Energy Efficiency Trends and Policies In Industry

An Analysis Based on the ODYSSEE and MURE Databases

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Didier Bosseboeuf

Project leader

[1]Alphabetic order of countries

KEY MESSAGES

TRENDS

- Industrial energy consumption has remained roughly stable at EU level between 2000 and 2007 and has decreased rapidly since then with a contraction twice faster than the industrial activity.
- As a result, industrial consumption was in 2013 17% below its 2000 level at EU level and only represented 25 % of the energy used by final consumers, compared to 29% in 2000.
- Between 2000 and 2007, the stability of consumption was the result of the balance between the increase in industrial activity and energy savings.
- Since 2007, more than half of the reduction in consumption was linked to the decrease in industrial activity and only one fourth to energy savings.
- Energy savings were 2.5 times lower since 2007 than over 2000-2007,as there has been a much slower energy efficiency progress since the recession (0.9%/year since 2007 compared to 1.9%/year before), because of a slower progress in most branches and even no more improvement for some others (e.g. steel, cement, machinery). On average, energy efficiency has improved by 1.4%/year in the EU since 2000.
- This slower progress in energy efficiency is due to the recession, as the consumption did not follow the reduction of activity, because, on the one hand the large equipment did not operate at full capacity and were thus less efficient, and, on the other hand, part of the consumption is not linked to the level of production.
- The market share of electricity, biomass and heat in industry has progressed significantly (+4 points for electricity since 2000; +3 points each for biomass and heat).
- Chemical industry is the main energy consuming branch with 19% of total industrial consumption in 2013, followed by steel with 18%; while the share of chemicals is progressing (+1.5 points at EU level since 2000), the share of steel is declining (- 2 points).
- Since 2007 the energy consumption has decreased in all industrial branches: steel and non-metallic minerals experienced the strongest reduction with consumption 25% lower in 2013 than in 2000.

POLICIES AND MEASURES

- Financial measures are the by far dominating measure type in industry in almost all EU Member States. Around half of the policies addressing energy efficiency in industry can be attributed to this type. However, the new “Successful Policies” facility in MURE shows that in many countries the remaining part of the the policies in place includes a broad mix of other types (incl. new market-based instruments).

- The financial crisis since mid 2008 did not considerably change the dominance of financial measures. They are still dominating the policy mix and became even more important since 2013. Only in some countries which were hardest hit by the crisis (esp. Ireland, Portugal, Italy, Spain and Greece), no or only very few new financial measures have been implemented after 2008.

- The Energy Efficiency Directive (2012/27/EU) also triggered new energy efficiency policies in the Member States. With regard to industry, these are especially measures introduced under Article 7 (energy efficiency obligations and/or alternative measures), mandatory audits (Article 8) and new certification/qualification schemes. NEEAP measures, i.e. measures reported in the NEEAP 1 and/or NEEAP 2 and/or NEEAP 3, constitute about 50% of the total measures in the industrial sector in MURE.

- There is no clear correlation between the impact level of the measures and the measure types. Both high-impact and low-impact measures are of various types. Only informative measures usually have a relative low impact and are mainly seen as accompanying measures in a policy mix.

- Energy audits and energy management can be seen as important instruments to recognise and observe existing economic energy efficiciency potentials by systematic procedures to gain knowledge and developing a strategy to achieve energy efficiency targets. Insofar they play a crucial role in a policy mix for the industrial sector. One central element to wider spread this kind of instruments in Europe is the implementation of Article 8 of the EED, which is, however, delayed in several Member States. To the date of June 2015, some Member States did not even deliver a national response to Article 8 to the European Commission.

- While several energy efficiency measures are already in place for small and medium enterprises (SMEs), more tailored programmes are needed to address their special needs. The MURE database shows several best practice examples from countries where SMEs already are an important target group for energy efficiency policies.

- A suitable policy mix addressing energy efficiency in industry should both break down the most important barriers which hinder the uptaking of energy efficiency measures in companies (as e.g. information and knowledge deficits, several uncertainties, low priority fore energy efficiency investment or high transaction costs), and make use of the driving forces which facilitate the implementation of energy efficiency efficiency measures (as e.g. positive image of energy efficiency, motivated employees). A suitable policy package for industry should therefore comprise regulatory as well as the other incentivising instruments ("stick and carrot"), where the regulatory instruments define the technological baseline. The other instruments may then either encourage the investor to undertake measures complying with this baseline or they may set incentives to even exceed the standards significantly and make use of more advanced technologies.

- If this kind of policy package is designed for industry, a specific energy use in industry will usually be targeted by several policy measures. In that case, measure interactions can occur, i.e. measures in the package may reinforce each other but they could also counteract against each other. These measure interactions have to be taken into account in order to assess the impact of the policy actions on the EU (or national) energy efficiency targets in a realistic manner. The new MURE "Policy interaction" facility provides a flexible tool to catch these impacts in a user-friendly way.

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INTRODUCTION

The objective of this brochure is to analyse energy efficiency in the industrial sector. The analysis includes both a review of energy efficiency trends and of the policy instruments currently implemented to improve energy efficiency in this based on the ODYSSEE and MURE databases.

BACKGROUND

The industrial sector accounts for around 26% of total final energy consumption in the EU-28 in 2012. Though industry is only the third-largest end-use sector in the EU after buildings with a share of 40% and transport with 32% , in some countries with more energy-intensive industries, such as Austria, Germany, Czech Republic, or Sweden, the share varies between 30 and around 35%. In Finland and Slovakia, industry contributes with more than 40% to total final energy consumption.

With the Energy Efficiency Directive from 2012 (2012/27/EU) the Member States are obliged to meet their national energy efficiency target set in Article 3 EED and the 1.5% energy saving target from Article 7 of the EED. In order to achieve these targets, usually all end-use sectors have to contribute to these targets, also industry. The EED also includes specific regulations for this sector, especially Article 8 on energy audits. The achievement of the new 2030 target for energy efficiency, which prescribes a reduction of primary energy consumption by 27% compared to a reference development, will also need contributions from all end-use sectors.

At the level of the EU, the industrial sector is regulated by the EU Emission Trading System (ETS). At the national level, the policy mix addressing the industrial sector is dominated by financial instruments to support investment in energy-efficient technologies. More recently, the role of energy management also became important and was more and more addressed by national policies and by the EED.

CONTENTS OF THE REPORT

The first part of this report is dedicated to energy efficiency indicators. It analyses the main trends in energy consumption and energy efficiency since 2000 based on data and indicators from the ODYSSEE database (Chapter1).

