a cost-effective solution. For example, the Danish Government has evaluated its various energy efficiency policies and concluded that the Danish EEO is one of the most cost effective (Ii, P., Ii, P., Obligations, E. E., & Map, G. O., n.d.).

Typically, obligations in EEO schemes are placed on providers of networked energy (e.g., electricity and natural gas distributors or standalone retail suppliers). Obligations can also be placed on providers of other energy forms (e.g., LPG, heating oil, transport fuels, district heating), and even on end users of energy. In some schemes, energy savings to meet the obligation are delivered by a third party "energy efficiency utility" (Joshi, 2012).

"Despite the diversity of implementation options, it is possible to identify three broad types of EEO schemes:

- Schemes with quantitative energy saving targets that have been established relatively independently, often with their own enabling legislation. Energy saving targets are specific to each scheme and are not related to resource planning and acquisition by the obligated energy providers. Governments will usually set the targets, but the schemes can be administered by the government or by a body (often the energy regulator) that is independent of both government and the obligated energy providers. Schemes in Australia and Europe generally follow this model (Joshi, 2012).
- Schemes with quantitative energy saving targets that are integral components of resource planning and acquisition by the obligated energy providers. These schemes are often established by energy regulators to influence the resource mix adopted by energy providers. The design and implementation of the schemes are frequently subject to legal hearing processes as part of energy provider rate cases. The schemes are usually administered jointly by the energy regulator and the obligated energy providers. Schemes in North America generally follow this model (Joshi, 2012).
- Schemes with quantitative energy saving targets that have been established principally by governments as integral components of government policies. Energy saving targets for these schemes are set by the government and a government agency acts as the scheme administrator. Schemes in China and Korea generally follow this model (Joshi, 2012)".

The concept of Energy Service Company (ESCO) has gradually been present in the energy efficiency obligation schemes. An ESCO is an Energy Service provider that takes over both the technical and the financial risk (wholly or in part) by providing a guarantee of the results (energy savings or reduction of energy costs) to its clients. From the customer's point of view, energy performance contracting is similar to the outsourcing of financial and technical risk. Their clients may be public or private organizations (Altmann, M., 2010).

2.1.2 Trading of Energy Savings

"Some EEO schemes allow trading of energy savings among obligated parties, and between obligated parties and accredited third parties where non-obligated third parties are enabled to produce eligible savings. The purpose of trading is to broaden the pool of opportunities to produce eligible energy savings and to enable market forces to identify the most cost-effective opportunities" (Joshi, 2012).

Trading of energy savings is often carried out through the creation and sale of energy efficiency certificates (White Certificates). An energy efficiency certificate is a legal instrument distributed by an authorising body guaranteeing that a specified amount of energy savings has been achieved. Each certificate is a unique and traceable commodity carrying a property right over a certain amount of additional energy savings and guaranteeing that the benefit of these savings has not been accounted for elsewhere. However, trading of energy savings can be carried out bilaterally without the necessity to create energy efficiency certificates (Joshi, 2012).

A trading scheme facilitates other players such as ESCOs becoming active. ESCOs, which are established market players, could sell White Certificates for their energy savings projects. White Certificates, therefore, represent an additional source of revenue for ESCOs, making the business case more attractive (Altmann, M., 2010).

2.1.3 Funding schemes

There are costs incurred by obligated parties in meeting energy savings targets under an Energy Efficiency Obligation Scheme (EEOS). Schemes vary in how these costs are recovered and who pays them (Joshi, 2012).

The obvious costs involved with the deployment of energy efficiency measures under an EEO are met by energy companies in the form of subsidies along with contributions from customers, landlords (especially social landlords), local authorities, charities, manufacturers, and other actors. There is an additional cost to the energy company for marketing, selling, reporting, or planning its activities under the obligations.

Costs assumed by the energy company assume different natures depending on the way that they are passed on to the end-use customers. If the EEO is on an energy retailer in a liberalised market, the cost of the EEO simply becomes a cost of business like other environmental requirements and will be passed on to the end customer, with competition ensuring, in principle, that the energy companies deliver their obligations at the lowest cost possible. In contrast, if the EEO is on a regulated part of the energy company, such as a distributor or any supply price regulations are in place, the costs are normally included in the regulated tariff that is charged to the end customers. The experience both within Europe and globally shows that over time, the EEO will save money on individual customer's bills and possibly all customers' bills by reducing peak demand and costs to the grid (Ii, P., Ii, P., Obligations, E. E., & Map, G. O. n.d.).

2.1.4 Context of energy efficiency policies in sustainable development

Governments together with institutions are confronted with expanded pressure to improve on energy consumption reduction, which has been regarded as a major component of sustainable development policies. Energy efficiency has specifically been linked to bringing down the use of energy resources, along with a decreasing amount of carbon emissions. If carbon offset strategies are implemented then impacts on climate change will be mitigated. Therefore, it can be recognized that energy efficiency presents the most efficient and economical method which addresses challenges on sustainable economic growth, also contributing to the reduction of the use of non-renewable sources of energy as well as alleviating energy poverty (Rosen, 2014).

The continued dependence of non-renewable resources, the use of inefficient technology, and adoption of less effective energy efficiency policies have been identified as obstacles to a more sustainable future. Hence energy efficiency refers to different policies, technologies, and strategies that are aimed at solving issues related to energy use either at residential, commercial, industrial, or national level to minimize the emission of greenhouse gases which cause global warming, together with reducing financial costs.

The climate summit of 2015 in Paris represented a crucial juncture for global climate governance, where it was agreed legally binding and universal agreement to keep global warming below two degrees. A new set of universal goals, the Sustainable Development Goals (SDGs) [**Fig. 1**] where

established for the member states of the United Nations, therefore, from January 2016 to the end of 2030 they should frame their agendas around those goals (Troschke, 2015).

Meeting the SDGs will require a more universal approach. These goals aim at improving the lives of people worldwide while respecting ecological limits. New technologies, business models, and social concepts – in both developing and developed countries alike – will play a key role to ensure sustainable development. The SDGs are focused around six elements: (1) Dignity, (2) Basic needs of people, (3) Prosperity, (4) Planet, (5) Partnerships, and (6) Justice. Around these six elements, there are currently 17 suggested goals with 169 targets.

***Fig. 1**. Sustainable Development Goals. Source: https://sdgs.un.org/goals*

The SDGs and targets are integrated and indivisible, global in nature and universally applicable, taking into account different national realities, capacities and levels of development and respecting national policies and priorities. Targets are defined as aspirational and global, with each Government setting its own national targets guided by the global level of ambition but taking into account national circumstances. Each Government will also decide how these aspirational and global targets should be incorporated into national planning processes, policies and strategies. It is important to recognize the link between sustainable development and other relevant ongoing processes in the economic, social and environmental fields (Johnston, 2016).

Sustainable Development Goal 7 (SDG 7) is to "ensure access to affordable, reliable, sustainable and modern energy for all" (United Nations, 2018). The third of this goal's three targets (SDG 7.3) is to double the global rate of energy efficiency improvement by 2030 (IEA, 2018).

Goal 7. Ensure Access to affordable, reliable, sustainable and modern energy for all:

7.1. By 2030, ensure universal access to affordable, reliable and modern energy services;
7.2. By 2030, increase substantially the share of renewable energy in the global energy mix;
7.3. By 2030, double the global rate of improvement in energy efficiency;
7.4. By 2030, enhance international cooperation to facilitate access to clean energy research and technology, including renewable energy, energy efficiency and advanced and cleaner fossil-fuel technology, and promote investment in energy infrastructure and clean energy technology;
7.5. By 2030, expand infrastructure and upgrade technology for supplying modern and sustainable energy services for all in developing countries, in particular least developed countries, small island developing States and landlocked developing countries, in accordance with their respective programmes of support.

Energy efficiency is central to achieving other SDGs beyond SDG 7.3. For example, universal energy access (SDG 7.1) is made much more possible by achieving SDG 7.3, as a more efficient use of the world's energy resources will help more people gain access to modern energy services. Achieving SDG 7.3 also supports the pursuit of many non-energy related SDGs, including taking urgent action to combat climate change (SDG 13), reducing premature deaths and illnesses from energy-related air pollution (SDG 3.9) and improving household incomes (SDG 8) (IEA, 2018).

It is expected that these objectives will be the basis and inspiration for the development of future energy policies, including energy efficiency obligations.

2.2 An Analysis and Comparison of Energy Efficiency Obligations Schemes Worldwide

2.2.1 Introduction

Energy efficiency obligation schemes emerged out of a debate in the USA in the 1970s and 1980s around least-cost planning and later in the 1990s around integrated resource planning, an approach that requires systematic consideration of energy efficiency as a means for achieving competitive outcomes. As mentioned in section 2.1 EEOS require obligated parties, generally energy utilities, to meet energy saving targets by delivering or procuring energy savings at the customer end of the energy system. Within this general definition, individual EEOS look very different from each other, with obligations being variously placed on energy retailers, energy distributors, or both; across different geographical scales [**Fig. 2**]; on a variety of energy types; with different levels of ambition and metrics; and across all sectors of the economy, or just for particular customer groups (Fawcett et al., 2019).

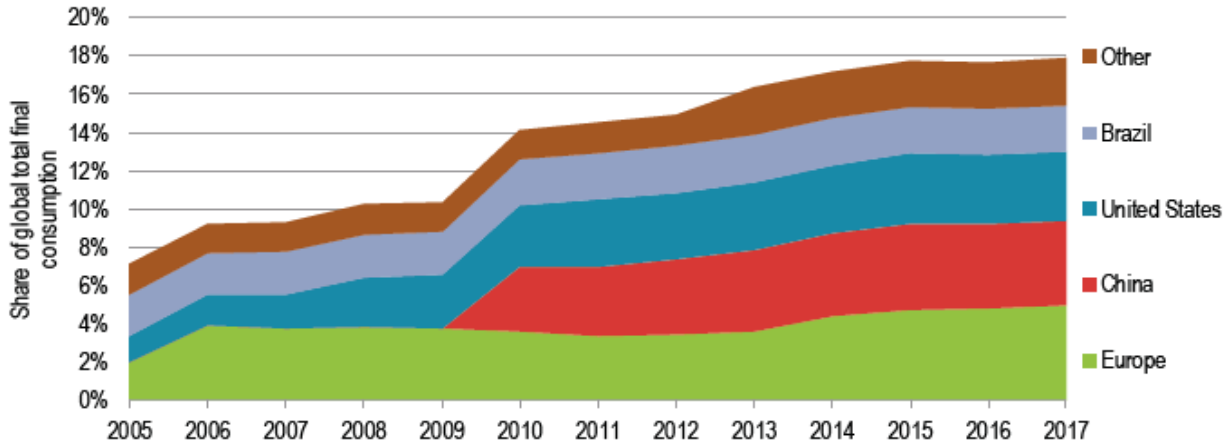

Fig. 2. *Coverage of energy utility obligations, by country/region*

2.2.2 The main parameters used in the EEO schemes

In the following chapter, case studies of nine EEO schemes implemented in various jurisdictions around the world are discussed in detail. A table summarises and compares key design parameters among these schemes [**Table 1Table 1**]. This table and the detailed case studies of the schemes themselves demonstrate that there are many different ways to design and implement EEO schemes.

Australia – Victoria

The Victorian Energy Efficiency Target (VEET) Scheme, that commenced operation on 1 January 2009 and is scheduled to end on 31 December 2029, aims at reducing the use of electricity and gas by consumers.

Obligated parties under the scheme are referred to as "relevant entities." Relevant entities are energy retailers who sell electricity and/or gas to 5,000 or more customers in Victoria and who purchase electricity or gas from specified sources (called making a "scheme acquisition"). A scheme acquisition for electricity retailers means the purchase of electricity for on-sale from the Australian Energy Market Operator. For gas retailers, a scheme acquisition means the purchase of gas for on-sale from a producer, storage provider, or interconnected pipeline operator, or from the Australian Energy Market Operator.

Each obligated energy retailer must each year give notice of its contribution, in terms of number of Victorian Energy Efficiency Certificates, to VEET Scheme target for the year. Each certificate represents one metric tonne of tCO2-e abated by specified energy saving activities. Certificates offered for delivery must comply with two criteria:

- the certificates must not have expired, that is, the energy efficiency project from which the certificates were created must have been completed within six years before the date on which the obligated energy retailer gives notice of them;
- the certificates must have been created by 30 January of the year following the relevant compliance year - for example, certificates created after 30 January 2012 cannot be used by retailers to meet their 2011 target, but can be used to meet their 2012 compliance year liability.

Each obligated energy retailer must submit an annual energy acquisition statement that sets forth the amount of electricity or gas acquired for on-sale for the year, the number of certificates being considered for the year, and any surplus certificates carried forward from the previous year or into the following year (Joshi, 2012).

Canada – Ontario

In 1998, the Legislative Assembly of Ontario passed Bill 35, called the *Energy Competition Act*, which restructured Ontario's electricity market by enacting the *Electricity Act, 1998* and the *Ontario Energy Board Act, 1998.* This established the Ontario Energy Board as the province's electricity and natural gas sectors regulator. The Ontario Energy Board protects consumer interests, promotes economic efficiency in the entire electricity sector, promotes energy efficiency, facilitates implementation of the smart grid, and promotes renewable energy. The Acts also set the legal framework for restructuring Ontario Hydro into successor companies, and opening the competitive wholesale market in electricity on 1 May 2002.

As a condition of their license, the Ontario Energy Board assigns each Ontario electricity distributor a Clean Development Mechanism (CDM) target. The requirement for CDM targets does not apply to electricity distributors that are not connected to the Independent Electricity System Operator-controlled grid or to distributors whose rates are not regulated by the Board.

Electricity distributors must file for Ontario Energy Board approval a CDM Strategy that provides a high-level description of how the distributor intends to achieve its CDM targets. The CDM Strategy must include:

- a high-level description of the distributor's year-by-year plan, including annual milestones, for achieving its CDM targets;
- a description of each of its CDM programmes, divided into Ontario Power Authority-Contracted Province-Wide programmes and Ontario Energy Board approved programmes;
- a section detailing how the distributor will pursue administrative efficiencies and coordinate its CDM activities with other electricity distributors, natural gas distributors, government agencies, and other organisations.

Each electricity distributor must file an Annual Report, which includes participation levels for each programme, funds spent, verified electricity savings and peak demand savings, and the progress the distributor has made toward meeting its CDM target (Joshi, 2012).

China

Demand Side Management (DSM) was first introduced in China in the early 1990s when there was growing recognition of energy and environmental problems resulting from increasing electricity consumption driven by rapid economic growth. During the early years, DSM in China was mainly supported by government funding and targeted load management rather than energy efficiency. DSM was seen as a systematic way to balance economic, environmental, and social development.

After a decade of experience with DSM, the central government in China realised that energy providers can take an important role in achieving energy savings through end use energy efficiency measures. In November 2010, the government issued a national DSM Rule *Guidance on Electricity Demand-Side Management Regulations*. This rule for the first time placed an EEO on the State Grid Corporation of China and China Southern Grid Company, the two large government-owned entities that operate electricity transmission and distribution networks and sell electricity directly to end use customers in the majority of China.

