DYNAMIX Decoupling growth from resource use and environmental impacts

Dynamix project policy mix evaluation

Increasing industrial energy efficiency in Portugal

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AUTHORS

Maria Elander, IVL

Peter Stigson, IVL

Felipe Oliveira, IVL

Tomas Ekvall, IVL

With contributions by:
Ana Faria Lopes, IEEP

Project coordination and editing provided by Ecologic Institute.

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DYNAMIX PROJECT PARNTERS

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LIST OF ABBREVIATIONS

ADENE	Portuguese Energy Agency
CO_2	Carbon dioxide
CO_2 eqv	Carbon dioxide equivalent
DGAIEC	Directorate General of Customs and Excise on Consumption
DGEG	Portuguese Directorate General for Energy and Geology
EE	Energy efficiency
EEF	Energy Efficiency Fund
EU	European Union
EUR	Euro
GDP	Gross domestic product
GHG	Greenhouse gas
GWh	Gigawatt hour
Mtoe	Million tonnes of oil equivalent
NES 2020	[Portuguese] National Energy Strategy for 2020
NH_3	Ammonia
NO_x	Nitrogen oxides
PNAEE	[Portuguese] National Energy Efficiency Action Plan
ppp	purchasing power parities
RES	Renewable energy sources
RGCE	Management Regulation of Energy Consumption
SGCIE	Intensive Energy Consumption Management System
SO_x	Sulfur oxides
toe	Tonnes of oil equivalent

1 Resource/Issue

Name of resource targeted (or focus of the case study, if the policy mix is broader than the specific resource(s) we have decided to analyse).

The European Union (EU) and the Member States have launched a number of initiatives, which aim to increase efficiency of energy use, reduce energy demand, and attempt to decouple it from economic growth. This case study focuses on policy instruments with the objective to increase the efficiency of energy use in the Portuguese industry.

Energy efficiency comprises efficiencies on different levels, such as efficiency in the production of fuels, in energy generation, in the final consumption of energy, etc. This case study only addresses the area of energy end-use efficiency in industry. Also, potential effects resulting from a (potential) change in the energy mix (e.g. by increasing the proportion of energy derived from renewable sources) are considered to be out of the scope of this case study.

Increased energy efficiency reduces the energy consumption needed per unit produced, for example the fuel needed for production of heat and mechanical energy in the production process. It also reduces the dependency on fossil fuels and fuel imports as well as environmental impacts such as emissions to water and air (including emissions of carbon dioxide (CO_2)).

2 Geographical area of policy mix coverage

Country name, and region or city if appropriate (if policy mix is applied regionally or locally)

The case study addresses a mix of policy instruments introduced to increase energy efficiency in industry on a national level. Hence, the geographical area of policy mix coverage is Portugal.

That said, the local context should not be underestimated when analyzing industrial energy efficiency. For example, there may be a possibility to utilize waste heat (from district heating systems or other heat demand) for useful purposes and thus increase efficiency from a larger systems perspective.

The international context can also be important. Prices in the international electricity market, the global oil market, etc. are likely to affect the energy efficiency of Portuguese industry and might also affect the impact of the policy mix.

3 Policy context

3.1 The environmental problem/resource challenge

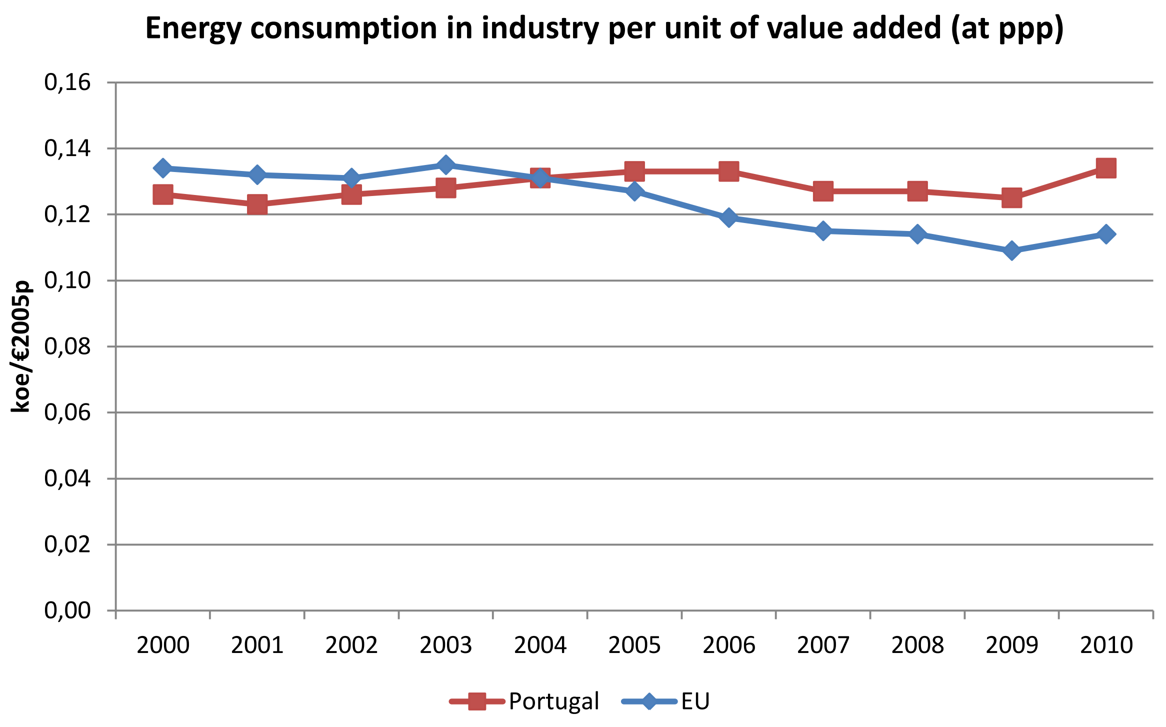
What is the environmental problem/concern (consider both quantity and quality), e.g. soil erosion, excessive use of non-renewable or renewable resources and the crossing of environmental thresholds/tipping points for impact, resource scarcity concerns?

Are there any economic or social problems related to the issue and environmental problems – e.g. is there important price volatility, (risk of) unavailability of resources for the economy or society?

Who is the target group affected that have been, are or will be beneficiaries of the policy response?

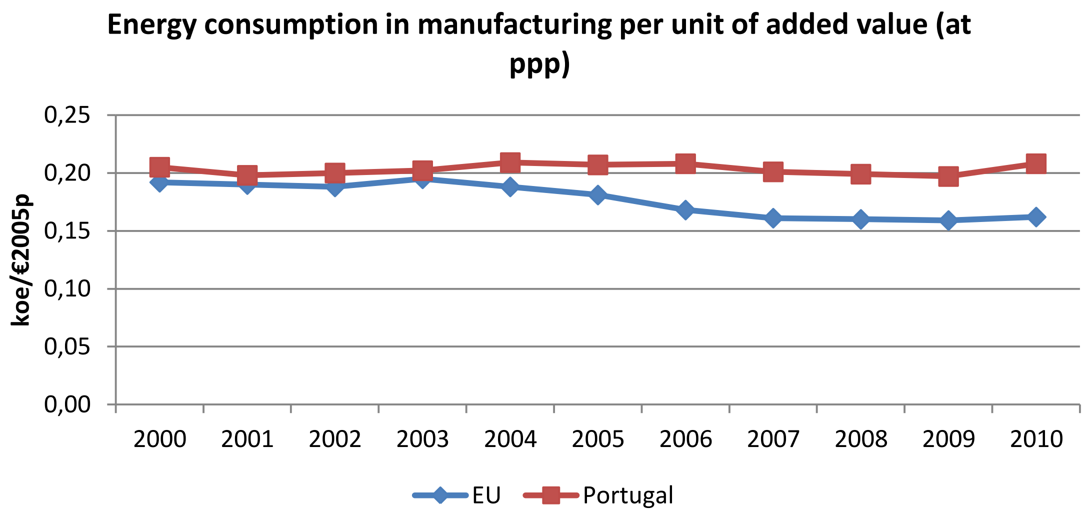
Energy use in Portuguese industry is higher than the EU average - see Figure 1 and Figure 2 which show the consumption of energy per unit of value added for Portuguese industry and manufacturing respectively. At the EU level, average energy consumption in industry and manufacturing per unit of value added was reduced between 2000 and 2010 (by 15 % and 16 % respectively). During the same time period, energy intensity in Portuguese industry and manufacturing increased by 6 % and 1 % respectively. In 2010 energy consumption per unit of value added in the Portuguese industry and manufacturing was 18 % and 28 % higher than EU average respectively (Odyssee 2013b).[1] This implies that the need for policies improving energy efficiency is particularly high in Portugal.