The second part of the report deals with energy efficiency policies, starting with an overview of the main EU regulations addressing the industrial sector (Chapter 2.1). Afterwards, an overview of the main national energy efficiency policies is given (Chapter 0). The main focus is on the policies which were reported by the Member States in the National Energy Efficiency Action Plans (NEEAPs) under the Energy Efficiency Directive (EED).

In the following Chapter 3 we discuss specific topics which are relevant in the industrial sector. These include the dynamics and innovation of policies, the growing importance of energy management and the role of policies for specific target groups as e.g. small and medium enterprises (SMEs) or the energy intensive industry.

The focus of the final Chapter 4 is on the design of a suitable policy mix for the industrial sector. Here we discuss issues as e.g. the role and non-economic barriers in industry and the importance of policy interaction.

THE MURE AND ODYSSEE DATABASES

Both databases are regularly updated by a network of national correspondents from all EU Member States, generally from the energy efficiency agencies. They are managed by a technical coordination, namely Enerdata for ODYSSEE and Fraunhofer-ISI and ISIS for MURE. The two databases can be accessed at http://www.odyssee-mure.eu/.

BOX 1.1: THE ODYSSEE DATABASE

The ODYSSEE database contains detailed energy efficiency and CO2-indicators, about 180 indicators with data on energy consumption by sector and end-uses, their activity drivers and their related CO2-emissions, about 600 dataseries.The ODYSSEE database provides a comprehensive monitoring of energy efficiency trends in all the sectors and priority areas to address EU policies. The database contributes to the development of a monitoring methodology based on top-down assessment of energy savings, through different types of indicators:

- *Energy and CO2 intensities, that relate the energy used (or CO2 emissions) by sector to macro-economic variables (GDP, value added, …)*
- *Specific energy consumption (or CO2 emissions) (e.g. consumption per ton of steel, per car or per dwelling, gCO2/km)*
- *Adjusted intensities to allow the comparison of intensities (adjustments for differences in climate, general price level , fuel mix, industry and economic structure…)*
- *Indicators of diffusion that monitor the diffusion of energy efficient technologies and practices Benchmark indicators compare specific energy consumption among countries and with reference values*
- *An energy efficiency index (ODEX) for assessing energy efficiency progress and energy savings by main sector (industry, transport, households, tertiary) and for the whole economy (all final consumers).*

BOX 1.2: THE MURE DATABASE

The MURE database provides an overview of the most important energy efficiency policy measures in the EU Member States, Norway, Croatia and the EU itself. The da-tabase is structured by final energy consumption sectors (household, tertiary, industry, transport) and also includes a general cross-cutting section. At the level of sectors, the focus is on single policy measures in order to allow a specific analysis of each measure. More general programs comprising several measures are mainly described in the cross-cutting section of MURE. The homogeneity of the measure descriptions over sectors and countries is ensured by detailed guidelines. All measures are classified according to specific keywords, thus allowing queries based on criteria as e.g.:

- *their status (completed, on-going or planned);*
- *their year of introduction and completion;*
- *their type: legislative/normative (e.g. standards for new dwellings), legisla-tive/informative (e.g. obligatory labels for appliances), financial (e.g. subsidies), fiscal (e.g. tax deductions), information/education, cooperative (e.g. voluntary agreements) and taxes (on energy or CO2-emissions);*
- *the targeted end-uses and the main actors involved by the policy measures;*

- *their semi-quantitative impact: low, medium or high impact, based on quantitative evaluations or expert estimates;*
- *the end-uses involved and the quantitative impact of the policy measure related to a specific end-use (if this information is available).*

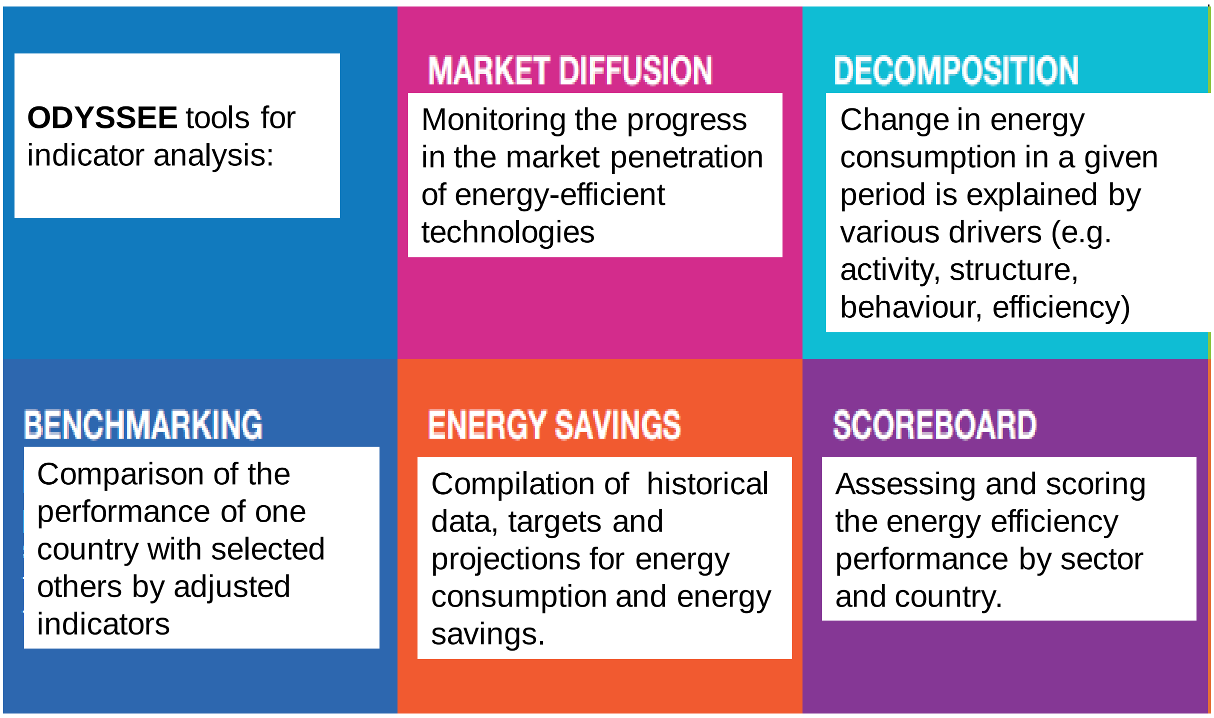
In order to allow a separate analysis of policy measures from specific sources, two ad-ditional categories have been added to the MURE database:

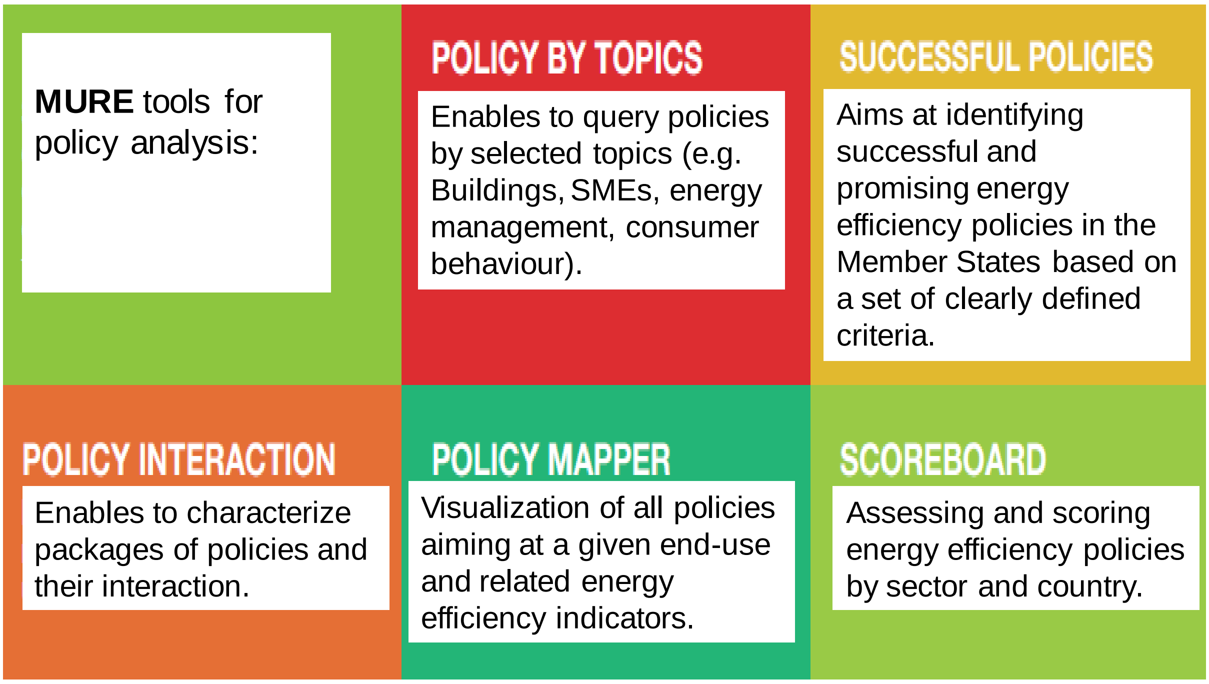
- *If a measure is included in the National Energy Efficiency Action Plan under the for-mer EU Energy Efficiency and Service Directive ESD (2006/32/EC) and the Energy Efficiency Directive (2012/27/EU, EED) respectively, it is classified as "NEEAP measure" in the MURE database. A distinction is also made between the 1st, 2nd and 3rd NEEAPs and the reporting on energy efficiency obligation schemes and alternative measures under Article 7 of the EED. This allows an easy identification of policy measures reported in the NEEAPs and under Article 7 EED and a specific analysis of these policies.*
- *In order to separate of EU-wide measures which are common to all countries (mainly EU Directives) from pure national measures, a set of "EU measures" was defined in the MURE database.*

In addition, for each policy measure a detailed description is available in the MURE database.

In order to make the use of these database easier and to enable the user to make its own analysis of indicators and policies, several support tools have been developed during the last 2 years (see Figure 1). Apart from the two databases themselves, these tools will be the main analytical basis for this brochure.

Figure 1 : The new ODYSSEE and MURE support tools for indicator and policy analysis





Source: MURE database

1. ENERGY EFFICIENCY TRENDS IN INDUSTRY IN THE EU

1.1. TRENDS IN ENERGY CONSUMPTION AND INDUSTRIAL ACTIVITY

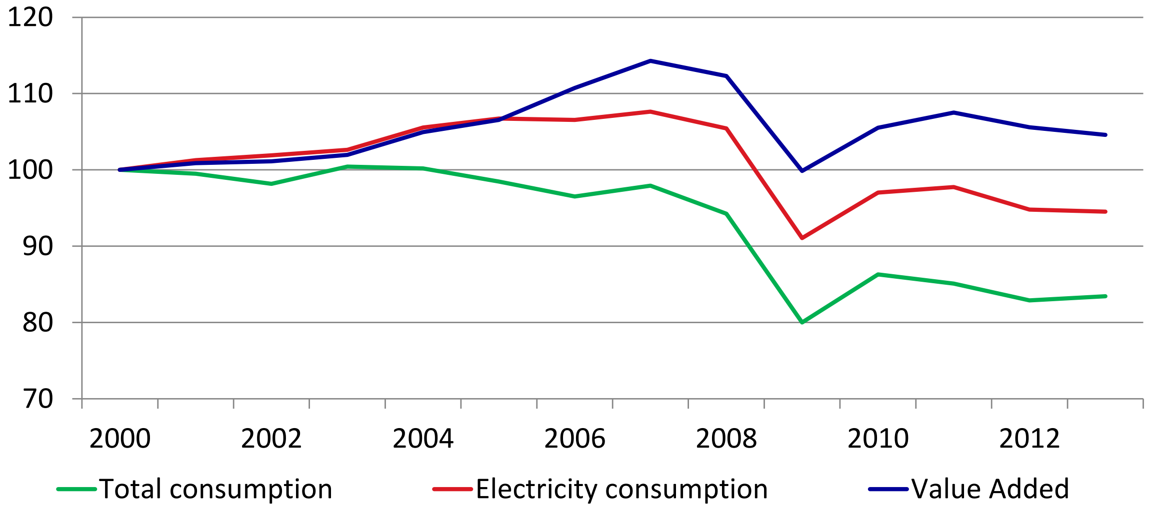
1.1.1. ENERGY CONSUMPTION TRENDS

Industrial energy consumption in 2013 17% below its 2000 level

The energy consumption of industry has been decreasing almost twice faster than the industrial value added at EU level since 2007 (by respectively 2.6% and 1.5%/year); there was a significant drop in consumption in 2009 (-15%) linked to the deep industrial recession (-13%) followed by a significant rebound in 2010 (+8%) (**Erreur ! Source du renvoi introuvable.**). Before 2007, energy consumption was strongly decoupled from the industrial activity, with a slight decrease of consumption (-0.3%/year), while industrial growth reached almost 2%/year. As a result, the energy consumption of the industrial sector[2] was in 2013 17% below its 2000 level.