Grid company compliance with the DSM Rule obligation is assessed by a points system using both quantitative and qualitative measures specified in the draft Compliance Evaluation Scheme. The maximum achievable score is 100 points, with measures related to the energy saving target receiving a maximum of 60 points and DSM implementation receiving a maximum of 40 points. There are four defined performance levels in the draft Compliance Evaluation Scheme: Excellent (>90 points), Good (80-90 points), Qualified (70-79 points), and Failed (<70 points) (Joshi, 2012).

Denmark

Denmark's energy providers have been working with energy efficiency since 1990. The first EEO for electricity utilities was introduced in 1995; natural gas and district heating were included in the obligation starting in 2000. The focus of this programme was on free advice and campaigns for energy efficiency, with industries and private enterprises as the main target groups. Since 2006, electricity, natural gas, district heating, and heating oil distributors have been obligated to undertake energy efficiency activities under a scheme called Energiselskabernes spareindsats (energy companies' efficiency efforts).

The obligated parties are distributors of electricity, natural gas, and district heating. Heating oil distributors participate on a voluntary basis. For electricity, natural gas, and heating oil, the obligation is negotiated with the sector trade association, whereas for district heating the obligation is put on individual companies.

An individual obligated party's share of the energy saving target is calculated in proportion to its market share of the relevant fuel sector. Almost 50% of the target has to be achieved by electricity distributors, 30% by district heating companies, 20% by natural gas distributors, and a very small share by heating oil companies.

The Danish Energy Agency is responsible for basic administration of the EEO scheme. The energy savings achieved must be well documented and they must be verifiable by an independent source. Each energy efficiency programme must have a quality assurance system, which is audited internally every year, and by an independent auditor every second year. The obligated energy companies must develop a transparent accounting of funds they use to achieve energy savings, categorised into direct savings and deemed savings.

Obligated energy companies that fail to meet their individual energy saving targets must pay a penalty of EUR 0.1 per kWh of shortfall. In addition, obligated distribution companies may lose their license to distribute energy if they fail to meet their target (Joshi, 2012).

Italy

EEO for electricity and gas distribution system operators was introduced as part of the legislation liberalising Italy's electricity and gas sectors in 1999 and 2000. The energy efficiency certificate scheme, coupled with annual energy saving targets, commenced operation in January 2005.

As a participant in the European Union emissions trading scheme and the Kyoto Protocol, Italy has committed to reducing its GHG emissions to 6.5 percent below 1990 levels between 2008 and 2012. End-use energy efficiency improvements play an important role in helping to meet this target. Italy's energy efficiency certificate scheme also plays an important role in helping achieve the European Union's "20-20-20 Climate Package," which calls for GHG emissions reductions and improved energy efficiency.

Obligated parties are distributors of electricity and natural gas who, as of 31 December of the preceding year, "have connected to more than 50,000 consumers through their distribution grid." At the end of 2009, 14 electricity and 62 natural gas distributors were obligated to meet energy saving targets. Individual targets for obligated parties are determined annually by the AEEG (Autorità per l'Energia Elettrica e il Gas) based on each distributor's proportion of energy distributed to final customers as compared to the total amount of energy distributed in Italy in the preceding year. The electricity sector is responsible for over half of the total obligation (3.6 Mtoe in 2012 out of a total of 6 Mtoe).

Each obligated electricity and gas distributor achieves compliance by surrendering the number of energy efficiency certificates that corresponds to their individual annual energy saving target. Penalties for shortfalls in meeting the annual target are assessed on a case-by-case basis. The minimum overall penalty is EUR 25,000; the maximum is EUR 155 million (Joshi, 2012).

Korea

In 1979, Korea promulgated the *Rational Energy Utilization Act* to ensure energy security and to promote energy efficiency. Korea's energy efficiency programmes are planned and implemented based on the Act. The Korea Energy Management Corporation was established in 1980 and functions as the national energy efficiency centre responsible for the implementation of national energy efficiency programmes.

Under the *Rational Energy Utilization Act*, the Ministry of Trade, Industry and Energy must draft a Basic National Energy Plan every five years. In addition, all local governments, assisted by the Korea Energy Management Corporation, must make and implement a regional energy plan every five years that is in tune with the Basic National Energy Plan.

More recently DSM has been progressively pursued in Korea because of the growing difficulty in securing suitable sites and investment capital for constructing new power supply facilities. Additionally, an increase in the use of air conditioners in the 1990s caused a severe drain on electricity reserves and resulted in shortages on several occasions. In 1995, the Government revised the Rational Energy Utilization Act to require that all energy utilities establish and implement a DSM investment plan on an annual basis.

The energy utility DSM investment scheme places obligations on the Korea Electric Power Corporation, the Korea Gas Corporation, and the Korea District Heating Corporation. The Minister of Knowledge Economy may designate other companies that supply a large amount of energy as obligated parties, however it has not yet done so. In the future, the scope may be expanded to include private utilities, such as gas and heat retailers, in order to maximise energy savings. Additionally, oil companies may be included as obligated parties.

Energy utilities must submit their DSM investment plans and report the results to the Ministry of Knowledge Economy, which has authorized the Korea Energy Management Corporation to serve as the project management company with regard to the DSM plans. The Korea Energy Management Corporation evaluates the plans and the results of energy supplier DSM. The total investment budget for DSM programmes implemented by energy utilities must exceed the total investment budget of the previous year. Energy utilities must report investments to the Korea Energy Management Corporation the following year (Joshi, 2012).

United Kingdom

The United Kingdom has in place two programmes that set mandatory carbon reduction targets for retail suppliers of electricity and natural gas and for electricity generators:

- the Carbon Emissions Reduction Target;
- the Community Energy Savings Programme.

Both programmes support the United Kingdom's national and international climate obligations, primarily by promoting energy efficiency retrofits in the residential sector.

The Carbon Emissions Reduction Target entered into force in 2008 and is authorised through 2012. It represents a continuation of the United Kingdom's Energy Efficiency Commitment programmes.

The Community Energy Savings Programme was initiated in 2009 as a pilot programme focussing the activities of obligated parties into partnerships with local authorities and other local bodies, to provide whole-house retrofits in low-income communities. It has a target that is split equally

between electricity retailers and generators, but in practice nearly 80 percent of the target has to be met by the main six retailers of electricity and natural gas.

The schemes require retail suppliers of electricity and natural gas who have 50,000 or more domestic customers to meet a proportion of the overall targets based on their shares of residential customers. As of May 2010, there were six obligated electricity and gas retail suppliers.

The Community Energy Savings Programme further requires electricity generators that are not part of a group that also owns an electricity retailer and that generates 10 TWh/year or more of electricity to meet half of the overall target. Each obligated generator's individual target is based on the amount of electricity they generated relative to other obligated generators. As of March 2012 there are 11 obligated generators.

Obligated parties must fulfil certain reporting requirements. They must notify the Office of Gas and Electricity Markets of any energy efficiency projects that they intend to promote at least one month prior to commencement of a project, and submit a proposal for approval. Progress reports are required every three months for the Carbon Emissions Reduction Target and every six months for the Community Energy Savings Programme, and a completion report is due at the end of the programme period.

Compliance is determined at the end of the programme period, based on final measurement of the carbon reductions achieved by each obligated party. Noncompliance is enforced by the Office of Gas and Electricity Markets through an order securing compliance and/or imposition of a penalty.

Up to 100 percent of a retailer's or generator's obligation may be met through a transfer of carbon emissions reductions (Carbon Emissions Reduction Target) or trade of carbon obligations (Community Energy Savings Programme) between obligated parties. The transfer or trade must occur prior to the end of the compliance period, must be approved by the Office of Gas and Electricity Markets, and cannot compromise the transferring or trading party's ability to meet its target (Joshi, 2012).

United States – California

In 2005, California State Governor issued an executive order that established GHG emission reduction targets of 2000 levels by 2010; 1990 levels by 2020; and 80 percent below 1990 levels by 2050. The Order further directs the Secretary of the California Environmental Protection Agency to coordinate efforts made to meet the targets with the Chair of the California Energy Commission and the President of the Public Utilities Commission, among others. The California Global Warming Solutions Act of 2006 (Assembly Bill 32) outlines the state's timetable for reducing its GHG emissions to 1990 levels by 2020.

The obligated parties for the California EEO are the investor owned, and publicly owned electricity and natural gas utilities. Individual energy efficiency targets, budgets, and programmes for investor-owned utilities are set by the California Public Utilities Commission. Individual energy efficiency targets, budgets, and programmes for the publicly owned utilities are proposed by the utilities themselves and reported to the California Energy Commission.

California utilities comply with their individual energy efficiency targets by implementing approved energy efficiency programmes and reporting the results to the relevant agency, the California Public Utilities Commission for investor-owned utilities and the California Energy Commission for publicly owned utilities (Joshi, 2012).

United States – Massachusetts

In 2008, the Massachusetts State Governor signed the *Green Communities Act.* Among many other energy-related provisions, the Act requires that the Department of Public Utilities ensure that "electric and natural gas resource needs first be met through all available energy efficiency and demand reduction resources that are cost effective or less expensive than supply." In this regard, the Act builds on existing system benefits charge and utility-administered energy efficiency programmes. Since 1997, Massachusetts electricity utilities have used system benefits charge funds to offer end-use energy efficiency to their customers. Historically, electricity utilities offered annual programmes, while gas utilities offered five-year programmes. Under the Act, both electricity and gas utilities are required to implement three-year energy efficiency investment plans.

The targets do not necessarily apply equally to all obligated parties. The level of energy savings that each proposes to achieve may be different depending on factors such as service territory size and customer makeup. Four of the smaller utilities in Massachusetts, Western Massachusetts Electric, Berkshire Gas, New England Gas Company-Fall River Service Area, and Unitil, have individual targets lower than the state wide target.

The *Green Communities Act* requires obligated utilities to jointly file a three-year state wide plan describing how they will meet the EEO. The plans provide information on the energy efficiency programmes the utilities intend to implement, costs, funding sources to cover the costs, and savings and benefits expected to result from their programmes.

The obligated utilities must submit annual and quarterly reports to both the Department of Public Utilities and the Energy Efficiency Advisory Council on the status of their programmes. The Department of Public Utilities must determine the effectiveness of each utility's plan on an annual basis. If the utility has not reasonably complied with the joint plan, an investigation may be opened. The utility has the burden of proof to show good cause in failing to comply with the plan. If it cannot, a fine of USD 0.05 per kWh or USD 1 per term of shortfall may be levied against the utility (Joshi, 2012).

Table 1. *Comparison of Key Design Parameters Among EEOS(Joshi, 2012)*

Design Parameters	Australia Victoria	Canada Ontario	China
Policy Objectives	Reduce GHG emissions; encourage the efficient use of electricity and gas; encourage investment, employment, and technology development in energy services	To promote and expand energy efficiency in Ontario	To prioritise DSM in tight supply situations
Legal Authority	Combination of legislation and regulation	Combination of legislation and regulation	Regulation issued by central government agency
Fuel Coverage	Electricity and natural gas	Electricity	Electricity
Sector and Facility Coverage	Residential dwellings and commercial and other non-residential premises	Residential, commercial, industrial, institutional, and low-income customers	All economic sectors and any facility including transmission and distribution networks
Energy Saving Target	2.4 MtCO2-e per annum from 2009 to 2011; 5.4 MtCO2-e per annum from 2012 to 2014	1,330-MW reduction in peak demand by 2014 and 6,000 GWh of energy savings by 2014	Savings of 0.3% of electricity sales and load reduction of 0.3% of maximum load in the previous year
Sub-targets and Portfolio Requirements	None	Distributors assigned targets proportional to share of provincial peak demand and annual electricity consumption	Load-monitoring equipment on 70% of peak load and load-control equipment of 10% of peak load
Obligated Parties	Electricity and gas retailers with 5,000 or more customers in Victoria and who purchase electricity or gas from specified sources	Electricity distributors	Government-owned grid companies
Compliance Regime	Surrender of energy efficiency certificates	Electricity distributors must file for approval a strategy that describes how the distributor intends to achieve its targets	Score a minimum of 70 points in a system that uses quantitative and qualitative measures to score performance from 0 to 100 points
Penalty	AUD 40 per tCO2-e shortfall in 2010, adjusted annually for inflation	None	None
Performance Incentives	None	Allowed on a sliding scale between 80 and 140% of goal achievement	Available pending a result of "Excellent" (90 points or higher); no further details available
Eligible Energy Savings	Energy savings from installing preapproved energy efficiency products; accredited non obligated parties may install products	Savings achieved through distributor's own programmes, or through contracted government programme	Savings achieved by grid companies and energy service company subsidiaries of grid companies
Eligible Energy Efficiency Measures	Preapproved products with deemed energy saving values, additional products added from time to time	Government-run programmes or programmes approved by the regulator in the distributor's service territory	Measures not specified; energy savings from other fuel types may be converted into electricity saving
Measurement, Verification, and Reporting	Audits of records of product installations	Distributor programmes must be evaluated by a third party; the regulator must publish result annually	100% of savings can only be claimed if audited by third party or recorded by equipment
Trading of Energy Savings	Trading of energy efficiency certificates	No	Obligated parties may purchase savings from customers and ESCOs under bilateral contracts
Funding	Obligated parties' costs are treated as a cost of doing business	Collected from all ratepayers based on energy use or contribution to peak demand	City utility surcharge, revenue from differential electricity prices, and other funding sources

Design Parameters	Denmark	Italy	Korea
Policy Objectives	To decrease total energy consumption by 2% in 2012 and 4% in 2020	To serve as the primary driver for end-use energy efficiency	Improve efficiency in production, conversion, transport, storage, and utilisation of energy
Legal Authority	Voluntary agreements by obligated parties within a legislative framework	Combination of legislation and Ministerial Decrees	Combination of law and regulation
Fuel Coverage	Electricity, natural gas, district heating; and heating oil	Electricity and natural gas	Electricity, natural gas, and district heat
Sector and Facility Coverage	Residential, public, private business, and energy-intensive industry end users	All sectors including transport, and all end-uses including small-scale cogeneration and photovoltaics	Commercial, industrial, educational, and residential customers
Energy Saving Target	2.95 PJ for 2006-2009 (0.7% of consumption); 6.1 PJ for 2010-2012 (1.2% of consumption)	2.2 Mtoe cumulative in 2008; increasing to 6.0 Mtoe cumulative in 2012	None
Sub-targets and Portfolio Requirements	None	None	None
Obligated Parties	Distributors of electricity, natural gas, district heating, and heating oil	Distributors of electricity and natural gas	Energy utilities
Compliance Regime	Energy savings must be well documented and they must be verifiable by an independent party	Surrender of energy efficiency certificates; one-year grace period before penalty is assessed if at least 60% of target is met	Energy utilities must submit a DSM plan and report the results to a government agency
Penalty	EUR 0.1 per kWh of shortfall; possibility for distributor to lose license	EUR 25,000 to 155 million assessed on case-by-case basis	None
Performance Incentives	Weighting factors for longer lifetime energy efficiency measures	Possible 5% premium over achieved savings	None
Eligible Energy Savings	Distributors must engage third parties to achieve energy savings within own or any other energy type except for transport	Savings can be produced by obligated distributors and accredited energy service providers	Savings from energy efficiency projects implemented by energy utilities, ESCOs, and energy efficient equipment vendors
Eligible Energy Efficiency Measures	Many types, including energy audits, targeted information, subsidies for efficient appliances and equipment; also small scale renewables	Preapproved list of measures with deemed energy saving values plus other measures assessed on a caseby- case basis	No preapproval required; energy efficiency improvements or load management measures
Measurement, Verification, and Reporting	Distributors verify and report savings; can be calculated or deemed savings	Deemed savings, partial on-field measurement, or measures subject to preapproval	Verification of actual energy savings by an independent third party
Trading of Energy Savings	Energy savings may only be traded among obligated energy distributors	Trade of energy efficiency certificates through over-the-counter market or spot market	None
Funding	Cost recovery through tariffs	Fixed contribution to cost recovery through a tariff contribution; transport measures not eligible for cost recovery	Through a customer charge for electricity and from energy utility revenues for gas and district heating