Figure 1: Energy consumption in Portuguese and EU industry per unit of value added (at purchasing power parities), 2000-2010



Source: Odyssee. http://www.odyssee-indicators.org/online-indicators/

Figure 2: Energy consumption in Portuguese and EU manufacturing per unit of value added (at purchasing power parities), 2000-2010



Source: Odyssee. http://www.odyssee-indicators.org/online-indicators/

Comparing data for energy efficiency in industry can be uncertain due to varying energy requirements for specific processes and specific inputs to the process (such as calcium as a raw material for cement production, resulting in varying energy requirements as well as process emissions).

A primary concern of high energy use is the consequentially high emissions as well as high resource use. Looking at greenhouse gas (GHG) emissions, the industry sector represents 13 % of national emissions (2010, calculations based on Eurostat data). The corresponding figures for sulfur oxides (SO_x) are 37 %, nitrogen oxides (NO_x) 22 % and ammonia (NH_3) 1 %. Hence, increasing industrial energy efficiency can make tangible contributions to meeting energy, climate and environmental objectives.

3.2 Policy context and policy needs

What policy challenge(s) did the problem pose and what policy challenges does it still pose?

What is the policy context related to the policy mix being evaluated? What policies have been put in place to address the issues, what policies are currently in place and which ones are already foreseen for future introduction (e.g. to address past, existing and future objectives)?

What sort of policy response did (and does) the problem call for?

As an EU Member State, Portugal shares the Union's common energy, climate and environmental goals. This includes cutting Europe's annual primary energy consumption by 20 % by 2020. It also includes reducing GHG emissions by 20 % within the same period.

The strategic policy framework for increasing energy efficiency in Portugal is laid down in the National Energy Strategy for 2020 (NES 2020)[i]. The NES 2020 was preceded by the National Energy Strategy of 2005 which led to the restructuring of the organization and

[i] Cabinet Resolution no. 29/2010

functioning of the Portuguese energy industry.[ii] One of five main objectives of the NES 2020 is to encourage energy efficiency by promoting and implementing sustainable mobility, smart grids and a new national energy efficiency action plan (EEA 2011).[2] The NES 2020 initially targeted a 20 % reduction in overall energy consumption by 2020. In November 2011, the Portuguese Government raised the primary energy consumption reduction target to 25 % by 2020 (Ministério da Economia e do Emprego 2011).[3]

The policy mix analyzed in this case study is the result of the national implementation of Directive 2006/32/EC on energy end-use efficiency and energy services ("Energy Services Directive")[4] in Portugal. The Energy Services Directive aims to promote the cost-effective improvement of energy end-use in the EU and obliges Member States to save 9 % or more of their final energy consumption by 2016 (compared to 2008 levels). Member States must provide mechanisms and incentives as well as institutional, legal and financial frameworks to achieve this target. Member States are to document all elements of their policy towards achieving their energy savings target in National Energy Efficiency Action Plans.

Portugal adopted its National Energy Efficiency Action Plan (PNAEE) in 2008 and revised it in 2011 (Ministério da Economia e do Emprego 2011).[5] The PNAEE from 2008 comprised a set of measures aimed at an increase in energy efficiency, equivalent to 9.8 % of total final energy consumption in Portugal by 2015. The measures targeted energy efficiency improvements in all sectors, with 30 % of the projected energy savings coming from industry. It was predicted that full implementation of the plan could save a total of 1.8 Mtoe of total final consumption or the equivalent of 4.77 GWh of electricity consumption over the 2008 to 2015 period. In the revised PNAEE from 2011, the energy savings target was raised from 1.8 Mtoe in 2015 to 2.2 Mtoe in 2016. Of those savings, 24 % must be achieved by industry.[6] As such, Portugal has more ambitious domestic targets regarding energy efficiency than required by EU policy which makes it an interesting case to look at in terms of the policy instruments implemented to achieve these targets.

In a case study on energy efficiency, it is worth mentioning that many investments in increasing energy efficiency can be directly profitable or have short payback periods. Hence, potential economic barriers and investment costs should not pose a key obstacle to this type of activity. However, research has shown that profitable investments in energy efficiency may not be realised as they considered a low priority and not part of the core business, thus investments are directed towards increased production (see for example Rohdin and Thollander 2006).[7]

3.3 Historical performance and projections into the future: Insights on decoupling

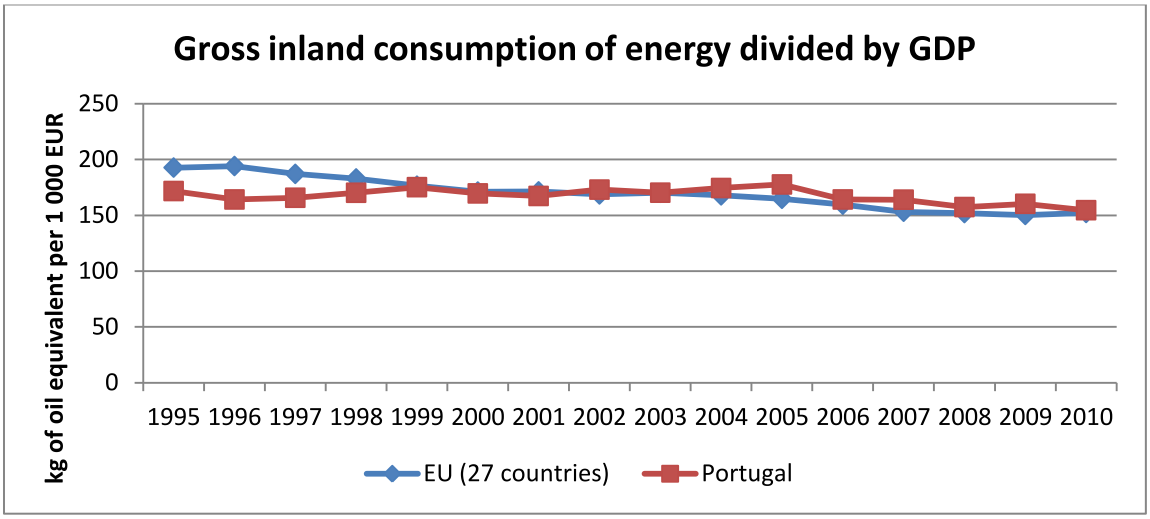
What has been the trend vs. GDP (or other economic performance metrics, such as sectoral growth) and what type of decoupling has been achieved?

Figure 3 illustrates the energy intensity of the Portuguese economy in terms of gross inland consumption of energy (coal, electricity, oil, natural gas and renewable energy sources) divided by the gross domestic product (GDP). While the energy intensity for EU 27

[ii] Cabinet Resolution no. 69/2005

decreased by 21 % from 1995 to 2010, the overall energy intensity in Portugal only decreased by 10 % over the same period.

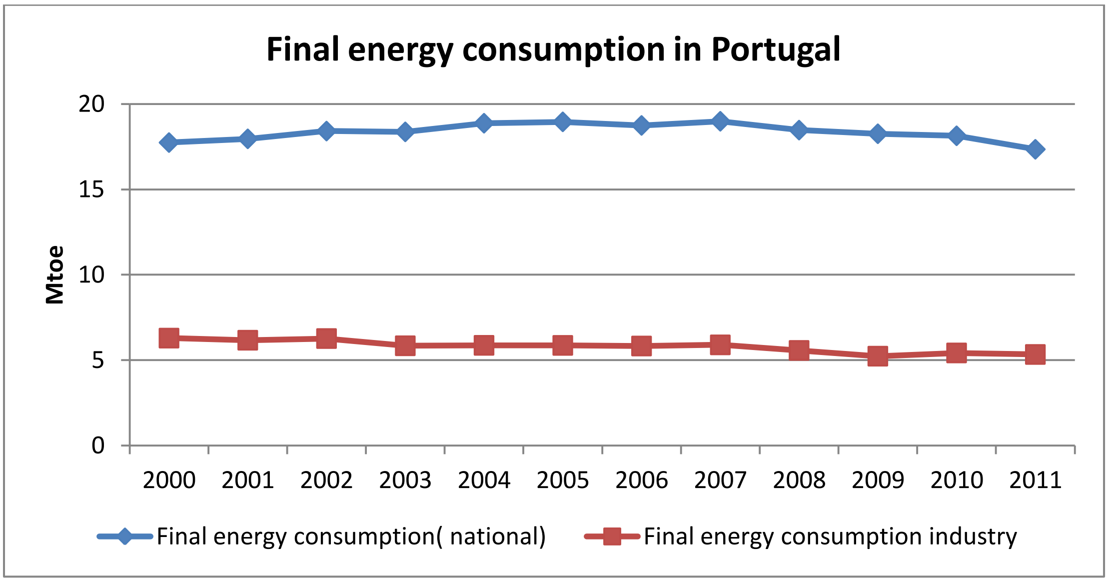
Figure 3: Development of energy intensity of the Portuguese economy and the EU, 1995-2010



Source: Eurostat. http://epp.eurostat.ec.europa.eu/tgm/table.do?tab=table&init=1&plugin=0&language=en&pcode=tsdec360

Total energy consumption in Portugal has remained relatively stable during the 2001-2011 period; however dropping slightly from 2007 onwards (Figure 4). The Portuguese industry sector represents ca. 33 % of the total energy consumption. Total energy consumption in the industrial sector remained relatively stable between 2000-2007, saw a slight reduction in 2007 and stabilized at a new level between 2008-2011.