Electricity consumption was more or less following the same trend as total energy consumption since 2007, while it was increasing regularly before, by around 1.2%/year. This progression was however almost twice slower than the industrial activity, thus reflecting also a decoupling between electricity use and industry activity.

Figure 2: Energy consumption trends and activity in industry in the EU

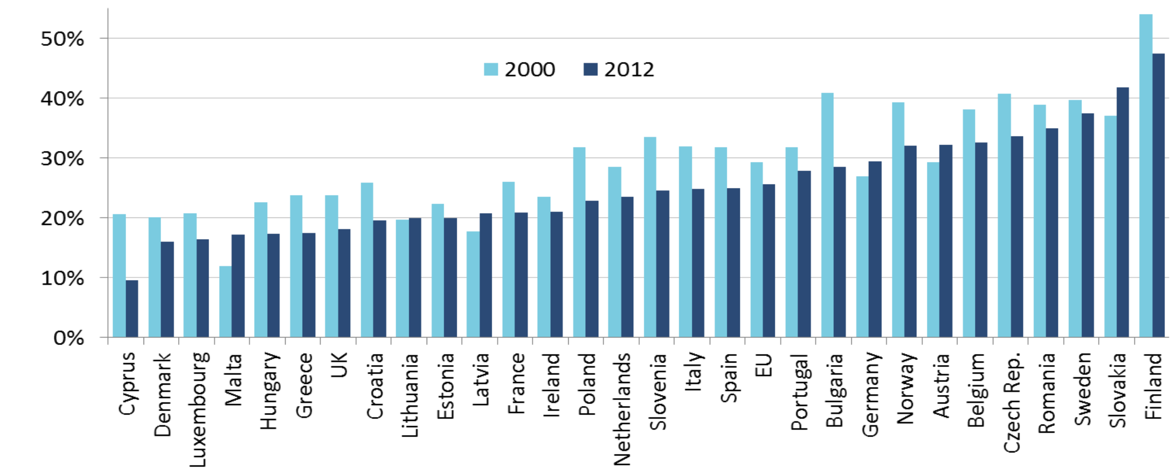


Source: Eurostat

As a result of these trends, the industrial sector is consuming a decreasing share of the energy used by final consumers in the EU, from 29% in 2000 to 25 % in 2013. In five countries (Austria, Germany, Latvia, Malta and Slovakia), the share of industry has however increased. Large discrepancies exist among countries as to the importance of the industrial sector: it absorbs almost half of the consumption in Finland, between 30 and 40% in Norway, Austria, Belgium, the Czech Republic, Romania, Sweden or Slovakia, but only 15 to 20% in Denmark Greece or UK (Figure 4).

[2]Industrial energy consumption includes manufacturing industry, construction and non-energy mining; it excludes the energy used for non-energy uses (e.g. gas or naphtha used as feedstock in petrochemicals).

Figure 3: Share of industry in total final energy consumption



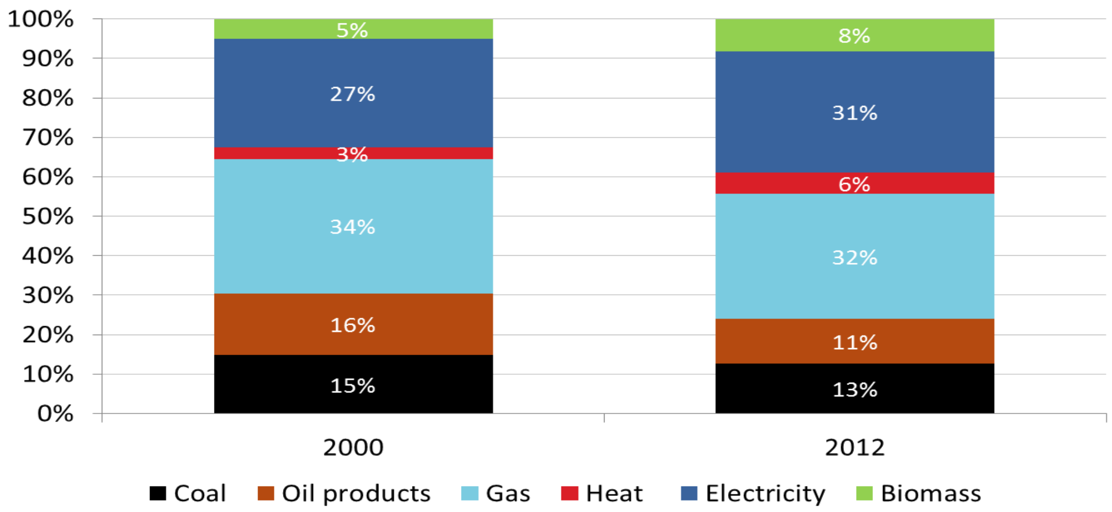
Source: ODYSSEE from Eurostat; total final energy consumption at normal climate

Significant progression of the market share of electricity, biomass and heat in industry

Natural gas and electricity are the dominant sources of energy for industry with respectively 32 % and 31% of the market in 2012 (Figure 4). Electricity has experienced a rapid growth between 2000 and 2012 (+4 points), as biomass and heat (+3 points each).

The contribution of all fossil fuels has decreased: -2 points for natural gas and coal (including lignite) and -5 points for oil.

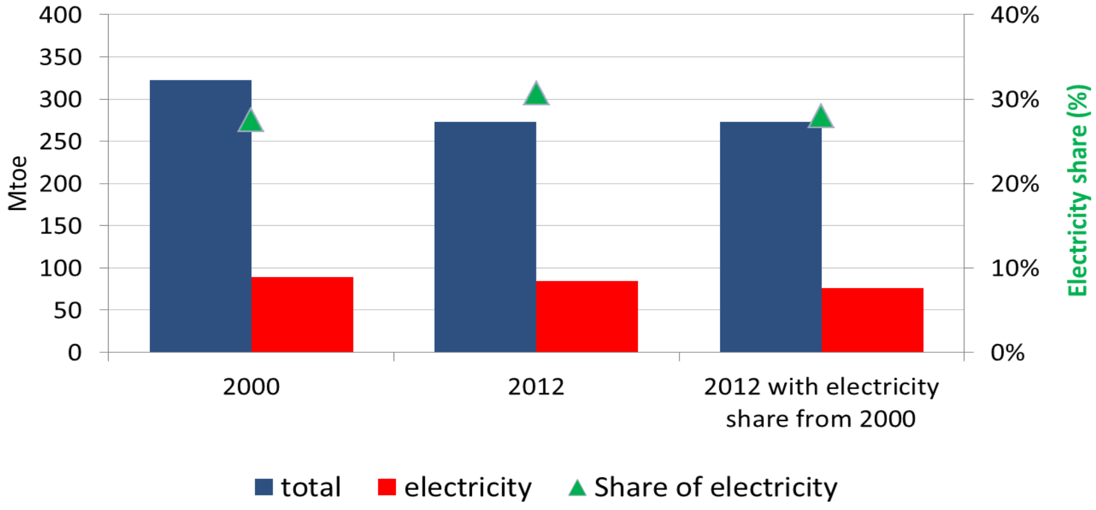
Figure 4: Energy mix in the industrial sector in the EU



Source: ODYSSEE from Eurostat

A small part of the progression in the market share of electricity is linked to substitution of fuels by electricity: if electricity share had remained constant, the electricity consumption would have been 9% lower than the level observed in 2012, i.e. 76 Mtoe instead of 84 Mtoe (Figure 5). This means that substitution explains 9% of the electricity consumption in 2012.