Design Parameters	United Kingdom	United States California	United States Massachusetts
Policy Objectives	Reduce fuel bills and the carbon impact of homes by improving energy efficiency	Obtain 100% of cost-effective energy efficiency and reduce total consumption by ten percent within ten years	Acquire all available energy efficiency and demand reduction resources
Legal Authority	Legislation and statutory instruments	Combination of legislation and regulation	Combination of legislation and regulation
Fuel Coverage	Electricity and natural gas	Electricity and natural gas	Electricity and natural gas
Sector and Facility Coverage	Residential dwellings including those of low-income households and disadvantaged groups	New construction; heating, ventilation, and air conditioning; and low-income customers	All customer classes in all sectors, including low-income customers
Energy Saving Target	Lifetime savings of 293 MtCO2-e for 2008 to 2012 and 19.25 MtCO2-e for 2009 to 2012	6,965 GWh (0.9% of sales), 1537 MW, and 150 million therms in 2010-2012 for investor-owned utilities; 700,000 MWh for publicly owned utilities	1.4% of retail electricity sales in 2010, 2% in 2011, and 2.4% in 2012; 0.6% of retail gas sales in 2010, 0.9% in 2011, and 1.15% in 2012
Sub-targets and Portfolio Requirements	40% of the target must be met with savings in households with low income and/or elderly people	None	Minimum spend on low-income residential customers of 10% of budget for electricity and 20% for gas
Obligated Parties	Electricity and natural gas retailers and certain electricity generators	Investor-owned and publicly owned electricity and natural gas utilities	Electricity and gas distributors and municipal aggregators
Compliance Regime	Determined by the regulator based on the final measurement of carbon reductions achieved by each obligated party	Obligated utilities implement approved energy efficiency programmes and report the results	Obligated utilities must jointly file a three-year statewide energy efficiency plan; regulator determines compliance
Penalty	Penalty may be imposed for noncompliance	Yes, if achievement is below 65% of target	USD 0.05/kWh or USD 1 per therm shortfall
Performance Incentives	Uplifts that increase the carbon reductions claimable for certain measures	Starting at achieving 80% of the target and capped at USD 450 million for investor-owned utilities	For achievement of between 75 and 125% of targets; based on program net benefits
Eligible Energy Savings	Savings from energy efficiency projects implemented by obligated parties or by contractors engaged by the obligated parties	Savings from programmes implemented by the utilities themselves or by contractors	Savings produced by obligated parties through implementing approved three-year plans
Eligible Energy Efficiency Measures	Energy efficiency measures implemented in residential dwellings	Measures included in 12 statewide energy efficiency programmes	Measures included in three-year plans approved by the regulator
Measurement, Verification, and Reporting	Deemed savings or calculated savings approved by the regulator	Rigorous protocol carried out by third-party contractors	Utilities are responsible for evaluation, measurement, and verification
Trading of Energy Savings	Transfers of emissions reductions and trading of obligations allowed among obligated parties	None	None
Funding	Costs are considered a cost of doing business and are passed on to the customer through increased prices	Public goods charge and natural gas DSM charge; additional funding through rate cases	System benefits charges, funding from carbon and capacity markets, plus other funding sources

2.3 European Union Energy Efficiency Directive: 2012/27/EU (EED)[1]

The reduction of total energy consumption not only evokes an environmental interest but also promotes the long-term energy security and the competitiveness of the European market. Having recognized its significance, the EU set a policy goal to save at least 20% reduction of primary energy consumption by 2020 compared to 2007 primary energy consumption projections in 2020 (based on the model PRIMES 2007) (Sousa, José Luís, 2015). The legal environment, which serves the realization of this goal, is going through continuous evolution. The adoption of the European 2012/27/EU Directive on Energy Efficiency (EED, 2012) was necessary because energy consumption in the EU was not progressing satisfactorily regarding the timetable set by previous regulations (Bányai & Fodor, 2014).

Directive 2012/27/EU amends Directive 2009/125/EC on eco-design requirements for energy-related products and Directive 2010/30/EU on energy efficiency labelling of energy-related products, and repeals Directive 2004/8/EC on the promotion of cogeneration and Directive 2006/32/EC on energy end-use efficiency and energy services. Each Member State should set an indicative national energy efficiency target based on the parameters set in the Directive and should notify those targets to the Commission. From 30 April 2013 onwards, Member States must report each year on the progress achieved towards their national 2020 energy efficiency targets. By 30 April 2014, and every three years thereafter, Member States should submit National Energy Efficiency Action Plans. The Directive lays down rules designed to remove barriers in the energy market and overcome market failures that impede efficiency in the supply and use of energy and provides national indicative targets for energy efficiency in 2020. The requirements laid down in the Directive are minimum requirements and do not prevent any Member State from maintaining or introducing more stringent measures. Among the Directive's provisions included in specific articles are:

[1] In the following, references to Annexes without further explanation refer to Annexes of the Energy Efficiency Directive.

1. **Concerning EFFICIENCY IN ENERGY USE**

- Energy efficiency targets
- Building renovation
- Purchasing by public bodies
- Energy efficiency obligation schemes
- Energy audits and energy management systems
- Metering and Billing information
- Consumer information and empowerment programme

2. **Concerning EFFICIENCY IN ENERGY SUPPLY**

- Promotion of efficiency in heating and cooling
- Energy transformation, transmission and distribution

3. **Concerning HORIZONTAL PROVISIONS**

- Availability of qualification, accreditation and certification schemes
- Information and training
- Energy services
- Energy Efficiency National Fund, Financing and Technical Support

Detailed information about the EED is provided in **appendix A** of the appendices of the present document available at Zenodo[2].

[2] https://doi.org/10.5281/zenodo.5633388

2.4 Energy Efficiency in Portugal: Third NEEAP (2017-2020)

2.4.1 Introduction

The European commitment to energy efficiency is based on strengthening the competitiveness of businesses, their capacity to generate energy-efficient products and new technologies, as well as job creation and skills development.

In this context, the third National Energy Efficiency Action Plan (NEEAP) (Diário da República, 2017) was drafted as part of the obligation to report to the European Commission in accordance with Article 24(2) and Annex XIV of the EED.

In the third NEEAP a new goal regarding a maximum limit of primary energy consumption was set for the period 2017-2020. The Government set a goal of 25% reduction in energy consumption by 2020, based on PRIMES projections made in 2007, setting the maximum consumption limit at approximately 22.5 Mtoe. This commitment goes a little bit further than the 20% reduction set by Directive on Energy Efficiency. Besides the 25% reduction goal, a specific reduction goal for the State was set to 30% of the primary energy consumption by 2020. The implementation of the NEEAP is supported by regulatory measures, fiscal differentiation measures and financial support to the implementation of the energy efficiency measures (Sousa & Martins, 2018).

2.4.2 Measures for implementation of the EED

2.4.2.1 Cross-cutting measures

Energy efficiency obligation schemes (Article 7 EED)

To achieve the proposed targets on an annual basis, the following measures were defined to be adopted to strengthen market conditions for a significant increase in energy efficiency through:

1) The creation of a ‘Local Energy Agreement’ (2017 - 2020) bring together local authorities in a joint strategy to guarantee commitments to reduce the final energy consumption of local public administration buildings annually by 1.5%.

2) Actively extending the promotion of energy efficiency to include the premises covered by the European emissions trading scheme provided for in Decree - Law No 93/2010 of 27 July and in Decree - Law No 38/2013 of 15 March, through the obligation to report a reduction in final energy consumption of 1.5%.

Additionally, if during implementation of the planned measures there were deviations that could jeopardise the cumulative energy savings target for 2020, additional measures would be taken. These may include further mandatory and/or fiscal measures, or other voluntary or non - voluntary measures that would increase the likelihood of achieving energy savings of 2.5 Mtoe by 2020.

It should be noted that the above measures are aimed at the energy consumer, and therefore not at the energy supplier.

Energy audits and energy management systems (Article 8 of EED)

With the aim of guaranteeing a market of energy audits and high-quality energy consumption management systems, a number of legislative mechanisms were created, supervised by the DGEG under national legislation, responding to the needs of the industry, services and residential sectors.

Likewise, for the transport sector, the Regulation on the Energy Consumption Management for the Transport Sector (RGCEST) was created by Order 228/90 of 27 March, which aims to improve energy efficiency in this sector. It applies to transport undertakings and undertakings with their own energy - intensive fleets whose energy consumption during the preceding year was more than 500 toe. It also sets targets for a progressive reduction in specific energy consumption. The methodology encourages conducting an energy audit every three years, with the aim of identifying potential energy savings, supporting the drafting of a restructuring plan with the energy efficiency improvement measures to be implemented over the following three years.

The new regulation for the transport sector will have the following objectives:

1) Focusing application of the regulation on land transport (road, rail and inland waterways), freight and passenger transport undertakings, excluding the fleets of undertakings considered within the scope of the SGCIE (Intensive Energy Consumption Management System in English);

2) Extending the scope of the current regulation to cover a greater number of transport undertakings whose energy consumption in the previous calendar year has exceeded 400 toe per year;
3) Changing the frequency of energy audits to four years.

In the industry sector, the SGCIE regulation – Intensive Energy Consumption Management System – was established through publication of Decree - Law No 71/2008 of 15 April, applicable to energy - intensive premises (CIE) with consumption of over 500 toe/year, with the aim of promoting energy efficiency and monitoring the energy consumption of these premises. To this end, energy-intensive premises are required to carry out regular energy audits to check the conditions under which energy is used, and to encourage greater energy efficiency, including the use of renewable energy sources. The energy audit focuses on the design and the operating condition of the premises. It must gather the input needed to draw up a plan to rationalise energy consumption, and subsequently ensure that the premises comply with the plan.

The SGCIE regulation has the following objectives:

1) To extend the scope of the previous regulation to cover a greater number of premises, reducing the coverage threshold from 500 toe to 400 toe of annual consumption;
2) Introduction of a differentiating mechanism to stimulate energy savings, creating two compliance schemes, with only one of them, the most stringent, giving access to tax and other benefits;
3) Introduction, where applicable, of meters and monitoring and control mechanisms and of centralised technical management as a mandatory improvement measure;
4) Recording and monitoring of energy consumption for premises with an annual consumption of less than 400 toe;
5) Integration of premises covered by the European Emissions Trading Scheme into SGCIE obligations;
6) Reducing the frequency of energy audits to four years;
7) Mandatory annual reporting of progress and implementation of rationalisation plans.

With regards to the buildings sector, two action areas are anticipated regarding the nature of the buildings, namely: i) Design of new buildings and ii) Renovation of existing buildings.

With regards to the Design of new buildings, the European legislative framework (Directive 2010/31/EU of the European Parliament and of the Council) requires Member States to draw up national plans to increase the number of nearly zero-energy buildings (NZEBs). The implementation of the NZEB concept, with a particular emphasis on the dates for its entry into force (1 January 2019 for public buildings and 1 January 2021 all other buildings), will help to ensure that the increase in Portuguese building stock (via these new buildings) will be guided by principles of low energy consumption and promoting energy from renewable sources.

Given that implementation of the NZEB concept establishes a new paradigm, the involvement of the main players affected in the construction sector will be encouraged, and establishing measures to promote adoption of this paradigm by these agents is necessary. Given the importance of the link between NZEB buildings and the quality of their construction (in order to ensure they are suitably efficient over their life cycle), there is also support for the technical training of the various players, from the design phase of the project through to the construction phase, and ending in the usage/operation of these buildings.

With regards to the Renovation of existing buildings, these represent great potential for reducing energy consumption in Portugal in the buildings sector. It is felt that they should be converted according to a strategy that includes: i) the vision set out in Directive 2010/31/EU, which encourages Member States to transform all buildings that are renovated into almost nearly zero - energy buildings (NZEB) and ii) a long-term strategy to mobilise investment in the renewal of the national stock of residential and commercial buildings, both public and private.

The focus of the energy retrofitting of existing buildings should be based on the following aspects:

1) Retrofitting of the passive components of buildings, seeking to implement cost-effective solutions wherever possible, leading to lower energy consumption in the life cycle of the buildings. These measures should also be based on the demand for buildings equipped with improved comfort, and reducing energy poverty;
2) Replacement of inefficient technical equipment or systems with more efficient solutions that guarantee effective energy savings. Special focus should also be given to the continuous maintenance and monitoring of these systems;

3) Promoting energy from renewable sources in order to promote greater energy independence and integration, with a reduction of energy consumption costs.

As a means of putting the two action areas referred to above into effect, the prevailing legal framework stands out. The latter will serve as a means of registering and monitoring implementation of these measures, such as the Energy Certification System for Buildings (SCE), the Regulation on the Energy Performance of Residential Buildings, and the Regulation on the Energy Performance of Commercial and Service Buildings. In the scope of the SCE, energy evaluation is carried out by experts accredited by the Portuguese Energy Agency (ADENE).

To obtain energy certification of the building or unit, a detailed evaluation of the energy usage conditions is performed, to identify the different energy vectors and energy consumption profile, as well as the potential for improving each of these buildings or units.

In this context, in order to identify the greatest number of opportunities for rationalising energy consumption, it is important to promote an extension of the scope of energy audits under the SCE, as provided for in national legislation, as well as promoting voluntary certification of buildings. In addition, it is essential to integrate and systemise the different monitoring and control platforms of the various existing systems (including the SCE, energy efficiency barometer etc.), with the aim of systematising audit processes, creating a useful database for end consumers, auditors and management entities.

Metering, Energy Billing and Billing Information (Article 9 to 11 of the EED)

Portugal has a vast network of individual energy meters which guarantee, at almost all end consumers of electricity and natural gas, precise knowledge of actual consumption and information about the corresponding actual period of use.

With the present regulations it is felt that the necessary initiatives have been taken to understand exactly how and when the consumer uses energy, thus enabling opportunities to rationalise consumption to be identified and managed.

However, the absence of a breakdown of consumption and of the costs of energy per end consumer for urban heating systems and/or domestic water heating is a weakness in the fulfilment of national

energy efficiency targets, and shows the pressing need to reinforce the provisions of Article 16(4) of Section V of Decree–Law No 68–A/2015 of 30 April. Responsibility for inspection and setting fines should be formally assumed by the minister for energy within 30 days of the date of publication of this Plan.