Figure 4: Final energy consumption of Portuguese industry compared to total Portuguese energy consumption, 2000-2011



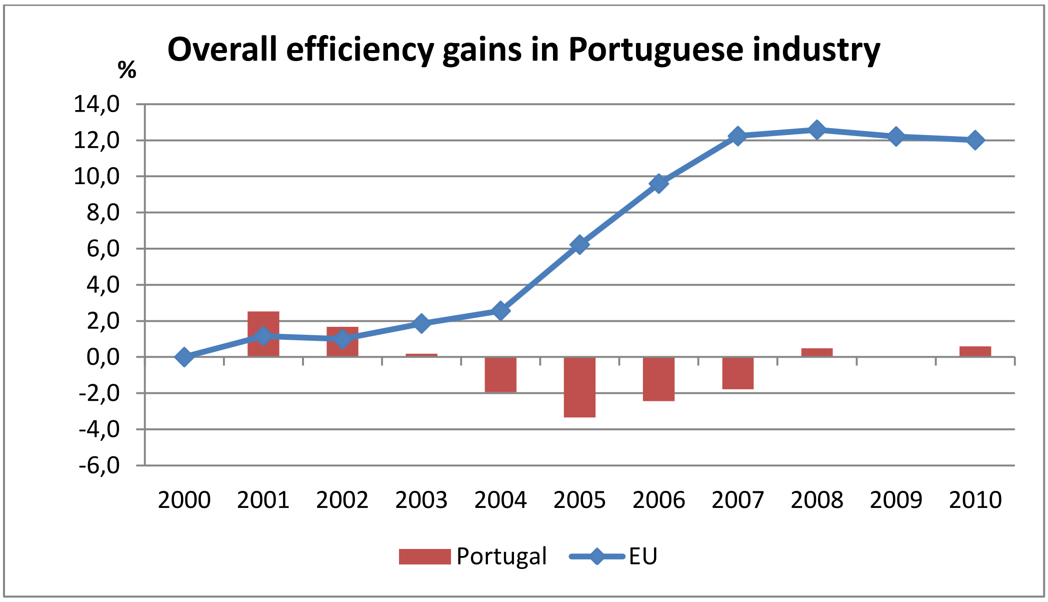
Source: Eurostat. http://epp.eurostat.ec.europa.eu/tgm/table.do?tab=table&init=1&plugin=1&language=en&pcode=tsdpc320

Between 2000 and 2009, the energy intensity of the Portuguese industrial sector decreased by only 1 %. The chemicals, metal and paper industry were the sectors that made the largest energy efficiency gains over this period (ADENE 2012).[8] Whereas the reduction in the energy consumption per ton in the cement sector (which is the largest energy-consuming activity in the industrial sector) was insignificant, the paper and steel industries improved their energy efficiency (by 1.4 and 4.4 % / year, respectively). However due to the limited shares of the paper and steel industries in overall industrial energy consumption, the impact of these improvements was marginal (ABB 2012).[9]

While the final energy consumption in Portuguese industry dropped by 14 % from 2000 to 2010 (as seen in Figure 4), Figure 1 shows that the energy use in industry per unit of value added slightly increased over the same period. This indicates that energy use in the sector has not been decoupled from industrial activity but rather that the reduction in energy use is fully explained by a reduction in industrial production, hence no decoupling was achieved.

Figure 5 illustrates the overall energy efficiency gains (calculated from ODEX) since 2000[iii]. Whereas EU industry (on average) improved its energy efficiency (calculated from ODEX) by 12 %, Portuguese industry has only improved its energy efficiency by 0.6 %, which is the lowest increase among all EU Member States (Odyssee 2013a).[10]

Figure 5: Portuguese industrial energy efficiency gains compared to the EU average, 2000-2010[iv]



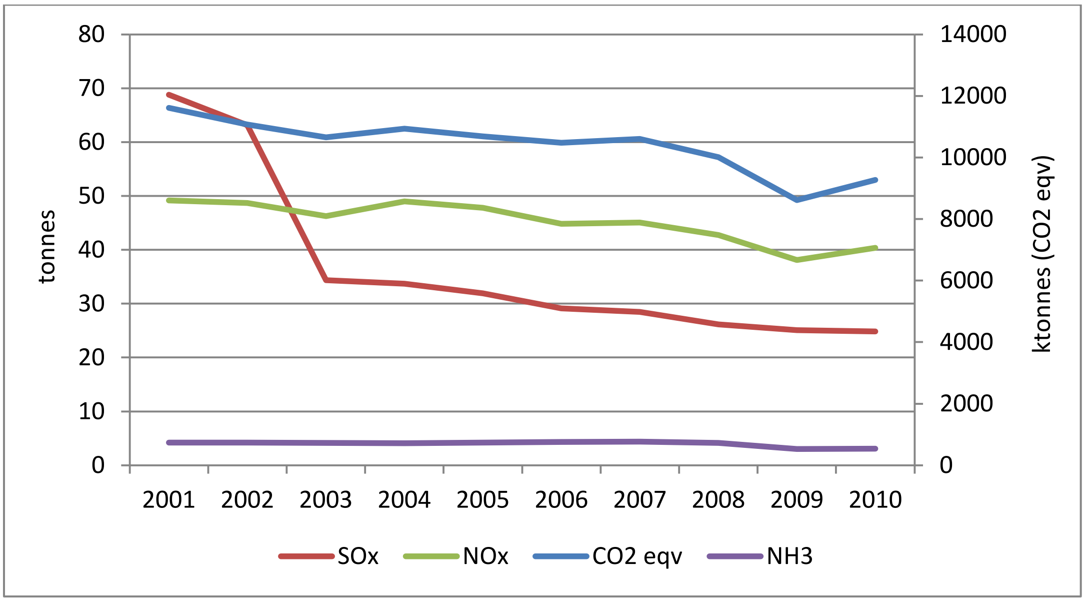
Source: Odyssee. http://www.odyssee-indicators.org/online-indicators/

[iii] ODEX in industry is calculated from unit energy consumption trends by branches and the unit energy consumption is expressed in terms of energy used per ton produced for energy intensive products (steel, cement and paper) and in terms of energy used related to the production index for the other branches.

[iv] For industry, the evaluation is carried out at the level of 11 branches including chemicals, food, textile & leather, machinery, transport vehicles, steel, cement and pulp & paper, other primary metals (i.e. primary metals minus steel), other non-metallic minerals (i.e. non-metallic mineral minus cement) and miscellaneous branches.

The main energy carriers used in Portuguese industry are oil, gas, electricity, and biomass (Eurostat 2013b).[11] Over time, the use of coal has been replaced with an increasing share of gas, which has also offset some of oil input. The share of renewable energy sources (RES) increased from 20 - 25 % between 2000 and 2010 (ABB 2012).[12] This shift in fuel use contributed to a decline in emissions of GHGs, NO_x, and, above all, SO_x by 20-60 % (see Figure 6). The reduction in emissions is much greater than the reduction in energy use. Comparing Figure 6 to Figure 1 and Figure 4, it seems that the GHG and NO_x emissions have declined at approximately the same rate as the value added in Portuguese industry. However, a decoupling is evident between the economy and SO_x emissions.

Figure 6 Air emissions from Portuguese industry (NFR 1A2 (a, b, c, d, e, f))



Source: Eurostat. 2013c. "Emissions of sulphur oxides (SOx) by source sector". Available online: http://epp.eurostat.ec.europa.eu/tgm/refreshTableAction.do?tab=table&plugin=1&pcode=tsdpc260&language=en; Eurostat. 2013d. "Emissions of nitrogen oxides (NOx) by source sector". Available online: http://epp.eurostat.ec.europa.eu/tgm/refreshTableAction.do?tab=table&plugin=1&pcode=tsdpc270&language=en; Eurostat. 2013e. "Greenhouse gas emissions by sector". Available online: http://epp.eurostat.ec.europa.eu/tgm/refreshTableAction.do?tab=table&plugin=1&pcode=tsdcc210&language=en; Eurostat. 2013f. "Emissions of ammonia (NH3), by source sector". Available online: http://epp.eurostat.ec.europa.eu/tgm/refreshTableAction.do?tab=table&plugin=1&pcode=tsdpc290&language=en

4 Drivers affecting change: resource use/environmental issues

What are the drivers affecting resource use (driving demand for the resource and leading to resource overuse) or other environmental impacts?