Figure 5: Effect of the electrification in industry



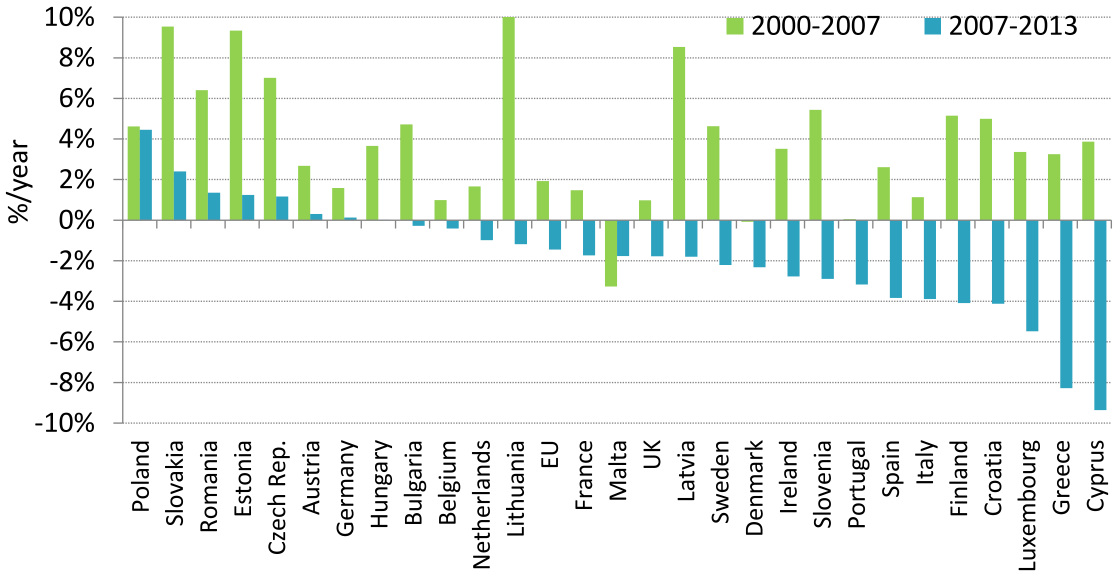
Source: ODYSSEE

1.1.2. ENERGY CONSUMPTION AND INDUSTRIAL GROWTH

Industrial recession in most countries since 2007

Since 2007, most EU countries have been hit by an industrial recession, except 5 countries (Poland, Slovakia, Romania, Estonia and the Czech Republic (Figure 6). At EU level, industrial activity contracted by an average of 1.5%/year between 2007 and 2013. This contrasts deeply with the period 2000-2007 when industrial growth averaged 1.9%/year.

Figure 6: Trends in industrial activity



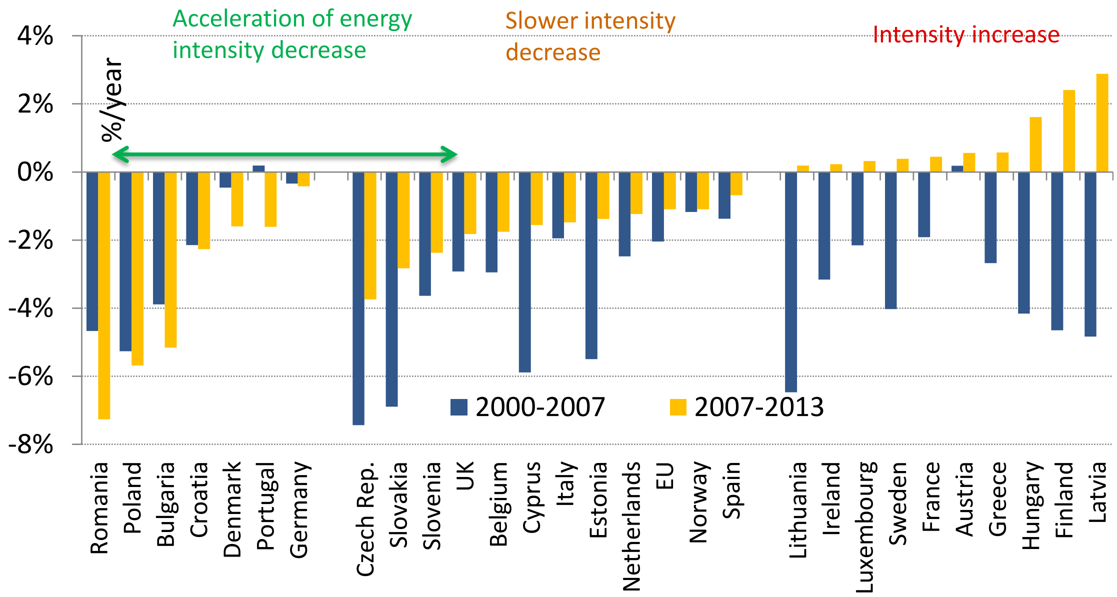
Source: ODYSSEE

Impact of the crisis on the energy intensity trend observed in three fourth of countries

Until 2007, the energy consumption grew less rapidly than the value added in all countries, which was reflected by an intensity decrease everywhere (Figure 7).

In 11 countries and at EU average, the intensity continued to decrease after 2007, but at a much slower rate (1.1%/year compared to 2%/year before), and in 10 countries the intensity trend has reversed: in other words, the recession had an impact on the energy intensity trend of industry in three fourth of countries. This break in historical trends is mainly explained by the fact that energy consumption did not follow the reduction in energy consumption during the recession because of lower efficiency (see Box). In 7 countries, however, the decreasing trend accelerated after 2007, generally in countries with an industrial growth.