In anticipation of the growth in smart grids and their benefits, Order No 231/2013 of 22 July was published, approving the technical and functional requirements of smart meters, together with the rules on the provision of information and billing, and the financing of installation costs.

The same Order also establishes an economic evaluation every two years of the costs and benefits of installing smart meters, based on which the implementation of new smart meters will be approved, including the respective installation schedule. This guarantees the penetration of smart meters in the national market, thus promoting energy efficiency in consumers' premises through network management.

With regards to the information that should be included in energy bills in order to promote energy efficiency in end-uses, this should be increased in order to guarantee consumers the possibility of comparing their current actual consumption with actual consumption in previous years under identical climatic conditions. In this context, the Logistics Operator for Change of Supplier (OLMC) was established through Decree–Law No 38/2017 of 31 March, with the responsibility of ensuring that a change of electricity and natural gas supplier by the consumer is carried out quickly, based on simple, transparent, standardised and electronic rules and procedures, as well as ensuring that consumers right to information can be exercised.

Consumer information programmes and training (Article 12 and 17 of the EED)

Articles 12 and 17, and Annex XIV, of the EED refer to the obligation to provide and encourage the creation of information campaigns, training and awareness initiatives in the field of energy savings and efficiency.

Under previous NEEAPs, which entailed the delivery of several campaigns and training programmes to promote energy efficiency, the results have been difficult to monitor and quantify due to their intangible features. However, their implementation is recognised as an essential

measure of direct influence on behavioural changes in final energy consumers, making a significant contribution to achieving national energy efficiency targets.

The aim of the campaigns will be to induce behavioural changes in energy consumers, to adopt good energy efficiency practices in the following areas:

a) Energy efficiency in buildings;
b) Efficient equipment;
c) Efficient public procurement;
d) High-yield generation;
e) Energy monitoring systems.

The following entities are therefore responsible for creating information campaigns regarding the respective scope of intervention:

f) Transport area: IMT – Instituto da Mobilidade e dos Transportes, I.P. (Institute for Mobility and Transport, public enterprise) (IMT);
g) Residential and services area: ADENE - Portuguese Energy Agency;
h) Industry area: Directorate - General for Energy and Geology (DGEG);
i) State area: Entidade de Serviços Partilhados da Administração Pública, I.P. (Entity for Shared Services of Public Administration, public enterprise) (eSPap);
j) Behaviours area: ADENE.

The same entities should, by March 31 of each year, notify the Executive Committee of the NEEAP Management Structure of the expected and achieved results in estimated final and primary energy savings (toe), with annual implementation of the relevant information campaigns.

Qualification, Accreditation and Certification schemes (Article 16of the EED)

Portugal has in place several mechanisms for the registration and control of qualified technicians conducting energy audits, in accordance with the Regulation on Energy Consumption Management for the Transport Sector (RGCEST), in the Intensive Energy Consumption Management System (SGCIE), and in the Energy Certification System for Buildings (SCE), meaning the technical

competencies, objectivity and reliability of the technicians who conduct the energy audits are already at a high standard.

In addition, many public sector undertakings and entities, due to energy challenges and a highly competitive economic context, have developed and implemented systems and processes aimed at improving energy efficiency. In this framework, many certifying and training entities have made positive efforts in the national market, with continuous training aimed at senior technical staff in Energy Management Systems (e.g.: ISO 50001).

Energy audits conducted under RGCEST and SGCIE are carried out by technicians duly accredited by DGEG, and registered on the country's relevant professional engineering associations. Under the SCE, energy audits prior to issuing the energy certificate are carried out by experts accredited by ADENE. These experts are architects, civil engineers, civil technical engineers, mechanical engineers, mechanical technical engineers, electrical engineers, technical energy and power systems engineers, specialists in air conditioning or energy engineering, registered with their respective professional public associations.

Energy Services (Article 18 of the EED)

The Energy-Efficient Public Administration Programme (Eco.AP) introduced a series of energy efficiency measures for short, medium and long-term delivery in services, organisations and public equipment, with a view to changing behaviour and promoting rational management of energy services, namely by contracting energy services companies (ESCO, ESE in the Portuguese designation). The ESCO provide energy services and other energy efficiency improving measures at a user's premises, assuming a degree of financial risk, whereby their remuneration for the services provided is wholly or partly based on the degree of achievement of energy efficiency improvements, and on satisfying other energy efficiency criteria that may be contractually set through an energy performance contract (CDE).

Under the Eco.AP programme, the quintessential driver of growth of the energy services market in the public sector, there were around ten contracts with an investment of around twenty million euros, all of which in the field of lighting (public and traffic lights) (Diário da República, 2017). In the private sector, despite greater freedom in the business model, namely the possibility of sharing

the financial risk agreed between the parties (ESCO and beneficiary), there is no control over the main relevant activities.

In order to achieve national targets, there have been information sessions, as well as awareness and communication activities around the energy services market, with working sessions on the contracting process, how the ESEs and energy services operate, focusing in particular on financing mechanisms

Synergies with European and/or national projects with common objectives should be considered, boosting the involvement and participation of stakeholders. These initiatives should be coordinated with the Energy Efficiency Awareness Campaign together with the Central Public Administration, supported by PO SEUR and to be implemented by ADENE in 2017-2018.

Energy Efficiency National Fund, Financing Sources (Article 20 of the EED)

The Energy Efficiency Fund is an autonomous asset with no legal personality, established by Decree-Law No 50/2010 of 20 May, as amended by law No 82 - D/2014 of 31 December, to finance programmes that demonstrably contribute to energy efficiency.

The Fund fulfils its financing objectives by supporting (i) projects of a predominantly technological nature in the transport, residential and services, industry, agriculture and public sector areas, and (ii) cross - sector initiatives that encourage energy efficiency in the behaviour, taxation, incentives and financing areas.

In addition, in a macroeconomic scenario beset with budget restrictions and limitations on the use of financing, in addition to the Energy Efficiency Fund, financial support is provided for energy efficiency programmes such as:

1) The Innovation Support Fund (FAI), established by Order No 32276 - A/2008 of 17 December 2008, which also approved its Management Regulations, subsequently amended by Order No 13415/2010 of 19 August 2010, and by Order of the Secretary of State for Energy of 5 July 2012, which broadened the scope of application of the FAI to projects investing in energy efficiency;

2) Plan for promoting efficient energy consumption (PPEC), promoted by the Regulatory Body for Energy Services (ERSE);
3) Partnership agreement between Portugal and the European Commission, bringing together the 5 European Structural and Investment Funds – ERDF, Cohesion Fund, ESF, EAFRD and EMFF – which define the programming principles under which economic, social and regional development policy are to be promoted in Portugal between 2014 and 2020 is delivered.

2.4.2.2 Energy Efficiency in Buildings

National Strategy for Building Renovation (Article 14 of the EED)

In Portugal, built-up area corresponds to around 452,000,000 m², of which 77% is made up of residential buildings. Commercial and service buildings can be broken down as follows: Offices: 26%; Schools: 21%; Hospitals: 7%; Hotels and Restaurants: 13%; Sports buildings: 4%; Commerce: 28%, Other 2% (Diário da República, 2017).

After a detailed and careful profiling of the national building stock, its dynamics and broad trends, it was possible to establish the National Strategy for Building Renovation in August 2014. A new version of the strategy to consolidate the work completed so far is being finalised.

In addition, it is essential to implement and support measures aimed at capturing the savings made through the implementation and application of energy efficiency measures in buildings, to ensure they are monitored.

2.4.2.3 Energy Efficiency in Public Buildings

The Programme to Promote Energy Efficiency in Public Administration (Eco.Ap) is expected to be refurbished with the following action areas:

1) Diversification of the mechanisms to support implementation of energy efficiency projects in public administration, ensuring interlinking between sources of financing available and the overall calculation of savings generated under Eco.Ap;

2) Restoration of the Energy Efficiency Barometer, making it a central instrument of energy efficiency policy, as well as a tool for managing the energy consumption of public entities;
3) Promotion of the use of Energy Efficiency Management Contracts by Public Administration entities, in particular by taking advantage of the potential replicating effect of interventions in public lighting systems;
4) Development of a new instrument to support implementation of energy efficiency measures and renewable energies in the public sector, suited to the characteristics and constraints of this sector as regards financing investments of this kind;
5) Development of a training programme for Local Energy Managers in order to train local energy managers to identify and implement energy efficiency measures.

In this context, and for the purposes of better implementation of the Energy Efficiency Barometer, the following are envisaged:

a) Periodic reporting by energy suppliers of the energy consumption and costs of Public Administration entities, preferably via electronic platform;
b) Periodic reporting by Public Administration entities of the characteristics of their buildings, activities, contracts and energy consumption, preferably via electronic platform;
c) Integration and sharing of information with other databases, namely the State Property Information System (SIIE) and the Building Energy Certification system (SCE).

2.4.2.4 Other Energy Efficiency measures

To achieve the 2020 energy consumption efficiency targets action on less efficient technologies will be strengthened through the application of additional charges on products and equipment. Through the energy labelling of white appliances, air conditioning systems, domestic hot water systems, lighting, tyres etc., a taxation value will be developed that is proportional to the product's inefficiency.

The total duties applied will be paid into the Energy Efficiency Fund, strengthening the allocation available for financing energy efficiency measures in the various sectors.

The incentive to choose the most energy-efficient solutions from the range of products, equipment and systems that, while not subject to European energy labelling, have strong energy saving potential, will be strengthened through the adoption of voluntary labelling systems (e.g.: the Product Energy Labelling System (SEEP) for windows, insulation, walls, paints and lifts, and the Energy Labelling System for Fleets (SEEF)).

In industry, with a view to corporate visibility, social responsibility and the promotion of energy efficiency measures developed voluntarily, or within the scope of the SGCIE, the creation of a voluntary system for the energy labelling of industrial undertakings, enabling organisation s to publicise their energy classification, will be considered.

In the transport sector, it is important to boost the electric mobility market through specific programmes, guaranteeing the updating of the current favourable tax framework for companies, promoting electric mobility in the private sector. Work carried out in recent years has enabled the phased penetration of electric vehicles (EV) and mixed-use passenger vehicles and electric scooter market, by extending the fast-charging stations network and creating conditions for battery charging in covered public and private car parks. However, there is a clear opportunity to create conditions for the development of domestic charging solutions in shared residential buildings and shared garages. It should be noted that electric vehicles have a tax differentiation that translates to total road tax (IUC) exemption, under the environmental component, and vehicle tax (ISV).

2.4.2.5 Promotion of efficiency in heating and cooling

Hight-efficiency cogeneration (Article 14 of the EED)

With the publication of Decree-Law No 68-A/2015 of 30 April, establishing the discipline of cogeneration activity following the paradigm assumed by the EED, and with sustainable remuneration schemes that maintain the incentive for renewable and high-efficiency cogeneration. The amendments introduced favour the installation of small and medium-sized units suitable for sectors with low cogeneration penetration, through a tariff defined and subsidised according to the efficiency obtained, and the use of renewable fuels, ensuring the purchase by last resort supplier of energy generated in units with interconnection power of less than 20 MW, guaranteeing the possibility of concluding contracts directly with consumers, or negotiating in the market.

The cogeneration potential that is believed to be achievable, based on the situation analysed in 2014, represents 11 TWh to 13 TWh of electricity generation (29% of national consumption) and 2.5 GW to 3.1 GW of installed capacity, representing an increase of 0.7 GW to 1.3 GW of electrical power, maintaining the average operating characteristics currently observed. To achieve this potential, and to ensure the energy savings achieved are sustainable, suitable incentives will be considered to promote high-efficiency cogeneration, and renewables-based cogeneration, favouring the implementation of small and medium power units, and ensuring adequate stability and sustainability of the remuneration schemes.

With regards to the potential associated with the heating and cooling supply networks, there was sufficient mismatch between consumption supply and demand to not justify such networks in an exclusively residential context, due to the climatic conditions and specific characteristics of the building stock in Portugal, which resulted in reduced consumption for space heating, and even less for cooling, and with a very small penetration of centralised air conditioning systems, which further increases costs incurred in any process of adaptation to a new infrastructure. Furthermore, the highest density of consumption identified is much lower than the minimum threshold proposed in the EED, so that even when combined with consumption in service buildings, viability thresholds would not be easily reached.

Increasing the number of cogeneration units, and thus achieving the overall saving of 1 Mtoe of primary energy, is a national target for 2020.

2.4.2.6 Efficiency in Energy Transmission and Distribution

Demand Management (Article 15 of the EED)

Portugal has mechanisms for managing demand, such as the interruptible tariffs scheme and time-of-use rates in the electricity sector.

As regards the introduction of dynamic pricing, the regulatory entity has established conditions for a new regulatory framework that facilitates the implementation of pilot projects for dynamic pricing by distribution system operators. This type of pricing ensures greater demand-side participation in the efficient use of resources in the electricity sector. Demand flexibility and

participation are fundamental in a context of an increasingly dispersed supply of energy in distribution networks, and using intermittent renewable resources.

Energy Efficiency in Infrastructure (Article 15 of the EED)

National legislation for the energy transmission sector stipulates that the operator of the National Transmission Network (RNT) and the National Natural Gas Transmission Network (RNTGN) must submit, for approval by the DGEG, a proposal of a Plan for Development and Investment in the Electricity Transmission Network (PDIRT-E) and a Plan for Development and Investment in the National Transmission Network, Storage Infrastructure and LNG Terminals (PDIRGN). The plans in question are decennial (10-year horizon) and must be submitted every two years.

In the current legislation on the distribution sector, operators of the National Distribution Network (RND) and of the National Natural Gas Distribution Network (RNDGN) must submit, for approval by the DGEG, a proposal for a Plan for Development and Investment in the Electricity Transmission Network (PDIRD-E) and a Plan for Development and Investment in the Natural Gas Distribution Network (PDIRD-GN). The plans in question are five-yearly (5-year horizon) and must be submitted every two years.

The Network Development and Investment Plans envisage an improvement in terms of increasing energy efficiency and reducing network losses.

3. ENERGY EFFICIENCY OBLIGATIONS IN THE EUROPEAN UNION: COMPARISON OF ADOPTED SCHEMES

3.1 European Union Energy Efficiency Targets for 2020

The Energy Efficiency Directive 2012/27/EU (EED) forms a key part of the EU's overall climate and energy legislative package, laying down the foundation for actions to be taken in order to help fulfil the energy efficiency potential of the European economy. All EU Member States are required to implement policy measures that improve energy efficiency at all stages of the energy chain from production to final consumption. This effort is aimed at achieving the EU energy efficiency target in 2020. In particular, the EU target corresponds to a 20% reduction in the EU primary energy consumption by 2020 compared to 2007 primary energy consumption projections to 2020 (based on the model PRIMES 2007) (Tsemekidi-Tzeiranaki, 2020). Under the EU2020 strategy, the overall EU saving target reaches 1474 Mtoe of primary energy or 1078 Mtoe of final energy consumption in 2020 (to be compared with 2007 projections of 1842 Mtoe of primary energy in 2020) [**Fig. 3**] (Sousa, José Luís, 2015).