About 75 % of the energy demand in Portuguese industry is supplied by coal, oil, gas and electricity (ABB 2012).[13] Fossil fuel prices have been highly volatile and reducing energy use could thus also be seen as helping to reduce economic risks.

Energy-intensive industrial sectors are responsible for two thirds of the total industrial energy consumption in Portugal (ABB 2012).[14] In 2011 the energy consumption by non-metallic minerals production (mainly the cement industry) corresponded to 28 % of total industrial energy consumption; paper industry 25 %, chemical industry 11 % and steel industry 3 % (Eurostat 2013b).[15] Production processes, which also include the production of process heat and steam, drive energy use in the industry sector. These are intrinsically linked although energy efficiency gains are naturally possible. The potential however depends on the specific production processes applied, the raw material used as input and the possibility to utilize waste heat.

As such, looking at drivers of energy use in the industry sector as a whole must consider the structure of the sector. Structural changes affecting energy use in the industry sector are long-term in their nature. It is assumed, that no major structural changes have taken place since the introduction of the policy mix evaluated in this case study.

5 Situation/trend prior to introduction of policy mix

Information on the baseline situation before the policy mix was introduced.

Looking at trends since 2000, industrial energy consumption has been reduced by 14 % while energy-related air emissions have been reduced to a larger extent (see Sections 3.1 and 3.3). Figure 6 shows that SO_x emissions from Portuguese industry were reduced by 69 %, NO_x emissions by 15 %, CO_2 emissions by 33 % and NH_3 emissions by 21 % between 2000 and 2010.

6 Description of policy mix(es)

This section presents the main policy mix that will be the focus of this ex-post assessment.

Lifecycle focus (point of application): Production, extraction and consumption

Sector(s) covered: All sectors

Scale of application of policy mix: National

Implementing body: The former Ministry of Economy and Innovation, currently with a new denomination, is responsible for the implementation of the PNAEE and does this in coordination with pertinent ministries, departments and bodies. The Directorate General for Energy and Geology (DGEG) and Energy Agency (ADENE) coordinate the monitoring of the implementation of programs and measures. This work is carried out in conjunction with the entities designated by the former Ministry of Environment, Spatial Planning and Regional Development (acting as coordinating ministry monitoring the National Program for Climate Changes, PNAC) and other ministries in the areas of their competence. Furthermore, the

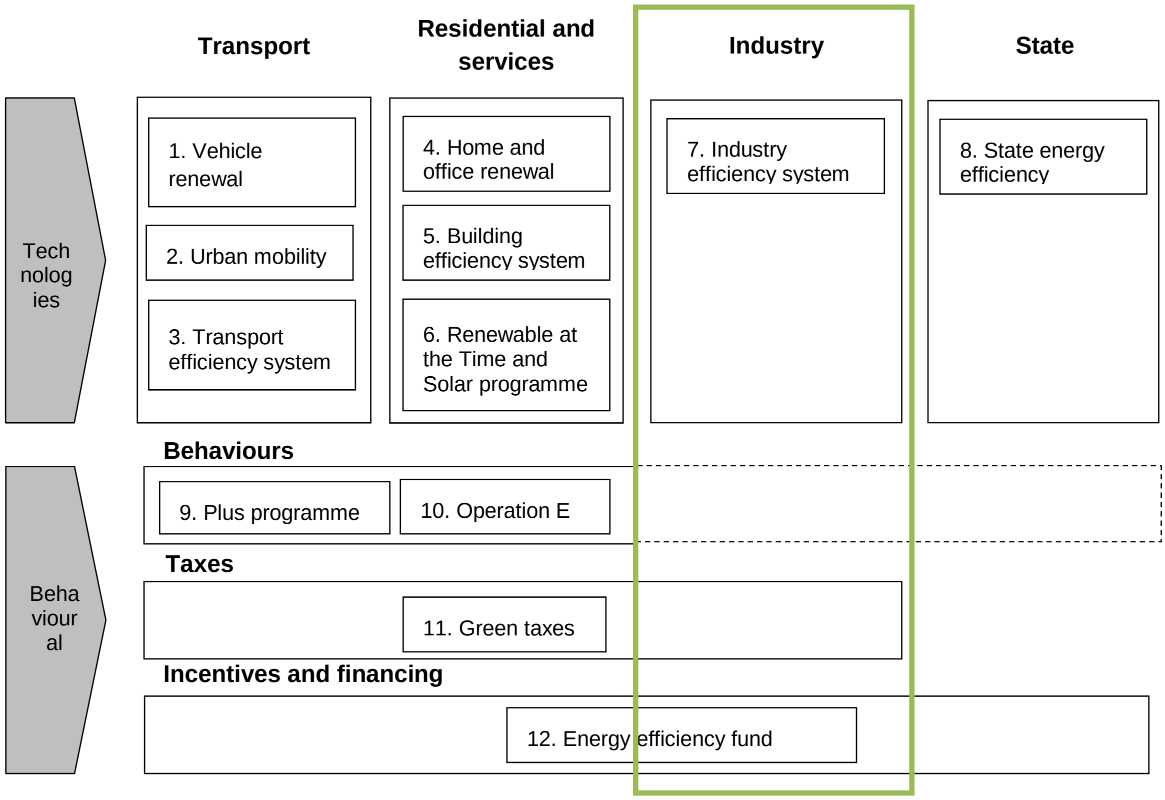
Regional Energy Agencies act as facilitators and promoters of energy efficiency initiatives in the regional and local implementation of programs and measures.[v]

Objective of policy mix: Increase energy efficiency, bring greater coherence to energy efficiency policies and aggregate the various measures previously in place.

The policy mix studied is an implementation of EU policy to increase energy efficiency (Directive 2006/32/EC). The elements of Portuguese policy that contribute towards the achievement of the set energy savings target are documented in the Portuguese National Energy Efficiency Action Plan (PNAEE).

Figure 7 illustrates the different elements of the PNAEE and indicates the policy mix considered within this case study. These are the policies oriented towards the industrial sector. The different policy instruments are described in more detail in Section 6.2.

Figure 7: Programmes in the Portuguese National Action Plan for Energy Efficiency and policy instruments considered in this case study



Source: ADENE. 2012. *Energy Efficiency Policies and Measures in Portugal. Monitoring of EU and national energy efficiency targets*. Odyssee-Mure 2010. Lisbon: Agência para a Energia.

[v] Council of Ministers Resolution 80/2008

6a. Supplementary context questions including elements pertinent to paradigm discussions in DYNAMIX

Timeline for the different phases of the policy cycle (i.e. rationale and objective-setting; appraisal; implementation and monitoring).

Description of the government in power during each of the three following policy phases: rationale and objective-setting; appraisal; and implementation and monitoring.

Does the mix contain policies that are unusual or not typical of the country/ies or regional/local administration that implemented it?

Names of resource efficiency concepts, terms, models, ranking/classification systems, accounting methods etc. used or relied upon in each of the three phases of the policy cycle: rationale and objective-setting; appraisal; and implementation and monitoring, and how they were used (e.g.: 'waste hierarchy' – used in objective-setting to link policy objectives to more desirable uses for waste).

We have found no information on the procedure that led to the development of the policy mix.

6b. Instruments and orientation of policy mix

Instruments in the mix and whether one type of tool (i.e. regulatory, economic, information) is dominant.

For each instrument, what is its aim? What requirements does it place on relevant players (for example, phasing out a certain substance, meeting minimum recycling targets, etc.)? What reporting requirements exist?

As illustrated in Figure 7 the PNAEE contains 12 different programs. Three of them contain policy instruments considered in this case study, tackling industry energy efficiency:

- Industry Efficiency System (no. 7)
- Green Taxes (no. 11)
- Energy Efficiency Fund (no. 12)

Industry Efficiency System

The program Industry Efficiency System replaced the previous energy consumption management regulations with the Intensive Energy Consumption Management System (SGCIE).[vi] The objective is to promote the increase of energy efficiency through the modification of production processes, the introduction of new technologies and behavior change (ADENE 2012).[16] The program applies to intensive energy facilities, consuming more than 500 toe/year, and includes a range of different policy instruments for increasing energy efficiency in industry. The elements of the SGCIE are:

- *Energy audits*

[vi] Decree-Law 71/2008

The SGCIE imposes binding energy audits for facilities with energy consumption higher than 500 toe/year. Energy intensive facilities with consumption above 1 000 toe/year must carry out energy audits every 6 years, facilities with energy consumption between 500 and 1 000 toe/year every 8 years (CA EED 2013).[17] These audits enable facilities to identify how much energy they consume, where it is consumed and, assumingly, to measure and set target indicators (see below). Facilities under the National Allocation Plan for Emission Allowances are not covered by SGCIE, but they may participate on a voluntarily basis, as can facilities with annual energy consumption below 500 toe/year (ADENE 2012).[18]

- *Energy Consumption Rationalisation Plans (PREn)*

Facility operators (with energy consumption > 500 toe/year) are obliged to elaborate an Energy Consumption Rationalisation Plan (PREn), establishing individual targets for energy and specific energy consumption as well as setting out energy rationalization measures. The facility operators have to present this to the Directorate General of Energy and Geology (DGEG) via a website[vii] as well as in biennial execution and progress reports (CA EED 2013).[19]

Decree-Law 71/20078 prescribes that the PREn should establish goals on energy efficiency, whenever applicable, using the following indicators:

1. Energy intensity measured by the quotient between the total energy consumption (considering just 50 % of the resulting energy from endogenous waste and other renewable fuels) and the gross value added of the industry
2. Specific energy consumption measured by the quotient between the total energy consumption (considering just 50 % of the resulting energy from endogenous waste and other renewable fuels) and the production volume.