Figure 7: Trends in the energy intensities of industry



Source: ODYSSEE

BOX 1.1: BUSINESS CYCLES STRONGLY INFLUENCE SHORT-TERM ENERGY INTENSITY VARIATIONS

The energy intensity in industry branch tends to decrease less (or even increase) in a period of recession for two reasons:

- First of all, process energy does not decrease proportionally to the activity as the efficiency of equipment drops if it is not used at full capacity.
- Secondly, part of the energy consumed is independent of the production level (e.g. heating and lighting): if production declines, only the former part of consumption decreases, but not proportionally: as a result, the energy consumed per unit of production tends to increase.

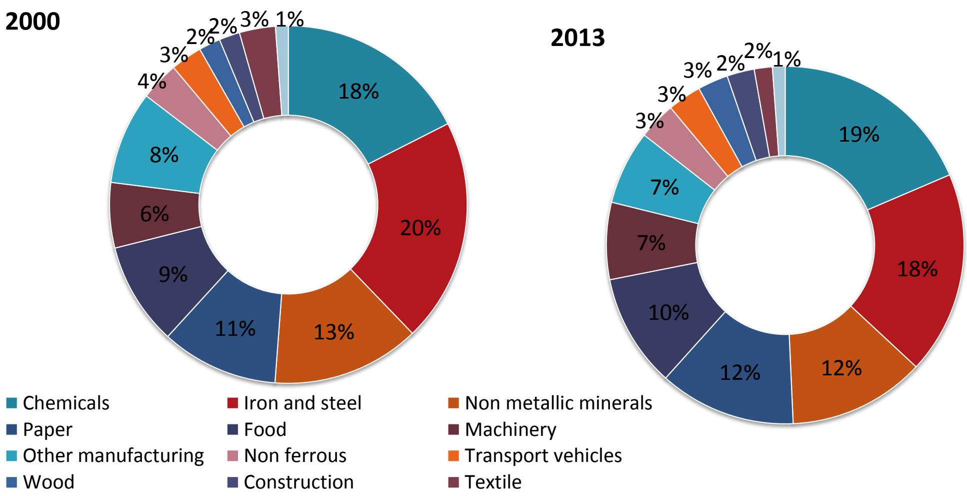
Chemical industry is the main energy consuming branch

The chemical industry is now the main energy consuming branch with 19% of total energy consumption of industry in 2013 in the EU (+1.5 points compared to 2000) **(**Figure 8**).** Steel arrives in second position with 18 %, followed by non-metallic minerals and paper (12% each), and food (10%). The share of chemicals, paper and food is increasing (around 1.5 percentage points more), while the share of steel is declining (- 2 points).

The share of all energy-intensive branches (steel, chemicals, non-metallic minerals, non-ferrous and pulp and paper) in industrial energy consumption is quite stable and represents two thirds of the industrial consumption.

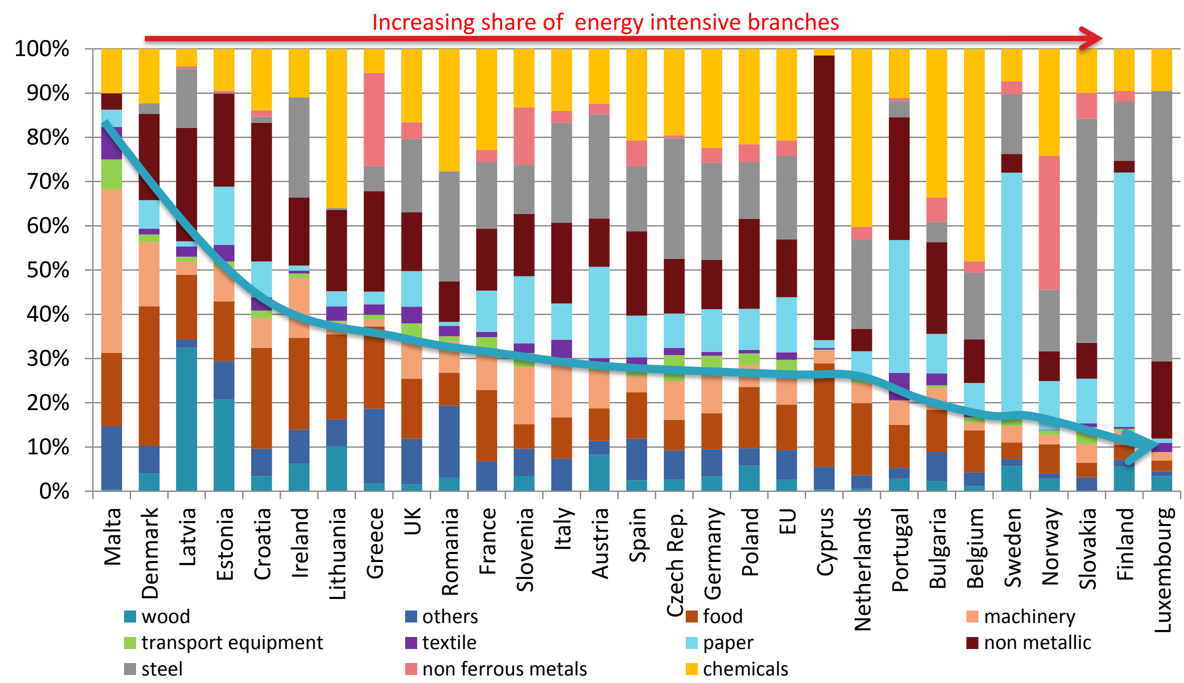
The breakdown of energy consumption by branch varies widely across countries: pulp and paper industry plays the dominant role in Finland and Sweden (more than 50% of the consumption), whereas it is chemicals in the Netherlands (around 40%), non-metallic minerals in Cyprus (64%), Croatia and Portugal (around 30%), steel in Slovakia and Luxembourg (above 50%) and food in Ireland and Croatia (20%) (Figure 9).