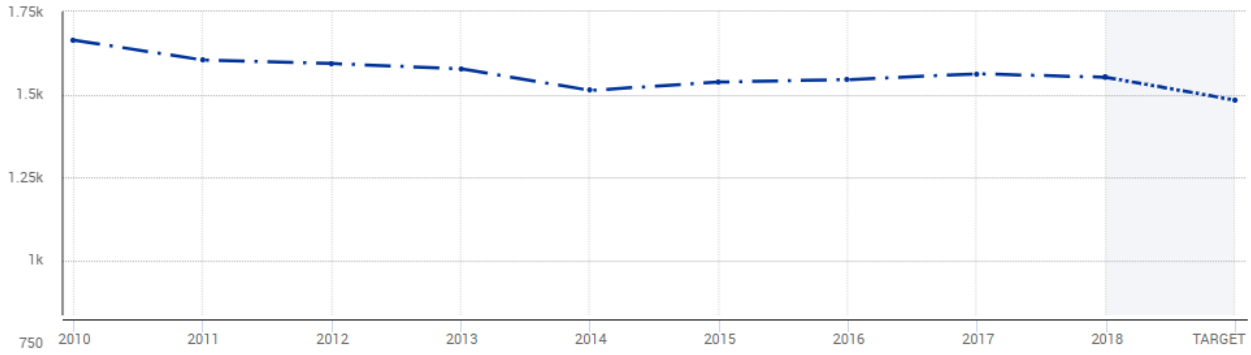

Fig. 3. *Primary energy consumption 2010-2018, source Eurostat.*

However, although the new binding 20% energy savings target perfectly fits in the sustainable energy strategy of the EU, it also raises the question of whether the implementation of the minimum requirements set down by the Directive is sufficient to achieve this target [**Fig. 4**].

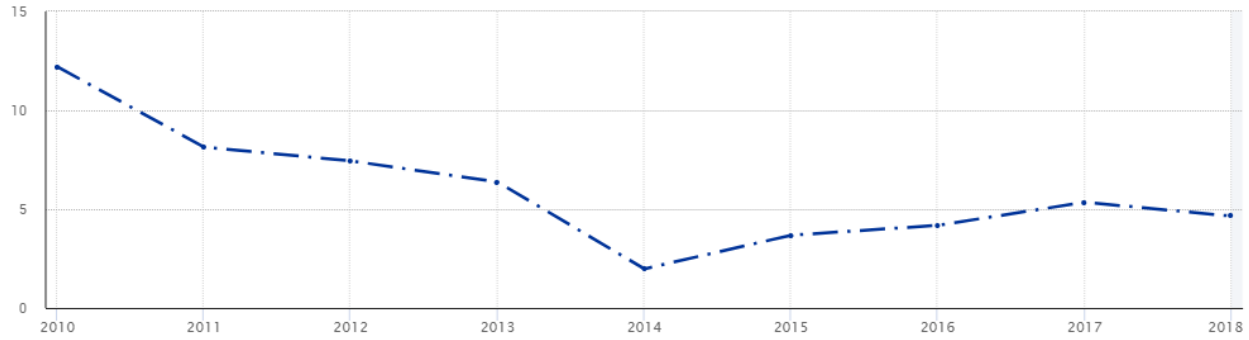

Fig. 4. *Distance to EU 2020 target in percentage, source eurostat*

Certain analysts assume that the provisions of the Directive by themselves (e.g., energy efficiency obligation schemes, the exemplary role of the public sector, informing the consumers, etc.) are insufficient to meet the 20% target (Scheuer, 2013). "*Our common position is that if the MSs realize the inherent economic, environmental, social and other opportunities (which are considered definitely positive by all economic analysis) of the implementation and do not try to find back doors, do not implement requirements at the minimum level and do not try to simply beautify statistical information, the target will be achievable*" (Bányai & Fodor, 2014).

It must be noted that the Directive requires the absolute reduction of energy consumption in primary or final energy. This is perfectly appropriate from an ecological point of view because both measures indicate the absolute reduction of energy consumption.

3.2 Article 7 of the European Union Energy Efficiency Directive

The EU Energy Efficiency Directive (EED) puts in place several important provisions to be implemented by Member States including the requirement to establish binding national energy efficiency targets (Article 3), national building energy efficiency strategies (Article 4), a requirement to renovate 3% of public sector buildings each year (Articles 5 and 6), the need to establish energy efficiency obligation schemes (Article 7), and provisions for auditing and metering (Articles 8–12) (Rosenow et al., 2017).

EEOS were promoted at EU level primarily because there is good quality evidence, from the EU and beyond, that well-designed EEOS can deliver significant, cost-effective energy savings over many years. The evidence base for the social and economic value of EEOS is strong and growing.

However, the literature also emphasizes that the performance of schemes is determined by the details of policy design, implementation, governance and market structure and conditions (Fawcett et al., 2019). The success of an energy efficiency obligation scheme cannot be taken for granted.

The EED sets up an EEO scheme under which a savings target is defined as, at least, 1.5 % of the annual sales of energy to final customers, averaged over the three-years period from 2010 to 2012.

According to Article 7 of the EED, Member States must establish energy efficiency obligation schemes (EEO) or use alternative policy measures to achieve the targeted amount of energy savings, which means the Directive does not lay down strict requirements on how to achieve the energy-saving targets (Bányai & Fodor, 2014). This article requires MSs to establish EEO schemes mandating energy sales companies or distributors to reach energy savings targets or use alternative policy measures to deliver a targeted amount of energy savings amongst final energy consumers.

The EED also requires MSs to put in place measurement, control and verification systems under which at least a statistically significant proportion and representative sample of the energy efficiency improvement measures put in place by the obligated parties is verified. That measurement, control and verification must be conducted independently of the obligated parties (Article 7.6). The Directive establishes only the main frameworks of such systems, the elaboration of the details (e.g., specifying the tasks of the managing authority and the reporting rules, developing sanction system, etc.) is left to the MSs (Bányai & Fodor, 2014).

According to a notification from the European Commission, the provisions under Article 7 require that until 31 December 2020, at least 1.5% of the new savings have to be achieved each year, which must be added to the energy savings of the previous year; therefore, the new savings delivered by 31 December 2020 must be at least 10.5%. This implies that the total amount of final energy savings delivered over the whole seven-year period must be at least 42% (cumulative end-use energy savings target) [**Table 2**].

Table 2. *Cumulative end-use energy savings target*

Year	Energy Savings (%)							Total
2014	1,50							1,50
2015	1,50	1,50						3,00
2016	1,50	1,50	1,50					4,50
2017	1,50	1,50	1,50	1,50				6,00
2018	1,50	1,50	1,50	1,50	1,50			7,50
2019	1,50	1,50	1,50	1,50	1,50	1,50		9,00
2020	1,50	1,50	1,50	1,50	1,50	1,50	1,50	10,50
Total	42,00							

MSs can exclude all sales from transport from the baseline. Furthermore, countries can use exemptions up to reduce their target by a maximum of 25 %. The 25 % exemptions include 4 specific elements (Bertoldi et al., 2015):

1) progressive phase-in of the target;
2) exclusion of energy sales in the Emissions Trading System (ETS) sector;
3) energy savings from early actions[3];
4) energy savings achieved in the energy transformation, distribution and transmission sectors implemented under Articles 14 and 15 of the EED.

In accordance with Article 3, Member States have set indicative energy efficiency targets – based on either primary or final energy savings, primary or final energy consumption or energy intensity – in view of the overall target of 20% reduction in EU primary energy consumption by 2020. To comply with Article 24, Member States are also requested to report on the progress achieved towards their national energy efficiency targets by 30 April each year as of 2013 in the form of the so-called Annual Reports (ARs) [**Table 3**]. In particular, Member States are required to specifically report on their recent consumption trends as well as policy updates and progress towards implementing Articles 5 and 7 of the Directive (Tsemekidi-Tzeiranaki, 2020).

[3] Savings resulting from energy saving actions newly implemented since 31 December 2008 that continue to have an impact in 2020.

Table 3. *Indicators to be included in the Annual Reports, as required by Annex XIV of the EED, source JRC 2020 Report*

(i) primary energy consumption (PEC)
(ii) total final energy consumption (FEC)
(iii) final energy consumption (FEC) of the industry sector
(iii) final energy consumption (FEC) of the transport sector
(iii) final energy consumption (FEC) of the household sector
(iii) final energy consumption (FEC) of the services sector
(iv) gross value added (GVA) of the industry sector
(iv) gross value added (GVA) of the services sector
(v) disposable income for households (DIH)
(vi) gross domestic product (GDP)
(vii) electricity generation from thermal power generation (thPG)
(viii) electricity generation from combined heat and power plants (CHPP)
(ix) heat generation from thermal power generation (thPG)
(x) heat generation from combined heat and power plants (CHPP), including industrial waste heat
(xi) fuel input for thermal power generation (thPG)
(xii) passenger kilometres (pkm)
(xiii) tonnes kilometres (tkm)
(xiv) combined transport kilometres (pkm + tkm), in case (xii) and (xiii) are not available
(xv) population

In addition to the general trends, the analysis of Annual Reports allowed to focus on the evolution in the short-term, by comparing the final consumption values with those of the previous year, for the four main end-use sectors (industry, transport, residential and services). Often this comparison has highlighted increasing (or stable) energy consumption trends which the Member States were required to explain (Zangheri et al., 2019).

3.3 Alternative Policy Measures to Energy Efficiency Obligations

The EED allows for the use of any policy measure that results in energy end-use savings equivalent to the target defined by article 7, providing a typology of instruments that can be considered for implementation [**Table 4**] (Rosenow et al., 2017). The alternatives to the implementation of EEO, regarding the 1.5 % annual savings target are:

1) already existing measures that will keep delivering new energy savings each year, for the period 2014–2020, and;

2) a mixture of EEO and alternative programmes, including national energy efficiency programmes, that, together, deliver the annual savings target.

Some policy measures are highlighted as possible ways to achieve the savings target. That includes:

1) energy and CO2 taxes with the effect of reducing end-use energy consumption;
2) financing schemes and instruments or fiscal incentives for the adoption of energy efficient technologies or techniques that reduce end-use energy consumption;
3) regulations or voluntary agreements;
4) "Standards and norms, including building codes that aim at improving the energy efficiency of products, buildings and services, provided they exceed the minimum requirements in the MS as required by EU legislation, including Eco-design and EPBD, the latter using the cost-optimal level";
5) energy labelling schemes, in addition to the ones already mandatory; and (6) training and education, as long as they actually contribute to the reduction of end-use energy consumption through the use of energy efficient technologies and techniques (Sousa, José Luís, 2015).

Table 4. *Energy Efficiency Instrument Types, source* [4]

Instrument type	Definition
Energy Efficiency Obligations (EEOs)	EEOs oblige energy suppliers and/or distributors to deliver a specified amount of end-use energy savings within a defined period of time.
Energy efficiency national fund	Even though many MSs operate a national fund for financing energy efficiency measures, in this context it means a fund where obligated parties can make an annual financial contribution to fulfil their obligation under Article 7 as defined in Article 20(6).
Energy or CO2 taxes	A levy on the energy and/or carbon content of fuels above minimum EU-requirements that – by increasing the price of the fuels incentivises fuel saving. Financial stimuli for energy efficiency investments through the taxation system (e.g. tax rebates for building renovations) are included in the financing and fiscal incentive policy group.
Financing scheme or fiscal incentive	Such schemes provide monetary support from public sources that are allocated either on the basis of application (e.g. applying for a grant under a renovation support scheme) or induce energy saving actions automatically (e.g. automatic eligibility for the abatement of the tax when purchasing an electric vehicle).
Regulation or voluntary agreements	Voluntary agreements are typically agreements by a sector – or group of similar actors- with public authorities in which they commit to a) reduce end-use energy consumption over time, b) design and implement an energy efficiency plan, or c) apply specific energy efficient technologies. Regulations – in this context – are obligatory and legally binding measures that do not belong in any of the other categories.
Standards and norms	These administrative measures aim at setting minimum energy efficiency requirements for products and services in addition to mandatory EU requirements.
Energy labelling schemes	Energy labels provide easy-to-understand energy use information for products that facilitate energy-conscious consumer choices.
Training and education	Educational actions that result in the use of efficient technologies or behavioural changes reducing end use consumption.
Other instruments	This category comprises any other instruments that do not fit with the main categories of policy instruments.

Fig. 5 provides an overview of the most commonly used policy instrument types for the purpose of complying with Article 7 of the Energy Efficiency Directive across the 14 Member States

[4] Rosenow, J., Kern, F., & Rogge, K. (2017). The need for comprehensive and well targeted instrument mixes to stimulate energy transitions: The case of energy efficiency policy. Energy Research and Social Science

analysed. In the residential sector by far the most frequently used instrument is grants (33%) followed by regulations (17%), loans (16%) and energy efficiency obligations (11%).

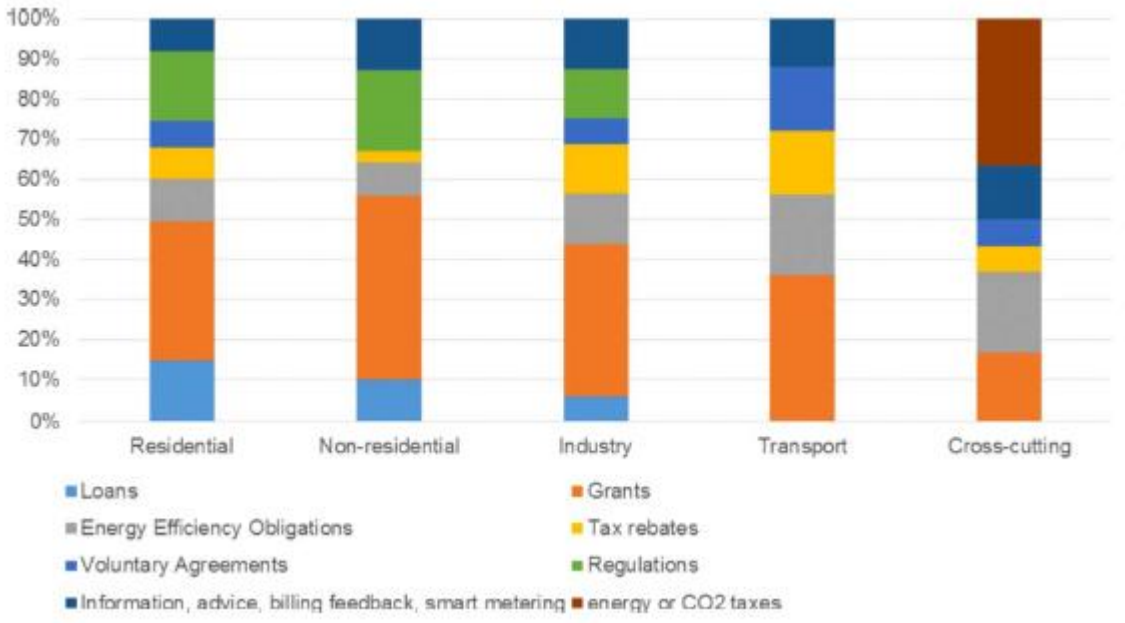

Fig. 5. *Instrument mix by sector and instrument type across Cases*

3.4 Schemes Implemented by European Union Member States

In December 2013, MS reported to the European Commission the implementation plans for Article 7, they had or were planning to introduce EEOS and/or alternative measures to reach the 1.5 % energy saving goal. Four MS planned to rely on EEOS alone, 14 used a mixture of EEOS plus alternative measures, and 10 MS used only alternative measures [**Table 5**].