By the end of each PREn period (6-8 years depending on total energy consumption of the facility), facility operators must reduce their target indicators by 4 % if their reference energy consumption is over 500 toe/year and by 6 % if their reference energy consumption is above 1 000 toe/year (ADENE 2012).[20]

- *Requirements on education/Disclosure*

Energy audits, Energy Consumption Rationalisation Plans and biennial execution and progress reports have to be carried out / developed by auditors recognized by DGEG according to their academic education and professional experience. This is regulated by specific legislation (Portaria no. 519/2008, of June 25th) (CA EED 2013).[21]

- *Rationalisation Agreement for Energy Consumption (ARCE)*

Upon DGEG's approval, the PREn becomes a Rationalisation Agreement for Energy Consumption (ARCE). This agreement is then communicated to the Directorate General of Customs and Excise on Consumption (DGAIEC) in order to be applicable for the exemption from excise duties as described below (Decree-law no. 71/2008).

- *Exemption from excise duties*

[vii] SGCIE website: http://www.adene.pt/pt-pt/SubPortais/SGCIE/Paginas/Homepage.aspx

The ARCE gives facility operators an exemption from excise duties (CA EED 2013).[22] Energy intensive consumers who have an approved ARCE can obtain an exemption from the tax on petroleum and energy products (ISP)[viii] for industrial fuels classified within codes 2701, 2702, 2704 and 2713, fuel oil with sulfur content of less than 1 % falling within code 2710 19 61, fuel oil with sulfur content higher than 1 % falling within code 2710 19 63 to 2710 19 69 and LPG classified by the code 2711 (ADENE 2012).[23]

- *Subsidies for energy audits and investments in energy management and monitoring equipment*

The ARCE gives facility operators the opportunity to apply for subsidies for energy audits and investments in energy management and monitoring equipment (CA EED 2013).[24] The costs for the energy audits are compensated to 50 % (or up to 750 Euro) and the investments for management and monitoring equipment and systems are compensated to 25 % (or up to 10 000 Euro). The levels of compensation is increased by 15 % if the facility only consumes natural gas and 25 % if the facility only consumes renewable energy (Decree-law no. 71/2008).

- *Penalties for non-compliance*

Penalties are foreseen for facility operators who do not meet the targets set out in the ARCE. If the difference between the defined values in the ARCE and those measured at the end of ARCE term is equal to or higher than 25 %, the facility operator pays 50 Euro for each toe/year exceeded. The fee is doubled to 100 Euro/toe if the deviation occurs more than once. If the difference between ARCE defined values and those measured at the end of the ARCE is equal to or higher than 50 %, the facility operator in addition has to return all received subsidies and tax exemptions (Decree-law no. 71/2008).

Green Taxes

The aim of this supporting policy is to create incentives through use of fiscal instruments (e.g. taxes, fiscal benefits) to increase the use of energy efficient equipment and disincentivise the acquisition of energy inefficient equipment. This measure tackles not only industry but also transport and residential and services sector.

An accelerated depreciation scheme was implemented for investments in energy efficient equipment for firms. These equipments were listed and the criteria to define them as energy efficient are periodically updated.

The green taxes were coordinated by the DGCI and DGAIEC, and currently by the AT (Autoridade Tributária e Aduaneira), which is the resulting entity of the fusion of 3 DGs.

Energy Efficiency Fund (EEF)

The Energy Efficiency Fund (EEF) was set up in 2010 with an initial allocation of 1.5 million EUR to encourage behavioral changes, raise awareness, and to support energy efficiency projects. [ix] The EEF is a key instrument for financing the national targets for energy efficiency

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[viii] Ordinance no. 1530/2008

[ix] Decree Law no. 50/2010

set in the PNAEE. For example, it supports the acquisition of equipment with better energy performance or equipment that promotes more rational energy use by citizens and companies, but also industry. Ordinance no. 26/2011 published on January 10 defines the financial support system for measures and programs eligible for the EEF. This regulation is intended to coordinate the funding and support process for projects that aim to reduce final energy demand and contribute to the achievement of national targets on energy efficiency.

To date there have been five calls of EEF financing, all of them in 2012. The second and fourth call was aimed at the SGCIE program and increasing energy efficiency in industry. As a result of these two calls, in total 386 457.53 Euro was granted as financing for 104 approved projects (ADENE 2013).[25]

Table 1 gives an overview of the policy instruments considered in this case study. It indicates the type, aim, requirements, reporting requirements, role in the policy mix and logic of intervention of each policy instrument respectively. Dominant policy instruments are marked in bold.

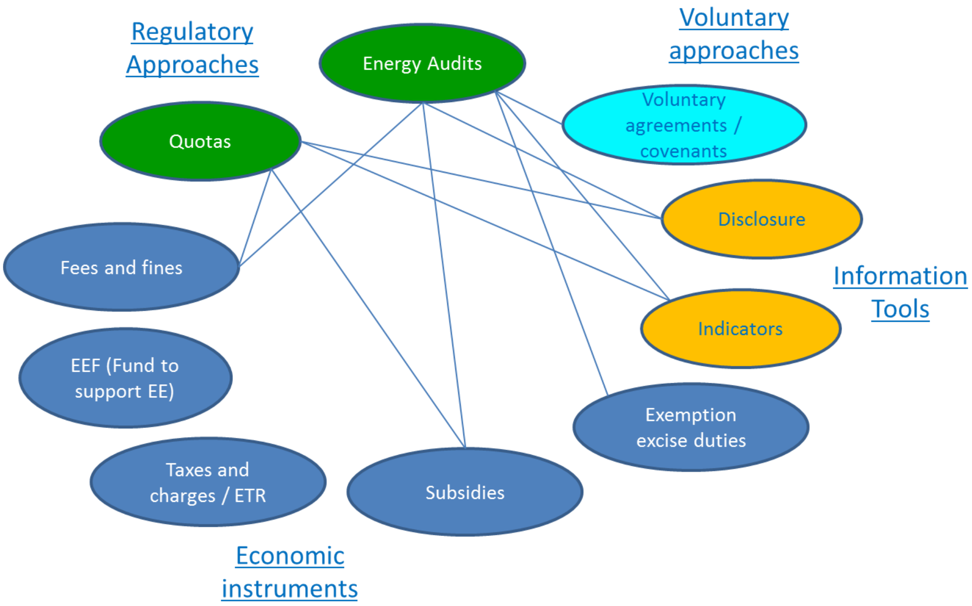
Table 1 Overview of the policy instruments considered in this case study

Policy instrument	Type of instrument	Aim	Requirements	Reporting requirements	Role in the mix	Logic of intervention
Energy audits	**Regulatory**	Identify potentials to increase energy efficiency, monitor developments in energy efficiency	Carry out energy audit	Reporting to DGEG	Primary	Maps energy consumption. Identifies energy efficiency potentials.
Energy Consumption Rationalisation Plans (PREn)	**Regulatory**	Implementation of potential to increase energy efficiency	Develop PREn	Reporting to DGEG	Primary	Sets a baseline for energy efficiency targets. Develops specific measures to increase energy efficiency.
Requirements on education	Regulatory, informative	Quality control, increase knowledge on energy efficiency, potentially create job opportunities	Employ a person with relevant knowledge	Reporting to DGEG	Enhancing	Maintains conformity and a high level of quality of the conducted energy audits and the PREn as well as of execution and progress reports.
Rationalisation Agreement for Energy Consumption (ARCE)	**Regulatory**	Translate potential to increase energy efficiency into binding agreements	Meet targets on energy efficiency	Reporting to DGEG	Primary	Makes energy efficiency targets and measures binding with legal consequences if the agreement is not fulfilled.