Figure 8: Distribution of energy consumption by industrial branch in the EU



Source: ODYSSEE from Eurostat

Figure 9: Share of industrial energy consumption by branch in EU countries (2012)

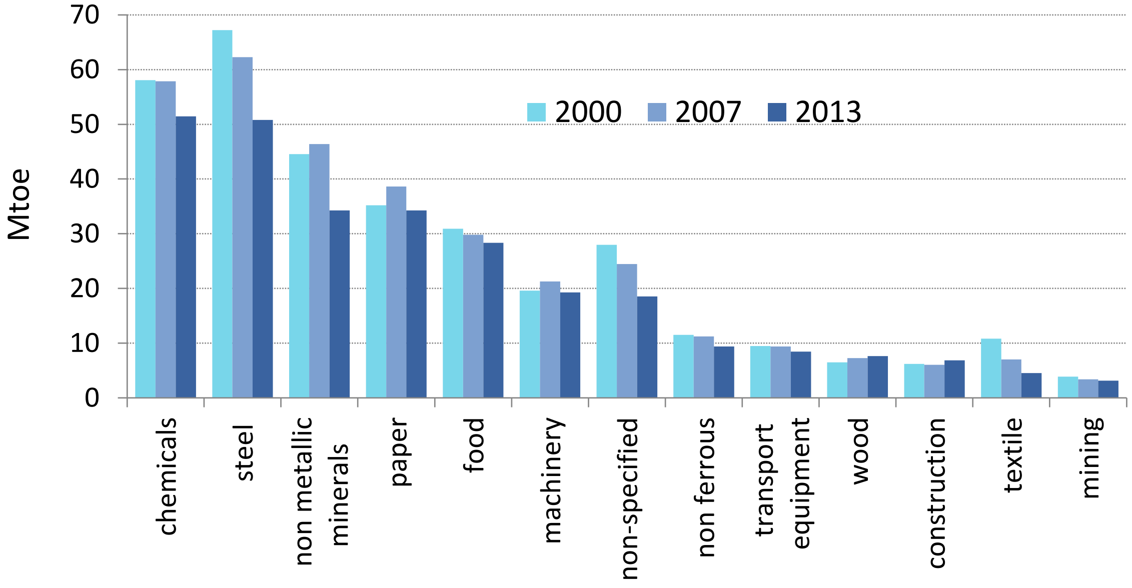


Source: ODYSSEE

Reduction of the energy consumption in all industrial branches since 2007

The energy consumption decreased in all industrial branches since 2007, and even since 2000 for steel, food, non-ferrous, transport equipment and textile. Steel and non-metallic minerals experienced the strongest reduction: their consumption was around 25% lower in 2013 than in 2000 (Figure 10).

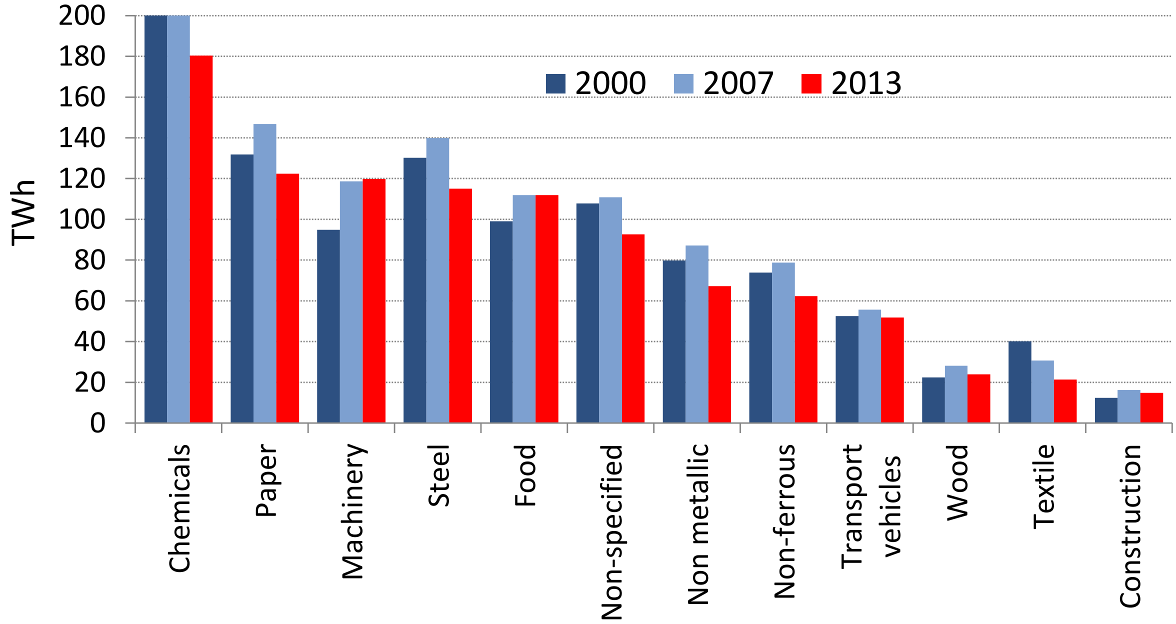
Figure 10: Energy consumption trends by industrial branch (EU)



Source: ODYSSEE from Eurostat

Since 2007, electricity consumption has also decreased in all industrial branches. It had increased before in most industrial branches. Chemicals industry is the largest electricity intensive branch (18%), followed by paper, steel and machinery (12% each) (Figure 11). Electricity has a market share above 50% in three branches: non-ferrous (57%), machinery and transport vehicles (53%).

Figure 11: Electricity consumption trends by industrial branch in EU



Source: ODYSSEE from Eurostat

1.2. ENERGY EFFICIENCY TRENDS

1.2.1. STEEL, CEMENT AND PAPER

This section gives a special focus to three energy intensive branches, steel, cement and paper[3], as these branches represent around 40% of the energy consumption of industry and have a large impact on the energy efficiency trends in industry. For these three branches, energy efficiency is captured by an indicator of specific consumption per tonne produced. Because of the impact of the economic crisis, trends will be analysed for two periods: 2000 -2007, i.e. before the crisis and the start of the recession, and 2007-2012.

As explained in Box 1, there is usually a loss of efficiency in a recession period, as the consumption does not follow the reduction of activity, because, on the one hand the large equipment, such as kilns, boilers or motors, do not operate at full capacity and are thus less efficient, and, on the other hand, part of the consumption is not linked to the level of production. As a result the specific energy consumption often increases during a recession.