Table 5. *Targets proposed by MSs under the EED as well as their intention to implement EEO.*

EU Member State	National Energy Efficiency target for 2020 (Article 3 of EED)	Status of EEOs and alternative policies in the EU
Austria	Final energy consumption of 1,100 PJ	Combination (EEO schemes & Alternative Measures)
Belgium	18 % reduction in primary energy consumption by 2020 relative to the Primes 2007 baseline (53.3 Mtoe)	Combination (EEO schemes & Alternative Measures)
Bulgaria	Increase of energy efficiency by 25 % until 2020 (5 Mtoe primary energy savings in 2020) and 50 % energy intensity reduction by 2020 compared to 2005 levels	EEO schemes
Croatia	Increase in energy efficiency resulting in final energy consumption reduction of 19,77 PJ in 2016 and 22,76 PJ in 2020	Combination (EEO schemes & Alternative Measures)
Cyprus	0.463 Mtoe energy savings in 2020 (14.4 % reduction in 2020 compared to a reference scenario)	Combination (EEO schemes & Alternative Measures)
Czech Republic	47,84 PJ (13,29 TWh) savings of final energy consumption (preliminary data)	Alternative Measures
Denmark	Primary energy consumption of 744.4 PJ (17.781 Mtoe) in 2020	EEO schemes
Estonia	Stabilisation of final energy consumption in 2020 at the level of 2010	Combination (EEO schemes & Alternative Measures)
Finland	310 TWh of final energy consumption in 2020	Alternative Measure
France	17.4 % reduction of final energy consumption in 2020 compared to a baseline	Combination (EEO schemes & Alternative Measures)
Germany	Annual improvement of energy intensity (energy productivity) by 2.1 % p.a. on average until 2020	Alternative Measures
Greece	Final energy consumption level of 20.5 Mtoe	Combination (EEO schemes & Alternative Measures)
Hungary	1,113 PJ primary energy consumption in 2020 (236 PJ savings compared to business-as-usual), resulting in 760 PJ final energy consumption	Not specified yet
Ireland	20 % energy savings in 2020 along with a public sector energy saving target of 33 % (resulting in energy savings of 31,925 GWh)	Combination (EEO schemes & Alternative Measures)
Italy	20 Mtoe primary energy reduction by 2020, 15 Mtoe final energy reduction by 2020	Combination (EEO schemes & Alternative Measures)
Latvia	Primary energy savings in 2020 of 0.670 Mtoe (28 PJ)	Combination (EEO schemes & Alternative Measures)
Lithuania	17 % reduction in final energy use compared to 2009 level (reduction of 740 ktoe)	Combination (EEO schemes & Alternative Measures)
Luxembourg	Preliminary target value for 2020 of 49,292 GWh or 4,239.2 ktoe final energy	EEO schemes
Malta	22 % energy or 237.019 toe savings target by 2020	Combination (EEO schemes & Alternative Measures)
Netherlands	1.5 % energy savings per year (partial)	Alternative Measures
Poland	13.6 Mtoe primary energy savings in 2020	EEO schemes
Portugal	Reduction of primary energy use in 2020 by 25 % compared to projections	Alternative Measures
Romania	Reduction of 10 Mtoe (19 %) in the primary energy consumption	Alternative Measures
Slovakia	3.12 Mtoe of final energy savings for the period 2014–2020	Alternative Measures
Slovenia	10.809 GWh energy savings by 2020	Combination (EEO schemes & Alternative Measures)
Spain	20 % energy savings to be achieved by 2020	Combination (EEO schemes & Alternative Measures)
Sweden	Energy use shall be 20 % more efficient by 2020 compared with 2008 and a 20 % reduction in energy intensity between 2008 and 2020	Alternative Measures
United Kingdom	Final energy consumption in 2020 of 129.2 Mtoe on a net calorific value basis	Combination (EEO schemes & Alternative Measures)

Member States implemented or plan to implement 479 policy measures. Some countries notified very few policy instruments (e.g., Italy) whereas others such as Germany and Slovakia adopted 112 and 66 policy instruments respectively. Five Member States have notified a single policy measure for the implementation of Article 7: Denmark, Poland and Bulgaria, and Luxembourg notified only EEOSs whereas Sweden exclusively uses an energy/CO2 tax. This shows that there are significant differences in how Member States decided to comply with Article 7 (Rosenow & Fawcett, 2016).

The largest share of the overall savings is expected to be generated by EEOS (34%), financing schemes or grants (19%), and taxes (14%). Hence more than half of the savings are expected to be delivered by policy instruments that provide a direct financial incentive to the target group(s) in order to persuade the beneficiaries to invest in energy efficiency improvements. **Fig. 6** provides an overview of the number of different policy measures by policy instrument category. **Fig. 7** presents the share of the overall savings by policy instrument type.

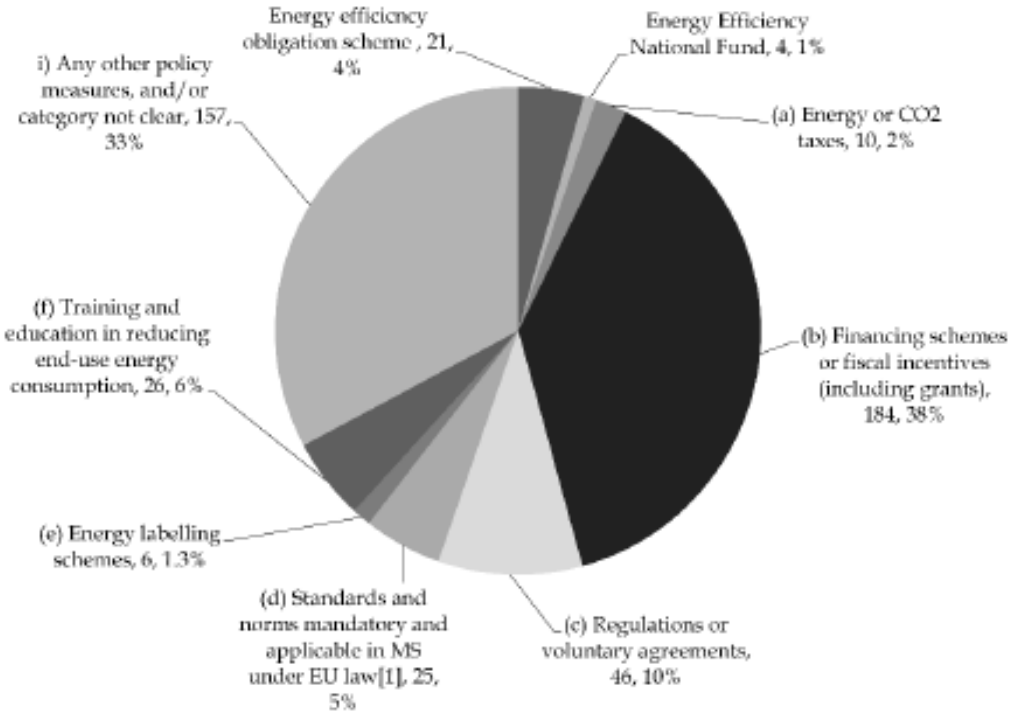

Fig. 6. *Number of notified policy measures by policy measure type, source: Commission services (2016)*

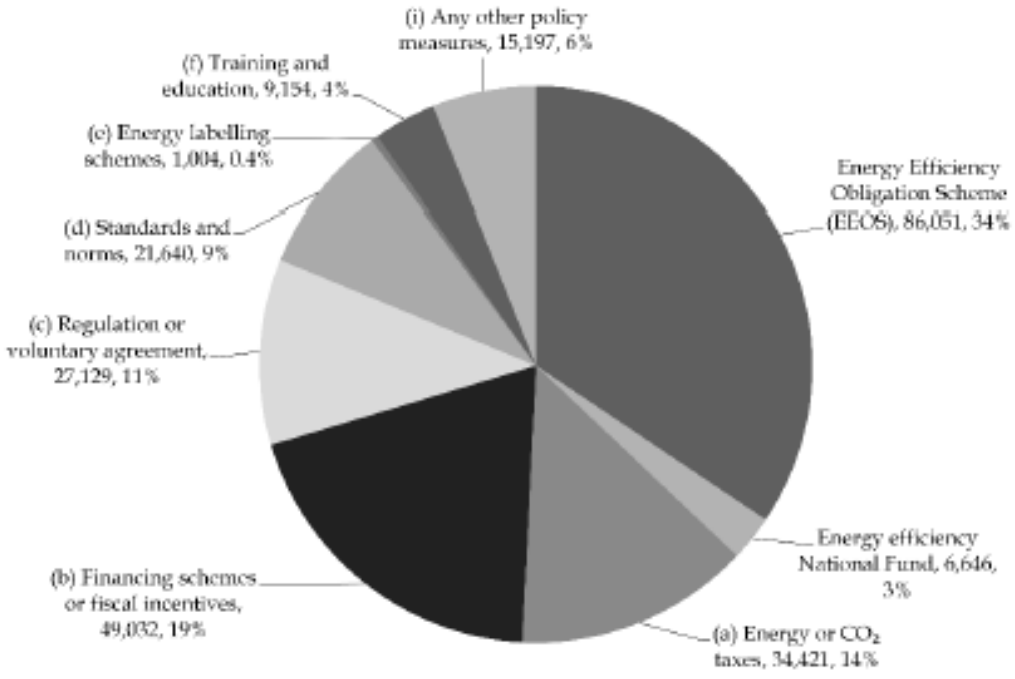

Fig. 7. *The expected energy savings [ktoe] by policy measure type, source: Commission services (2016)*

In terms of the number of policy instruments, EEOS comprise just 4% of all policy measures whereas in terms of expected energy savings their share is 34%. Similarly, the 10 notified energy and CO_2 taxes (2% of the total number) are expected to deliver 14% of overall savings. On the other hand, the financing schemes and fiscal measures policy group is more fragmented (38% of policy measures deliver about 20% of savings): such support schemes are often very specific according to the type of support (e.g. grant or loan), the target sector and even subsectors (e.g. public buildings only) (Rosenow & Fawcett, 2016).

4. MEASURES ADOPTED BY PORTUGAL RELATED WITH THE ARTICLE 7 OF EED

4.1 Proposed Savings as an Alternative to Energy Efficiency Obligations

4.1.1 Global energy-saving goal

The determination of the overall energy saving objective, in accordance with paragraph 1 of article 7 of the EED, was based on the average value of annual energy sales, in volume, to final consumers of all energy distributors or all retail energy sales companies for the three years prior to January 1, 2013, that is 2010, 2011 and 2012 [**Table 6**]. Energy sales from the transport sector have been totally excluded from this calculation.

Table 6. *Annual Energy Sales (2010-2012) (TOE). Source:Artigo 7 . º Medidas Políticas Alternativas Ao Regime de Obrigação de Eficiência Energética, 2013)*

SECTOR	ENERGY FORM	YEAR		
		2010	2011	2012P
INDUSTRY	PETROLEUM	1 012 838	866 242	-
	NATURAL GAS	988 895	1 053 662	-
	ELECTRICITY	1 430 797	1 396 518	-
	RENEWABLE ENERGY SOURCES	0	0	-
	OTHERS	54 169	75 815	-
HOUSEHOLD	PETROLEUM	679 765	586 880	-
	NATURAL GAS	300 266	259 089	-
	ELECTRICITY	1 248 873	1 182 947	-
	RENEWABLE ENERGY SOURCES	282 350	299 952	-
	OTHERS	0	0	-
SERVICES	PETROLEUM	249 772	180 836	-
	NATURAL GAS	208 962	213 898	-
	ELECTRICITY	1 479 924	1 462 918	-
	RENEWABLE ENERGY SOURCES	0	0	-
	OTHERS	0	0	-
AGRICULTURE AND FISHERIES	PETROLEUM	360 462	352 155	-
	NATURAL GAS	3 511	4 684	-
	ELECTRICITY	88 164	84 380	-
	RENEWABLE ENERGY SOURCES	65	42	-
	OTHERS	0	0	-
	TOTAL	**8 388 813**	**8 020 018**	**7 707 793**

At the time, the 2012 data were provisional, as these data were presented in a 2013 report.

Thus, and considering the data presented above, the average value of 8 038 874.7 toe for the 2010/2012 period was calculated.

Afterward, and based on the average value calculated for the years 2010, 2011, and 2012, the annual volume of energy savings was determined (x1.5%).

As described in Annex of the EED, point 2, point e), each specific energy-saving action is considered to produce savings, not only in the year of its implementation but also in following years, up to 2020. Hence, the savings are accumulated year by year [**Table 7**].

Table 7. *Global Energy Savings Goal (accumulated year-to-year values). Source: Artigo 7. º Medidas Políticas Alternativas Ao Regime de Obrigação de Eficiência Energética, 2013)*

YEAR	% SAVINGS	SAVINGS (TOE)						
2014	1,5%	120 583						
2015	1,5%	120 583	120 583					
2016	1,5%	120 583	120 583	120 583				
2017	1,5%	120 583	120 583	120 583	120 583			
2018	1,5%	120 583	120 583	120 583	120 583	120 583		
2019	1,5%	120 583	120 583	120 583	120 583	120 583	120 583	
2020	1,5%	120 583	120 583	120 583	120 583	120 583	120 583	120 583

According to the calculations described above, Portugal's global goal of accumulated energy savings was 3 376 327 toe.

4.1.2 Proposed energy savings: 2013 / 2020

In order to meet the objectives, a set of programs and measures were identified in the National Action Plan for Energy Efficiency (NEEAP) in different sectors that allow achieving the global energy-saving objectives established by the Directive.

The following table [**Table 8**] presents the annual energy savings resulting from the implementation of energy efficiency measures in the following sectors:

a) Transport;
b) Household and Services;
c) Industry;
d) Public Bodies.

Table 8. *Annual Energy Savings. Source:Artigo 7 . º Medidas Políticas Alternativas Ao Regime de Obrigação de Eficiência Energética, 2013)*

PROGRAM	RESULTS							
	ENERGY SAVINGS (TOE)							
	2013	2014	2015	2016	2017	2018	2019	2020
TRANSPORTS	6 641	19 944	12 396	13 914	13 938	15 101	16 156	17 643
HOUSEHOLD AND SERVICES	46 765	52 445	53 134	53 834	54 590	55 545	55 340	55 009
INDUSTRY	34 500	34 500	34 500	34 500	34 500	34 500	34 500	34 500
PUBLIC BODIES	14 842	15 086	19 831	20 930	22 023	23 115	24 208	25 300
TOTAL	**102 748**	**121 975**	**119 860**	**123 178**	**125 051**	**128 261**	**130 204**	**132 452**

The values presented above are based on the identification of energy efficiency measures that continue to produce effects in 2020, allowing to obtain a total accumulated energy savings of 4 288710 toe [**Table 9**].