Penalties for non-compliance	Economic	Increase the incentive for facility operators to meet targets	Penalties apply when target indicators measured at the end of an ARCE term are 25 % and 50 % higher than in the ARCE	Linked to the biannual reporting to DGEG	Supporting	Increases the incentive for facility operators to realize identified and agreed upon targets and measures for increased energy efficiency.
Exemption from excise duties	Economic	Increase incentives for facility operators to voluntarily carry out energy audits and establish PREn's that are converted into ARCE's	Carry out energy audit and develop PREn	-	Supporting	Provides a financial incentive for facility operators to carry out energy audits, developing PREn and ARCE.
Subsidies for energy audits and investments in energy management and monitoring equipment	Economic	Increase incentives for facility operators to establish ARCE (also voluntarily), increasing incentives to install energy management and monitoring equipment		-	Supporting	Provides a financial incentive for facility operators to carry out energy audits, developing PREn and ARCE as well as installing energy management and monitoring equipment.
Green Taxes	Economic	Disincentivise acquisition of energy inefficient equipment		-	Supporting	Financial incentives for the industry and other sectors
Energy Efficiency Fund (EEF)	**Economic**	Increase incentives to make investments to increase energy efficiency			Supporting	Enables / lowers costs for investments to increase energy efficiency.

Figure 8 indicates the policy instruments examined in this case study and their relationships.

Figure 8: Identified policy instruments on Portuguese industrial energy efficiency and their relationships



Source: Author's compilation

6c. Evolution of policy mix

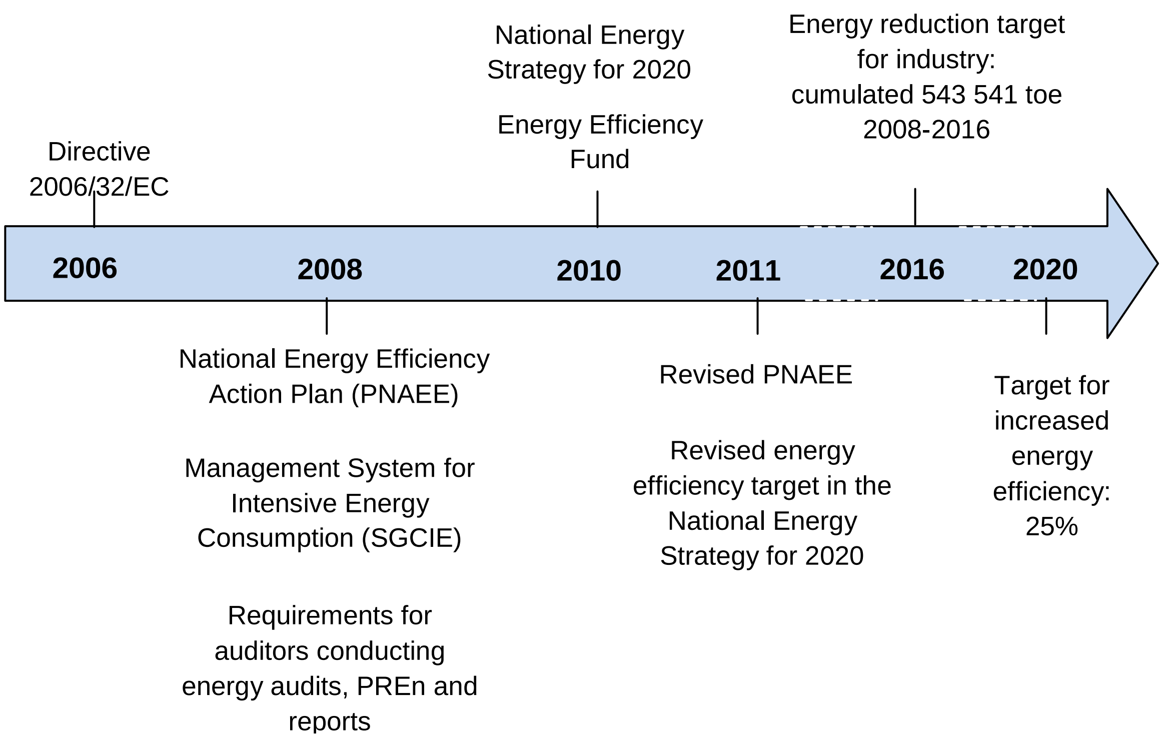
Evolution of the policy mix throughout its existence –details of the introduction of the first policy tool(s), then all subsequent relevant tools, and related revisions/reforms (e.g. progressive increases in rates applied through economic tools, broader extension of regulation requirements, etc.).

In 2005 Portugal introduced a National Energy Strategy which determined the main policy guidelines and most relevant measures for the energy sector. This strategy was superseded by the National Energy Strategy for 2020 (NES 2020) in 2010, which also includes the objective of promoting energy efficiency in terms of a National Energy Efficiency Action Plan.

Portugal introduced energy consumption management regulations for energy intensive consumers in the 1980s. These were revised in 2008 to better reflect the new energy efficiency targets laid down by Directive 2006/32/EC and the National Energy Efficiency Action Plan.

Figure 9 illustrates the timeline of the introduction and revision of policy instruments reviewed in this case study and also includes the set targets for increased energy efficiency.

Figure 9: Evolution of Portuguese industrial energy efficiency policy mix addressed in this case study



Source: Own compilation

7 Evaluation of policy mix: effectiveness (environmental sustainability)

Does/did the policy mix result in a positive environmental outcome?

Were its stated objective(s) met? Were the instruments used sufficient to meet the objectives?

Did other, unforeseen/unintended positive outcomes or impacts (environmental, social, economic) result? Did other such negative outcomes or impacts result?

Were these objectives set at a level to meet environmental needs (e.g. avoid crossing environmental thresholds/tipping points or achieve more sustainable levels of resource use/extraction (e.g. maximum sustainable yield (MSY) in fisheries)?

Which sectors/actors were identified as having key impacts/influences on the problem/issue? (e.g. specific industrial/ business sectors, consumers, economy as a whole?) Did any of the instruments specifically target these key sectors/actors? Was there significant take-up/implementation of (voluntary) instruments by these sectors?

Was the policy mix applied to a sector previously not targeted by policies on the issue under question, or in a new area/issue – thereby aiming to stimulate change?

What were the anticipated and actual outcomes, impacts and effects of the policy mix on the behaviour of sectors and actors targeted? (e.g. reductions in emissions from industry, increased recycling rates, increase/decrease in certain product purchases, etc.).

Relationships between the instruments, identifying positive/negative influences on the overall policy mix or on key instruments in the mix, as well as any positive or negative impacts from changes to the mix (introduction or termination of instrument(s), increase or decrease in tax/levy/charge, etc.). Level of 'connectivity' (strong, weak) between each instrument and the primary one(s).

Are there any indicators, monitoring systems, review processes or other monitoring mechanisms in place to track progress?

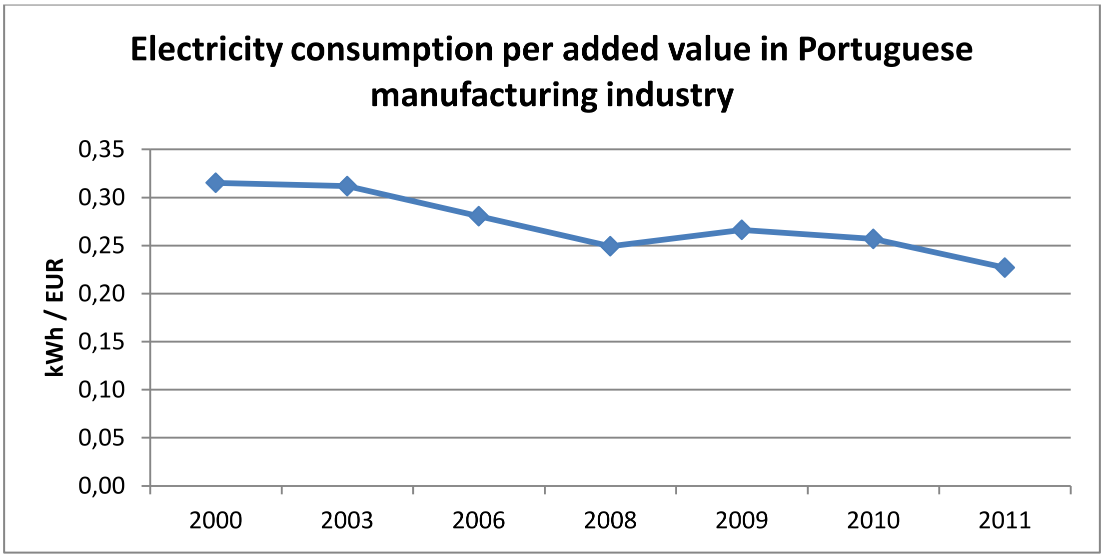
Energy consumption in Portuguese industry

Figure 4 illustrates the final energy consumption by Portuguese industry in the years 2000-2011. The final energy consumption was more or less constant over the 2003-2007 period. After the industry was hit by the global economic crisis, energy consumption fell in 2008 and 2009. In 2010 and 2011 industrial energy consumption recovered, although it remained below its pre-crisis level. The level in 2010-2011 is rather stable and ca. 7.5 % lower than the level in 2003-2007 (Eurostat 2013a).[26]

Energy intensity and energy efficiency in Portuguese industry

Figure 2 and Figure 5 illustrate, that the overall energy efficiency in Portuguese industry has been more or less constant over the last decade. However data on the Portuguese manufacturing industry show that electricity consumption in relation to value added has been reduced in the manufacturing industry, which implies an improvement in electricity efficiency in the sector. Figure 10 shows a reduction in the electricity consumed in producing the added value of 1 Euro by 28 % on average for the manufacturing industry as a whole from 2000-2011. This reduction indicates that electricity use has been decoupled from production in the manufacturing industry.