Table 9*. Accumulated Energy Savings. Source:Artigo 7 . o Medidas Políticas Alternativas Ao Regime de Obrigação de Eficiência Energética, 2013)*

PROGRAM	RESULTS							
	ENERGY SAVINGS (TOE)							
	2013	2014	2015	2016	2017	2018	2019	2020
TRANSPORTS	6 641	33 226	72 207	125 101	191 934	273 868	371 957	487 690
HOUSEHOLD AND SERVICES	46 765	145 975	298 319	504 497	765 266	1 081 579	1 453 233	1 879 896
INDUSTRY	34 500	103 500	207 000	345 000	517 500	724 500	966 000	1 242 000
PUBLIC BODIES	14 842	44 770	94 528	165 217	257 928	373 755	513 789	679 124
TOTAL	**102 748**	**327 471**	**672 054**	**1 139 815**	**1 732 628**	**2 453 702**	**3 304 980**	**4 288 710**

4.2 Analysis of the Annual Reports Submitted to the European Union

As mentioned, since 2013, member states have been required to submit to the EC an Annual Report [AR] on the progress achieved in meeting the proposed targets, and in fulfilling the requirements established under the various articles of the EED.

Under EED Article 24, Member States must describe implemented measures and estimate achieved and expected energy efficiency improvements in the AR submitted every year. Member States have been required to specifically report on their registered recent consumption trends, new or updated

policy measures, progresses in the implementation of Article 5, ("Exemplary role of public bodies' buildings") and Article 7 ("Energy efficiency obligation schemes") of the Directive. In particular, as requested by Annex XIV of the EED, Member States have been requested to provide the following minimum information:

a) An estimate of various energy-related indicators from two years before. Additionally, if a stable or growing energy consumption was observed, a discussion should be included on the underlying causes.
b) Updates on major legislative and non-legislative measures implemented in the previous year, which contribute towards the overall national energy efficiency targets for 2020.
c) The total building floor area of the buildings with a total useful floor area over 500 m2 and over 250 m2 as of 9 July 2015 owned and occupied by the Member States' central government that, on 1 January, did not meet the minimum energy performance requirements referred to in Article 5(1).
d) The total building floor area of heated and/or cooled buildings owned and occupied by the Member States' central government that was renovated in the previous year, referred to in Article 5(1) or the amount of energy savings in eligible buildings owned and occupied by their central government as referred to in Article 5(6).
e) Energy savings achieved two years before through the national energy efficiency obligation schemes referred to in Article 7(1), or the alternative measures adopted in the application of Article 7(9) (Zangheri et al., 2019).

Portugal Annual Reports

As the main objective of this work is to analyse Portugal's progress towards meeting the energy efficiency targets for 2020, a characterization of the annual reports sent to the EC was made [Erro! A origem da referência não foi encontrada.], in an attempt to use the reported values in the perception of the achievement of the targets.

As required by the EED, reports have been sent to the EC since 2013, always corresponding to the energy balance of the penultimate years, that is, the 2013 report corresponds to the 2011 balance. The first two reports (AR2013 and AR2014), were sent in a different format prepared by the Direção Geral de Energia e Geologia (DGEG). As of 2015, the reports sent were already in the

format defined by the EED (Annex 14). Although the main information required by the EED is in the two models of reports sent, the 2015 format is, as previously mentioned, more complete.

During the characterization of the reports, some difficulties were identified, namely due to the different formats, and also due to the different units used. In the format defined by the EED, there are two tables a) and b), a) referring to Eurostat values, and b) referring to National values. From 2015 to 2019 the reports were delivered with table a) completed, however in 2020 the option was to send the report with table b) completed. All this caused difficulties in interpreting and understanding the origin of the data present in the reports sent to the EC.

Detailed information about the characterization of the reports is provided in **appendix B** of the appendices of the present document available at Zenodo[5]

Also in the reports, Member States are asked to fill in the table corresponding to the savings achieved [**Table 10**] [**T*able* 11**], and which policy is associated with those savings. Once again, there are difficulties in interpreting the values presented, either because of the units used, or because of a lack of correspondence with any value present in the measures provided for in the Alternative Measures program, leaving the doubt as to whether the values reported to the EC correspond to the real ones.

[5] https://doi.org/10.5281/zenodo.5633388

Table 10. *Energy savings achieved through the national energy efficiency obligation schemes referred to in Article 7(1) or the alternative measures adopted in the application of Article 7(9). Source:Artigo 7 . º Medidas Políticas Alternativas Ao Regime de Obrigação de Eficiência Energética, 2013)*

			Savings achieved 2014-2016 [ktoe] expressed in final energy								
		Policy measure (Please, specify the policy measure)	**Savings achieved [ktoe] in 2014**	**New Savings achieved [ktoe] in 2015**	**Accumulative Savings achieved [ktoe] in 2015**	**New Savings achieved [ktoe] in 2016**	**Accumulative Savings achieved [ktoe] in 2016**	**New Savings achieved [ktoe] in 2017**	**Accumulative Savings achieved [ktoe] in 2017**	**New Savings achieved [ktoe] in 2018**	**Accumulative Savings achieved [ktoe] in 2018**
1	**EEOS**										
2	**Alternative measure 1**	Solar Thermal - Incentive programs to solar thermal utilization	8,134	7,299	15,433	3,696	19,129	2,010	21,139	7,118	31,132
3	**Alternative measure 2**	SGCIE - Management System of Intensive Energy Consumption	21,890	7,660	29,550	8,034	37,584	11,034	48,618	10,784	67,165
4	**Alternative measure 3**	RGCE ST - Management Regulation of Energy Consumption in Transport Sector	2,364	4,319	6,683	3,316	9,999	1,775	11,774	4,888	16,823
5	**Alternative measure 4**	PPEC - Consumption Efficiency Promotion Plan	13,720	0,000	13,720	13,760	27,480	13,760	42,240	13,760	56,000
6	**Alternative measure 5**	National Energy Efficiency Fund	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	21,500
7	**Total savings**		46,108	19,278	65,386	28,806	94,192	28,579	123,771	36,550	192,620

***Table 11**. Amount of energy savings in eligible buildings owned and occupied by their central government as referred to in Article 5(6) Source:Artigo 7 . o Medidas Políticas Alternativas Ao Regime de Obrigação de Eficiência Energética, 2013)*

Alternative approach Article 5(6)	Policy measure (Please, specify the policy measure)	Amount of energy savings [ktoe] achieved in 2016 in eligible buildings owned and occupied by their central government as referred to in Article 5(6)	Amount of energy savings [ktoe] achieved in 2017 in eligible buildings owned and occupied by their central government as referred to in Article 5(6)	Amount of energy savings [ktoe] achieved in 2018 in eligible buildings owned and occupied by their central government as referred to in Article 5(6)
Alternative measure 1	**Energy measures foreseen under the Energy Buildings Certification**	0,035	0,011	0,174
Alternative measure 2	**Energy Efficiency Programme in Public Admnistration(ECO.AP)**	0,000	0,000	0,000
Alternative measure 3	**Energy Efficiency Fund (FEE)**	0,000	0,000	0,000
Alternative measure 4	**POSEUR - Operational Programme for Sustainability and Efficient Use of Resources**	0,000	0,000	0,000
The amount of energy savings [ktoe] achieved in 2016 in eligible buildings owned and occupied by their central government as referred to in Article 5(6), in primary or final energy		0,035	0,011	0,174
Sum of energy savings [ktoe] achieved in eligible buildings owned and occupied by their central government through the implementation of Article 5(6) in primary or final energy since 2014		0,035	0,046	0,220

To understand whether there are differences between the values of final energy consumption by sector of activity presented in the reports sent to the EC, and the official values for Portugal (provided by DGEG), a comparative table was created between the values provided by the two institutions. As in the reports from 2015 to 2019, table a) corresponding to Eurostat values was always filled in, the values of this institution were also included in this comparison [**Table 12**]. In the analysis carried out, a significant difference was found in the totals, mainly in the values of the Agriculture, Fisheries, Industry and Transport sectors.

Table 12. *Comparison of energy indicators presented in the annual reports, DGEG national reports, and Eurostat balance sheets.*

		2010			2011			2012		
Indicators	**Unit**	**EC Report**	**National Balance**	**Eurostat Balance**	**EC Report**	**National Balance**	**Eurostat Balance**	**EC Report**	**National Balance**	**Eurostat Balance**
Primary Energy Consumption	Ktoe	N.A	23101,8	22654,5	20759,0	22109,6	22013,0	20197,0	21481,8	21042,5
Total Final Energy Consumtion	Ktoe	N.A	17698,7	17269,6	16913,0	16494,0	16441,3	15591,0	15639,9	15111,6
Final energy Consumption - Agriculture and Fishing	Ktoe	N.A	455,0	464,2	N.A	446,6	428,2	N.A	442,7	415,2
Final energy Consumption - Industry	Ktoe	N.A	5807,9	5456,0	5703,0	5225,7	5351,6	5061,0	5068,4	4606,2
Final energy Consumption - Transport	Ktoe	N.A	6488,1	6465,7	6047,0	6046,8	6002,3	5568,0	5560,4	5531,3
Final energy Consumption - Residential	Ktoe	N.A	2953,9	2970,6	2801,0	2804,4	2777,1	2657,0	2681,2	2695,0
Final energy Consumption - Services	Ktoe	N.A	1993,9	1884,2	1918,0	1970,6	1856,4	1868,0	1887,1	1843,4
Final energy Consumption - Other Sectors	Ktoe	N.A	N.A	28,8	N.A	N.A	25,7	N.A	N.A	20,5
Partial sum of the final energy indicators	Ktoe		17698,7	17269,6	16469,0	16494,0	16441,3	15154,0	15639,9	15111,6

		2013			2014			2015		
Indicators	**Unit**	**EC Report**	**National Balance**	**Eurostat Balance**	**EC Report**	**National Balance**	**Eurostat Balance**	**EC Report**	**National Balance**	**Eurostat Balance**
Primary Energy Consumption	Ktoe	21278,2	21460,9	21037,0	20700,0	21515,4	20681,1	21700,0	22633,9	21649,5
Total Final Energy Consumtion	Ktoe	15893,2	15167,0	14908,3	15807,0	15726,1	15386,4	16037,0	15922,0	15550,9
Final energy Consumption - Agriculture and Fishing	Ktoe	329,5	446,8	422,0	338,0	427,9	427,6	345,0	449,1	441,3
Final energy Consumption - Industry	Ktoe	4588,2	4774,9	4598,6	4403,0	4733,2	4405,5	4450,0	4778,9	4411,5
Final energy Consumption - Transport	Ktoe	6385,8	5443,1	5435,5	6472,0	5511,6	5464,2	6613,0	5608,0	5555,2
Final energy Consumption - Residential	Ktoe	2639,7	2619,6	2634,8	2570,0	2552,9	2776,7	2539,0	2839,9	2751,7
Final energy Consumption - Services	Ktoe	1779,3	1881,1	1786,7	1905,0	1941,2	2284,6	1960,0	2246,2	2356,4
Final energy Consumption - Other Sectors	Ktoe	4872,7	N.A	30,7	4931,0	N.A	27,7	35,0	N.A	34,8
Partial sum of the final energy indicators	Ktoe	20595,2	15165,5	14908,3	20619,0	15166,8	15386,4	15942,0	15922,0	15550,9

		2016			2017			2018		
Indicators	**Unit**	**EC Report**	**National Balance**	**Eurostat Balance**	**EC Report**	**National Balance**	**Eurostat Balance**	**EC Report**	**National Balance**	**Eurostat Balance**
Primary Energy Consumption	Ktoe	22100,0	22302,4	21766,4	22492,0	23119,7	22824,5	22631,0	22475,8	22654,8
Total Final Energy Consumtion	Ktoe	16110,1	15981,0	15640,7	15613,0	16256,6	15900,7	16908,0	16469,8	16152,6
Final energy Consumption - Agriculture and Fishing	Ktoe	341,9	446,9	435,8	371,0	459,4	459,8	382,0	468,9	466,2
Final energy Consumption - Industry	Ktoe	4331,8	4722,3	4381,4	4883,0	4888,8	4525,3	4571,0	4774,9	4553,9
Final energy Consumption - Transport	Ktoe	6769,9	5700,6	5691,0	5805,0	5819,1	5788,8	7223,0	5882,6	5847,6
Final energy Consumption - Residential	Ktoe	2620,7	2850,8	2819,5	2562,0	2825,7	2801,8	2654,0	2920,1	2877,8
Final energy Consumption - Services	Ktoe	1938,2	2260,3	2289,6	1903,0	2263,7	2301,4	1968,0	2336,5	2380,6
Final energy Consumption - Other Sectors	Ktoe	5008,4	N.A	23,4	88,0	N.A	23,6	110,0	N.A	26,7
Partial sum of the final energy indicators	Ktoe	21010,9	15981,0	15640,7	15612,0	16256,6	15900,7	16908,0	16383,0	16152,6

A direct comparison between the values in the annual reports and the proposed values for the savings shows these two sets of values are not compatible. Additionally, there are differences between the values of the same variables issued by different institutions. Hence, a contact was made with the DGEG in order to try to understand these differences.

From the meeting held with DGEG, it was found that in the process of verifying compliance with the targets set in the EED for 2020, the values that will most likely be considered will be those of Eurostat. It appears that neither national balances nor the reports to the EC will be considered. The differences observed in the final energy values can eventually be explained, at least partially, by the way Eurostat considers cogeneration, since the portion of self-consumption is neglected. Another factor that can explain the differences is the possibility of not considering the industrial energy consumption in full, as defined in the EED, concerning the industrial units covered by the European Union Emissions Trading System (EU ETS). According to the information given, the allowed reduction can reach 40% of the value of final energy consumption.

4.3 Achieved Savings and Distance to the Proposed Target

Despite the information that the values in the reports will eventually not be considered for the purpose of calculating compliance with the efficiency targets, this work continued, in order to try to verify whether the targets are being met based on the values in the reports sent to the EC. In fact, the reported values must correspond to data gathered according to some accepted protocol to represent the national performance

In an attempt to build a chart that would allow a comparison between the final consumption of energy without the transport sector, according to the assumed commitments, and the final consumption data in the reports to the EC, the value of the annual consumption without transport from 2011 to 2020 was calculated [**Table 13**]. It should be noted that the values corresponding to the years 2011 and 2012 are different from those in Table 6. Hence, in [**Table 14]** a series of final energy consumption values was estimated to be coherent with the values for 2011 and 2012 in Table 6. Since these were the values issued by DGEG to formulate the strategy of compliance with the EED in Portugal, they should be the basis for a possible assessment of compliance. For the years 2011 and 2012, the known values were used, and for the remaining years were calculated by

the difference between the average value from 2010 to 2012 (8038.9 kTep), and the value of accumulated savings for the respective year.