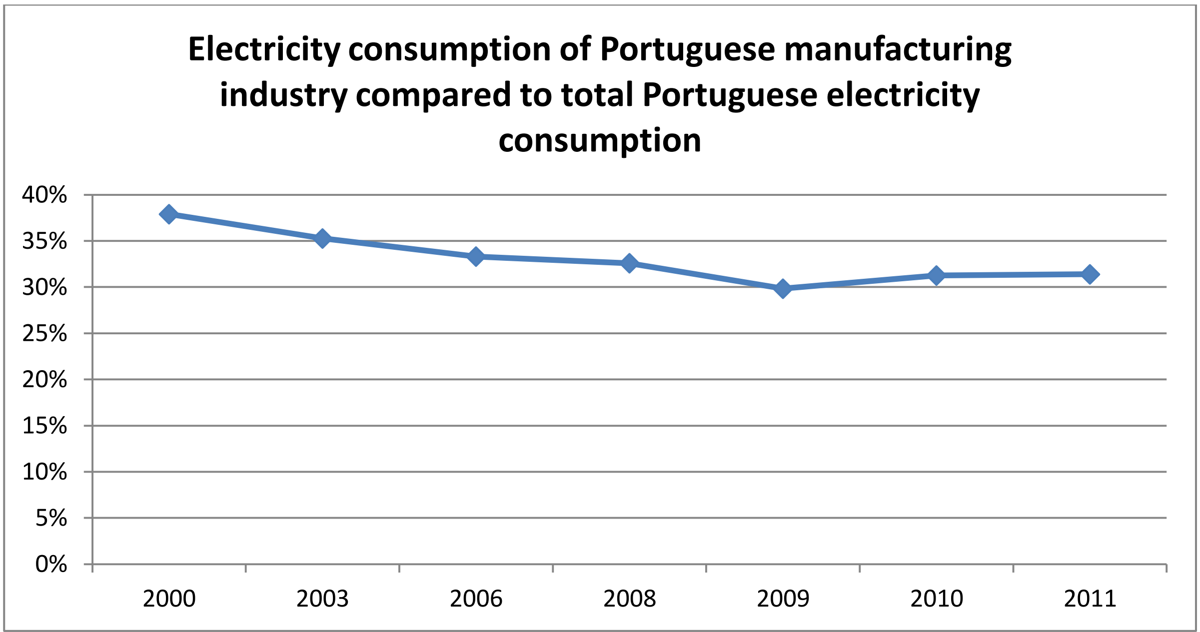
Figure 10: Development of Portuguese manufacturing industry electricity consumption per added value, 2000-2011



Source: Statistics Portugal. 2013. *Estatísticas da Produção Industrial*. Website section. http://www.ine.pt/xportal/xmain?xpid=INE&xpgid=ine_publicacoes&PUBLICACOESpagenumber=1&PUBLICACOESrevista=00&PUBLICACOEStema=55535&PUBLICACOESfreeText=Estat%C3%ADsticas%20da%20Produ%C3%A7%C3%A3o%20Industrial; Pordata. 2013. *Electricity consumption: total and by sector of economic activity*. Website section. http://www.pordata.pt/en/Portugal/Electricity+consumption+total+and+by+sector+of+economic+activity-1125

Figure: 11 shows, that during the same time period, the share of electricity consumed in the Portuguese manufacturing industry compared to total Portuguese electricity consumption was reduced by only 17 %.

Figure: 11 Development of the share of electricity consumption in Portuguese manufacturing industry, 2000-2011



Source: Statistics Portugal. 2013. *Estatísticas da Produção Industrial*. Website section. http://www.ine.pt/xportal/xmain?xpid=INE&xpgid=ine_publicacoes&PUBLICACOESpagenumber=1&PUBLICACOESrevista=00&PUBLICACOEStema=55535&PUBLICACOESfreeText=Estat%C3%ADsticas%20da%20Produ%C3%A7%C3%A3o%20Industrial; Pordata. 2013. *Electricity consumption: total and by sector of economic activity*. Website section. http://www.pordata.pt/en/Portugal/Electricity+consumption+total+and+by+sector+of+economic+activity-1125

Effects of the policy mix

Identifying the effects of the policy mix on energy efficiency is difficult for several reasons. On a general level, energy efficiency is closely linked to policies on renewable energy and climate and part of an even broader policy context. The price on CO_2 emissions is, for example, supposed to lower the CO_2 emissions in a cost efficient way, where companies can choose to decrease CO_2 emissions by increasing energy efficiency, increasing the share of renewable energy, or other measures. This makes it difficult to isolate effects of a more limited set of policies such as the one investigated in this case study. In addition, there might be energy efficiency improvements in some areas (such as in electricity efficiency in the manufacturing industry as described previously), which are overcompensated in other areas, making it difficult to differentiate and analyze the total efficiency and effectiveness of the policy mix.

In the Portuguese case, the economic crisis more or less coincided with the implementation of the policy mix investigated in this case study. The economic crisis is likely to be one of the main reasons for the decreased energy consumption seen among Portuguese industry. It is however worth noting that the production levels have differed greatly between different Portuguese industrial sectors in recent years (UNFCCC 2013).[27] For example, steel production has roughly doubled over the last ten years, while food production has remained relatively stable. The energy intensive production of cement clinker, which has grown slowly over the last ten years, has dropped by some 30 % since 2008. Lime production has increased by approx. 35 % over the same period. Glass production has seen a steady increase of ca. 30 % since 2003. In conclusion, the economic downturn appears to have had a limited effect on some sectors but a stronger impact on others. Hence it not only reduced the overall production but also shifted the balance between different sectors. The case study has shown that it is difficult to quantify the energy savings due to the crisis and differentiate them from energy savings due to the implementation of the policy mix investigated.

Finally, the policy mix is relatively new (implemented from 2008 onwards). The full effect of the policy instruments has not yet taken place. Most of the available data also only cover the years to 2010.

Despite these issues, we can make some general observations. By the end of February 2013, the Portuguese Directorate General for Energy and Geology (DGEG) had approved 649 PREn which became ARCEs. The implementation of these ARCEs is expected to lead to a reduction of 80.8 ktoe in energy consumption and 291.903 t CO_2 of GHG. Facilities that are in compliance with the SGCIE account for 1.389 ktoe of energy consumption and represent 24 % of final energy consumption in the sectors of Agriculture and Fisheries, Mining, Manufacturing and Construction and Public Works (CA EED 2013).[28] About a third (37 %) of the energy reduction target for industry (in total cumulated 543.5 ktoe until 2016) was met in 2010, with cumulated energy savings of 177.9 ktoe realized in 2008-2010 (Ministério da Economia e do Emprego 2011).[29] However, these savings obtained in the industrial sector might well be due to the economic crisis (OECD 2011).[30]

It can be concluded, that the final energy consumption of the industry sector in Portugal has been reduced since the introduction of the policy instruments examined in this case study. There are indications that the energy savings to a large extent reflect the economic crisis that has affected large parts of Portuguese industry. There are also indications that the energy efficiency gains compared to 2000 are significantly lower than the EU average. In recessions, the willingness to invest tends to be lower than average due to the high (perceived) risks. It is possible that investments to increase energy efficiency may have been carried out to a larger extent if Portugal had not been significantly affected by the economic crisis. Furthermore, the deadline for meeting the targets for reduced energy consumption in the industrial sector is 2016. Portuguese experts have different views, whether or not these targets will be met (EEW 2013).[31] Given the above mentioned issues, it is not possible within the scope of this case study to conclude on the effectiveness of the policy mix and the degree to which it has contributed to decoupling.

8 Evaluation of policy mix: efficiency (economic sustainability)

Is/was the policy mix considered cost-effective?

What has been the level of impact on resource use of the policy mix (the effect)?

What have been the costs of implementing the policy mix for target audience (e.g. business, households, etc.)?

What are the costs (financial, human) of implementing the policy mix for the implementing authority – i.e. the administrative/transaction costs?

Were sufficient resources made available to ensure an effective implementation of the policy-mix?

Was anything foreseen in the policy-mix to address competitiveness concerns (e.g. use of exemptions) or minimise transaction costs (e.g. thresholds below which monitoring wasn't required)?

Did the policy mix involve providing financial support (e.g. subsidies, low interest loans, tax breaks etc.) to key actors (e.g. sector, households, etc.)?

Did the measures generate revenues (e.g. in the case of taxes) and if so, was revenue recycled/re-injected into the economy, and to what levels and activities? Did revenue recycling have positive amplifying effects?

In synthesis - was the policy mix cost-effective?

What elements of the mix were (un)helpful in improving cost-effectiveness?

How was relative/absolute decoupling achieved?

Were resource limits or other thresholds taken into account and how were they addressed?

Portugal's considerable energy dependency is a weakness in its economy, inasmuch as it makes the country vulnerable to price fluctuations of energy products on international markets. Hence, improving energy efficiency is an important goal to hedge risks against price fluctuations of fuels and other energy sources.

According to simple economic theory, the most cost-efficient policy instruments are environmental taxes set at a level that corresponds to the external costs of the emissions. With such taxes, environmental costs are internalized in the economic system which allows industry to make economically rational decisions that take environmental impacts into account. According to similar economic theory, cap-and-trade systems for emissions are cost-effective ways to reach specific environmental targets which allow industry to find the least-cost solution to meet each environmental target.

The Portuguese policy mix is quite different to what is outlined in simple economic theory. The PREn system requires a specific energy efficiency target to be set by each individual facility, regardless of the cost of additional energy efficiency measures at that specific facility. Such an approach has a risk of economic sub-optimization as some energy measures are implemented where they are expensive, while cheaper measures at other facilities are not taken.

In practice, however, market-based policy instruments such as environmental taxes and cap-and-trade system might not be effective. Investments in energy efficiency are in many cases not made even when they are profitable for the industry as industrial decision-makers focus on other matters, namely increasing the production volume and quality of the products, etc. As a result, the costs for measures increasing energy efficiency can have short payback periods, or even be negative (profitable from the start). Hence, one could argue that a policy mix should rather include regulations that set standards and obligations than incentives through market based policy instruments. Moreover, given the large share of cost-efficient investments in industry, competitiveness concerns should arguably be low.

The policy mix considered in this case study is a mix of regulatory and economic instruments. The fact that the energy consumption in Portuguese industry and manufacturing lies above the EU average implies high energy efficiency potentials (including low-hanging fruits). There might be different reasons why these potentials have not yet been realized. In some cases the facility operators may have a lack of knowledge as to potential efficiency gains as well as to where in the production process the efficiency gains can be realized. In other cases the facility operators might have a lack of financial means to carry out mid-term investments in energy efficiency.

The obligation to carry out energy audits and develop PREns help facility operators identify and assess energy efficiency measures that have not yet been realized even though these measures could potentially also decrease costs. The binding ARCEs linked to penalties for non-compliance with the set targets imply that a large proportion of the identified and agreed upon energy efficiency measures are realized as operators seek to avoid paying unnecessary penalties. The fact that facility operators have to reduce their energy intensity by 4 % and 6 % respectively (depending on energy consumption) with each PREn period encourages facility operators to consider mid- and long-term energy efficiency measures instead of focussing only on short-term solutions. This has positive effects on the economic sustainability of the policy mix.

The regulatory instruments are coupled with a set of economic instruments; most of which are connected to the fulfilment of the regulatory instruments (e.g. exemption from excise duties for facilities with an ARCE, subsidies for energy audits and investments in energy management and monitoring equipment for facilities with a PREn, and financial penalties for non-compliance with the targets in the ARCE). These economic instruments serve as financial incentives to comply with the regulatory instruments and, as a result, improve energy efficiency. Consequently, the economic instruments complement and strengthen the regulatory instruments. In addition, the Energy Efficiency Fund supports the acquisition of equipment improving energy efficiency and lowers risks for facility operators making investments in energy efficiency measures.

It has been estimated that the PNAEE will cost the Portuguese government about 30 million EUR annually (excluding tax incentives). Half of this cost is supposed to be covered by the differential between electricity tariffs charged for different types of domestic consumers (those consuming more have to pay higher prices while those consuming less pay lower prices). The rest is supposed to be covered by national and EU funds as well as by proceeds of the taxes on electricity consumption and on low energy efficiency lighting (OECD 2011).[32]

9 Evaluation of policy mix: welfare (social sustainability)

What social impacts have you found associated with the policy mix? E.g. jobs created, reduced health impacts, distributional impacts etc.

Were social aspects included in an ex-ante impact assessment of the policy mix if one was undertaken? What were these?

Has monitoring of social impacts been included in implementation, to identify actual effects compared to anticipated ones?

Was the policy mix designed to not be socially regressive? What measures were undertaken to ensure this?

Were equity concerns addressed and, in case of re-structuring of the economy/sector, measures in the area of reskilling of the workforce foreseen?

What other public acceptability elements were addressed or considered?

We have found little information on the social impacts associated with the policy mix. The Management System of Intensive Energy Consumption (SGCIE) broadened the scope of the previous regulation, Management Regulation of Energy Consumption (RGCE). The SGCIE includes energy intensive facilities consuming more than 500 toe/year, whereas the RGCE only included energy intensive facilities consuming more than 1 000 toe/year (CA EED 2013).[33] This broadening of scope increases the equity in the treatment. The different requirements for facilities consuming 500-1 000 toe/year and more than 1 000 toe/year respectively (e.g. in terms of periodicity for the energy audits as well as in terms of the required minimum energy reduction targets per PREn period) take into account the different administrative burdens in companies of different sizes.

The Portuguese Directorate General of Energy and Geology (DGEG) sees the documentation of the performed energy audits, PREns and ARCEs via uploads on the SGCIE website[x] as a helpful measure to monitor facilities' energy consumption. The database includes information on consumption by energy form, production, measures and potential energy savings by type of measure and is very useful in terms of energy policy planning and monitoring as well as for the definition of appropriate incentives (CA EED 2013).[34]

10 Overall assessment

What is your overall view on the success(es) or failure(s) of this policy mix?

How did the policy mix enable decoupling?

How could it have been improved to achieve its original objective(s) and to achieve absolute decoupling?

[x] SGCIE website: http://www.adene.pt/pt-pt/SubPortais/SGCIE/Paginas/Homepage.aspx

As stated in Section **Error! Reference source not found.**7, the effect of the policy mix is difficult to estimate, partly because the mix was recently implemented and coincided with an economic crisis. Hence, it is hard to say if the policy mix enables decoupling.

However, Energy Efficiency Watch recently published findings of a survey with 21 national experts on implementation of energy efficiency policies in Portugal. According to experts, the Portuguese energy efficiency policies have progressed comparatively well since the first PNAEE. The binding energy audits for industry are considered to be the most effective among the specific energy efficiency policy instruments (83 % of the interviewed experts consider them to be partly or very effective). 68 % of the interviewees consider the qualification, accreditation and certification schemes partly or very effective. Opinions differ, however, on the achievement of the energy savings target: about a third of interviewees consider that the target set in Directive 2006/32/EC will certainly or probably be achieved, while another third believes that the target will not be achieved. The most critical issues identified for this shortcoming include the lack of funding, especially in the face of the financial crises (EEW 2013).[35]

There is a risk that the policy mix is economically inefficient, because it requires the same increase in energy efficiency from all facilities with a similar energy demand, regardless of the variations in costs for the efficiency measures introduced. On the other hand, such inflexible requirements might also be necessary for cost-effective efficiency measures to be implemented. Although the requirements are inflexible, they are less strict for facilities that consume less energy. This reflects the fact that the potential for energy efficiency improvements might be less in such facilities, and also that less resources might be available for energy-efficiency measures at smaller facilities.

A positive aspect of the policy mix is that the results from the energy audits and the PREns are transferred into binding ARCEs. In this way the facility operator gets involved from the beginning and might have a better understanding and acceptance of the measures he/she has to carry out.

11 Relevance to the EU and transferability

Can the policy mix be applied at the EU level? Is it transferable to other Member States/countries?

What lessons are there that may be of general interest regarding policy mixes and what issues are there as regards transferability of the insights?

The combination of energy audits and energy consumption rationalisation plans could probably be transferred to the EU level with good results. The active involvement required from the facility operators can result in better understanding and awareness of the importance of energy efficiency. This, in turn, would increase the acceptance of requirements to reduce energy use or increase energy efficiency.

However, the inflexible targets of 4 % and 6 % reductions are probably only justified in countries where the initial energy efficiency is low. In countries with high energy efficiency, such as Denmark, the cost of a 4 % or 6 % increase in energy efficiency at an individual production facility could be exceedingly high.

12 Stakeholder contribution

What insights did stakeholders provide?

No stakeholders were contacted in this case study. We contacted the Portuguese embassy in Stockholm to receive information on relevant studies, experts and stakeholders in Portugal. We made similar enquiries to Susana Xara, an environmental researcher at the Portuguese Catholic University in Porto. Unfortunately, none of these contacts yielded any information.

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