***Table 13**. Calculation of energy consumed without transport.*

Years	Energy Consumption in Transport (KTOE)	Total Energy Consumption (KTOE)	Energy Consumption Without Transport (KTOE)
2011	6 047,0	16 913,0	10 866,0
2012	5 568,0	15 591,0	10 023,0
2013	6 385,8	15 893,2	9 507,4
2014	6 472,0	15 807,0	9 335,0
2015	6 613,0	16 037,0	9 424,0
2016	6 769,9	16 110,1	9 340,2
2017	5 805,0	15 613,0	9 808,0
2018	7 223,0	16 908,0	9 685,0

Table 14. *Comparison between real values (estimated) and expected values according to commitments.*

Years	Final energy consumption without transport according to commitments (kToe)	Reported energy consumption without transport (kToe)	Savings commitments (kToe)	Total final energy consumption according with estimated savings (kToe)	Accumulated savings commitments (kToe)	Consumption without savings that would result of the values issued when the commitment was made (kToe)	Differences in final consumption without transport between consecutive years (estimation of variations in consumption, to be compared with annual savings commitments) - positive value means savings (kToe)	The same as the preceding column, in accumulated values	Estimated "effective" consumption (kToe)	Deviations (positive means that the verified variation was better than the projection) (KToe)
2011	8 388,8	10 866,0								
2012	8 020,0	10 023,0					843,0			
2013	7 936,1	9 507,4	102,748	10 763,3	102,748	8 038,9	515,6	515,6	7 523,3	412,9
2014	7 814,2	9 335,0	121,975	9 798,3	224,723	8 038,9	172,4	688,0	7 350,9	463,3
2015	7 694,3	9 424,0	119,86	9 162,8	344,583	8 038,9	-89,0	599,0	7 439,9	254,4
2016	7 571,1	9 340,2	123,178	8 867,2	467,761	8 038,9	83,8	682,8	7 356,1	215,0
2017	7 446,1	9 808,0	125,051	8 831,2	592,812	8 038,9	-467,8	215,0	7 823,9	-377,8
2018	7 317,8	9 685,0	128,261	8 619,1	721,073	8 038,9	123,0	338,0	7 700,9	-383,1
2019	7 187,6		130,204		851,277	8 038,9				
2020	7 055,1		132,452		983,729	8 038,9				

The calculated consumption values constitute the first series of the comparative graph, corresponding to the "Final Energy Consumption without Transport" according to the commitments. However, there is a lack of data that is needed to assess the difference between the proposed values and the actual values. To fill this gap, the differences between the reported energy consumption values of consecutive years were calculated to obtain the energy consumption annual variations (energy savings, if positive). Additionally, to obtain the series "Estimated Effective Consumption", the differences between the average consumption value of 2010-2012 and the accumulated energy savings values of each year were calculated. These series of values made it possible to graphically compare the values of the energy savings commitments and the effective savings values up to the date of delivery of this work [**Fig. 8**].

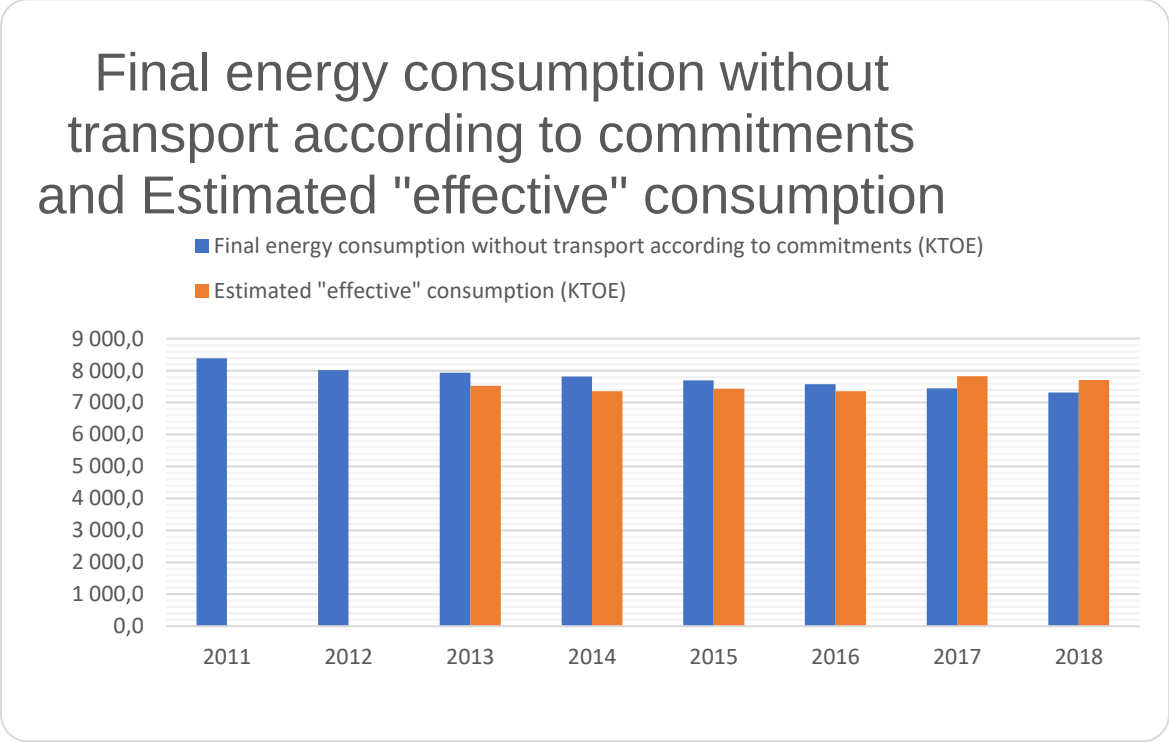

***Fig. 8**. Final energy consumption without transport according to commitments and estimated "effective" consumption.*

4.4 Comments and Conclusions

For many of the indicators present in the reports sent to the EC, any comparison with a national indicator is found to be extremely difficult, as it is difficult to assess the correspondence of the values presented for the achieved savings with actually achieved savings.

Even with the information obtained from the meeting with the DGEG, based on the values of the National Energy Balances and those of Eurostat, it was not possible to obtain the values of the final energy consumed in the reports sent to the EC.

Apparently, the role of the reports is solely to check whether the targets set by the Member States regarding the reduction of final energy consumption are progressing favourably, that is, whether the final energy consumption indicator is falling. However, this same indicator in the reports to the EC does not correspond with the same indicator of other institutions (Eurostat and DGEG).

As shown in **Fig. 8** and **Table 14**, although in 2017 and 2018 there was an increase in effective final consumption, it can be seen that from 2013 to 2018 the targets are being met and even globally surpassing forecasts. However, the increase in the actual estimated final energy consumption in 2017 and 2018 was significant, which could call into question the proposed targets, if the difference with final consumption without transport according to the commitments increases considerably in 2019 and 2020. This perspective is supported by the values in the column of deviations in **Table 14**, where the differences between the final consumption without transport according to the commitments, and the estimated effective consumption are represented.

5. PERSPECTIVES FOR 2030 (DIRECTIVE EU 2018/2002 and PNEC)

5.1 European Union Efficiency Strategy

The revised Energy Efficiency Directive (EU) 2018/2002 (11 December 2018) established a binding 32.5% energy efficiency target for 2030, with a clause for an upward revision by 2023. The 2030 Framework updates and further develops the 2020 Framework.

In contrast to previous acts of energy efficiency, in the revised EED, the energy efficiency target (2007 PRIMES baseline projections) was translated into a reduction target compared with the historical 2005 energy consumption levels. In particular, primary energy consumption in the Union should be reduced by 26%, and final energy consumption should be reduced by 20% compared with the 2005 levels'(Trotta, 2019).

The new Regulation establishes an integrated framework for planning, reporting, and review related to the 2030 Framework. Building on related provisions in the existing Renewable Energy (RE) and Energy Efficiency (EE) Directives, the Governance Regulation, in particular, requires each member state to submit in 2019, and every ten years thereafter, an integrated National Energy and Climate Plan (NECP). This plan is to include national contributions to the EU-wide RE and EE targets as well as related existing and planned policies and measures and is to be updated every five years (Articles 3, 9 and 14). Member states are also required to submit biennial progress reports on the implementation of their NECPs (Articles 17, 20–25), report biennially on policies and measures to implement their GHG emission target (Article 18) and annually on GHG emissions (Article 26). Member states must also prepare, submit, and regularly update long-term strategies for climate and energy with a time horizon of at least 30 years (Article 15) (Oberthür, 2019).

According to article 7 of the revised directive, the obligations go from 1.5% of new annual savings to 0.8% of new annual savings, ensuring the attainment of the accumulated target until 2030.

5.2 Portugal National Energy and Climate Plan

The EU has established several energy and climate targets for decarbonization until 2030 that mainly concern the energy sector. According to them, EU countries have elaborated their 10-year integrated National Energy and Climate Plans (NECPs) from 2021 to 2030 to meet those goals.

Portugal NECP 2030 is the main instrument for energy and climate policy, and was drafted in articulation and aligned with the vision defined by the RCN 2050 in accordance with the EU targets. It addresses the different aspects of climate change and energy transition in order to comply with the Paris Agreement. The goal is to develop a competitive low carbon economy based on renewable energy sources, in order to achieve carbon neutrality by 2050.

In order to comply with the objectives, Portugal is facing an energy transition, which is essentially based on the incorporation of renewable energy sources in the various sectors of the economy, energy efficiency, and the reinforcement of networks, which translate into the goals as shown in **Table 15**.

Table 15. *Portuguese targets for the 2030 horizon, source (PNECP, 2020)*

EMISSIONS	ENERGY EFFICIENCY	RENEWABLES	RENEWABLES IN TRANSPORT	ELECTRICITY INTERCONNECTIONS
-45% to -55%	35%	47%	20%	15%

With the goals and objectives defined for the 2030 horizon, 8 national goals were defined as an energy and climate integration strategy [**Fig. 9**]. The achievement of all these goals will contribute to making carbon neutrality a reality.

Fig. 9. *Portuguese targets for the 2030 horizon, source: (PNECP, 2020)*

Other key energy and climate indicators defined by the NECP are as follows in **Table 16**.

Table 16. *Other quantified indicators for 2030, source (PNECP, 2020)*

INDICATOR	TARGET
Renewables in transportation	20%
Renewables in electricity consumption	80%
New installed renewable capacity (electricity)	+15 GW
Electricity in final energy consumption	38%
Carbon sink capacity	+7 kt CO2
Energy dependency	65%

Regarding energy efficiency obligations, Portugal will maintain the alternative measures for the period 2020-2230, as presented in the national plan (NECP).

5.3 Possible Scenarios for 2030

It is not clear whether the nature of the 2030 Framework's is more or less stringent than the 2020 Framework. On one hand, binding national targets for the expansion of RE for individual member states have been discontinued. On the other hand, the accompanying procedural obligations have been significantly strengthened. Planning elements that were previously separate (RE, EE, climate action) have been further improved and integrated into the NECPs, which enhances visibility, and a firm requirement for member states to prepare, submit, and regularly update long-term strategies has been introduced. Furthermore, an agreed formula allows national RE contributions to be determined for each member state which allows the detection of those cases where the actions taken by member states do not add up to the EU's overall target of 32 per cent by 2030. Any member state that falls short of its progress is required to implement additional measures. Overall, the abandonment of national binding RE targets is thus significantly balanced by the introduction and strengthening of other elements (Oberthür, 2019).

Regarding EEO, which have the advantage of not overloading the national budget and are therefore independent of budgetary changes, has become a more widely used instrument in Europe. They are some of the most long-standing and successful schemes supporting energy efficiency upgrades in Italy, France, Denmark, and the UK. They, however, require political support for their continuation, as confirmed by the recent extension of the EED Article 7 till 2030. While offering the possibility to engage third parties with a wide range of skills, they may often be faced with reluctance due to possible energy bill surcharges and low consumer trust to energy suppliers. They are usually more suitable for "low-hanging fruit" type of investments, focusing mainly on measures that yield the cheapest savings, such as boiler replacement (Bertoldi et al., 2021).

Since Portugal is a small/medium country, with a geographic situation that is good in terms of renewable resources, it could be a reference case for the energy transition. These foreseen programs/measures/activities might well impel this country to achieve that goal, and to be at the forefront of energy transition and decarbonisation.

6. CONCLUSIONS

Article 7 of the EED obliges MS to ambitious targets in reducing energy consumption. In order to meet the 2020 targets, two paths were defined, either by the EEO schemes or by alternative measures. The energy policies that each MS decided to follow to reach the targets were diverse and depended on the choice they made regarding Article 7 of the EED. Regardless of the path chosen, MSs were required to submit a NEEAP to the EC, where they defined their savings programs and targets to be achieved. The MSs were also required to present an annual report where the main energy indicators and savings achieved should be presented.

The path followed by Portugal for 2020 was a set of alternative measures presented in its NEEAP. In this document, Portugal committed to a total of energy savings in the amount of 4 288 710 toe for the period 2013-2020, also presenting the savings to be achieved by sector of activity. For the purposes of energy savings, Portugal opted to exclude values from the transport sector, which is allowed by the EED.

Based on the reports sent by Portugal to the EC since 2013, an analysis of the progress towards the energy efficiency targets for 2020 was carried out.

During the characterization of the reports, there were some difficulties, namely in the comparison with the national indicators, as well as in the correspondence of the presented values of the savings achieved with the values of the savings actually achieved. It was concluded that the reports are only interesting to observe whether the defined targets are progressing favourably in terms of reducing final energy consumption.

A contact was made with DGEG to try to clarify the differences found, but even with the information obtained, based on values from national energy balances and Eurostat, it was not possible to verify the final energy consumption values in the reports sent to EC. From this contact, it was also learned that for the process of verifying compliance with the goals defined in the EED for 2020, the values to be considered will most likely be those of Eurostat.

Despite the information that the values in the reports are eventually not considered for the process of verifying the compliance with the targets, an analysis was carried out considering the reports'

values in order to estimate the savings achieved and the distance from the proposed target. The results showed that there were considerable savings between 2013 and 2016. In the following years, 2017 and 2018, the estimated "effective" values increase compared to final energy consumption (without transport) according to commitments. From a global perspective, it can be seen that from 2013 to 2018 the targets are being met and even globally surpassing forecasts. However, the increment in the estimated final energy consumption in 2017 and 2018 was significant. Therefore, if the estimated "effective" values continue to increase in the following years, the variations between real values (estimated) and expected values according to commitments could jeopardize the proposed target. For the period 2020-2030, an updated EED will be in place, which obliges ME to new NEEAPs which are now called NECPs for the period 2020-2030. The NECPs are more comprehensive, including in a single document energy efficiency and renewable energies, as the instruments for energy and Climate Action. The policies that emerged from these plans will constitute the basis for achieving carbon neutrality in 2050.

By performing a retrospective and prospective analysis through the years, this study could contribute with a critical assessment of the different types of approaches to achieve the objectives set for energy efficiency. Therefore, this document aims to assess Energy Efficiency Obligations in order to characterize the effectiveness of the Energy Efficiency targets for 2020, allowing a general reflection for a 2030 perspective.

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