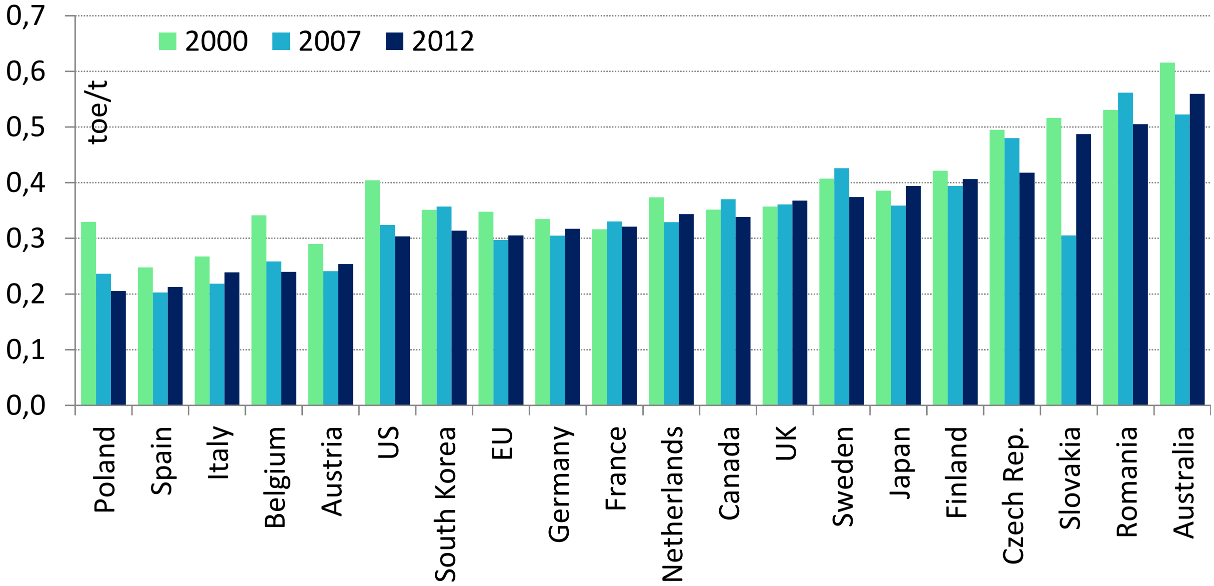
Decreasing specific energy consumption per tonne of steel until 2007

Until 2007, the average specific consumption per tonne of steel has been decreasing in most countries (by 2.2%/year at EU level) (Figure 12). Since 2007, there has been a slight increase in this specific consumption in half of countries and at EU level (by 0.5%/year for the EU average). This deterioration of energy efficiency since 2007 is mainly explained by a lower rate of utilisation of the steel factories. In some EU countries however, this specific consumption has still been decreasing (e.g. Poland, Belgium, France, Romania and the Czech Republic), as a result of an increased penetration of electric steel, the less energy intensive process[4], and the closure of old and less efficient steel mills.

[3]Steel refers here to the branch “iron and steel” and paper to the branch “pulp, paper and printing”.

[4]The electric process, in which steel is producedby melting iron scraps in an electric furnace requires 2 to 3 times less energy than the oxygen process, which uses pig iron produced in a blast furnace(this is only true if electricity is converted in toe on the basis of the calorific value of electricity, which is done here and by Eurostat).

Figure 12: Specific energy consumption per tonne of steel5



Source: Odyssee for EU countries and Norway, IEA for the other countries

The specific energy consumption per tonne of steel depends on the process mix

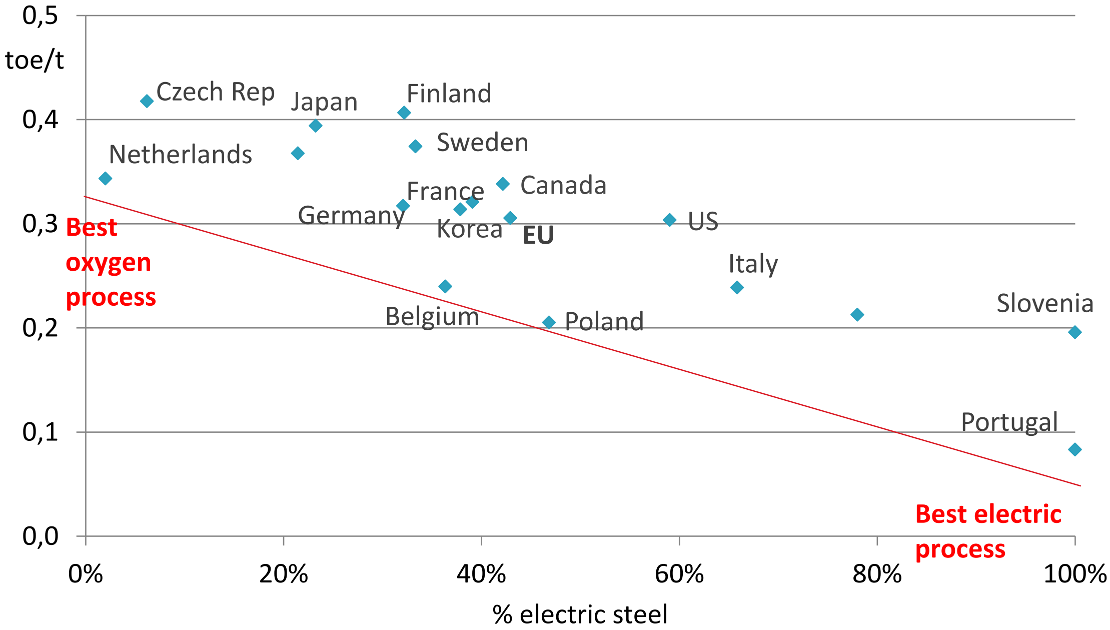
As the oxygen process requires 2 to 3 times more energy than the electric process, it is important, when comparing the average specific energy consumption per tonne of crude steel among countries, to take into account the "process mix" (i.e. the relative share of the two processes).

Figure 13: Energy consumption per tonne of steel and process mix (2012) compares the specific consumption per tonne of steel in relation to the share of electric steel in total crude steel production. The vertical distance from the world benchmark (shown by the red line) shows the possible improvement with the present process mix. The distance to the 100 % electric process shows the potential theoretically open to process substitution. In reality, this might be restricted by the availability of iron scrap and quality requirements of the steel produced.

Benchmarking of countries should be done at similar process mix: for instance, for countries in a range of 30-35% share of electric steel, Belgium represents the benchmark countries.

[5] Only countries with production > 4 Mt are shown.

Figure 13: Energy consumption per tonne of steel6 and process mix (2012)



Source: Odyssee for EU countries and Norway, IEA for the other countries

Cement production is now less efficient than before the crisis at EU level and in half of the countries

Cement is made from the mixture of clinker and additives; the ratio clinker/ additive can vary with the quality of cement (typically 80% clinker and 20% additive, but can go up to 95% clinker and 5% additive). Most of the energy consumption occurs during the fabrication of clinker in high temperature kilns, and not for producing cement itself, which consists of grinding clinker with additives (e.g. ashes). The higher the ratio clinker/cement, the more energy is required to produce one tonne of cement. In addition countries can produce all the clinker they need for their cement production or can import part of it or export their surplus. Importing clinker will, all things being equal, decrease the specific consumption per tonne of cement. On the other hand countries exporting clinker will have a specific consumption per tonne of cement higher than if they were only producing for their own needs.

Trends in the specific energy consumption per tonne of cement are therefore influenced by two main factors: the efficiency of clinker kilns and cement grinding, on the one hand, and the ratio between the clinker and cement production, on the other hand.

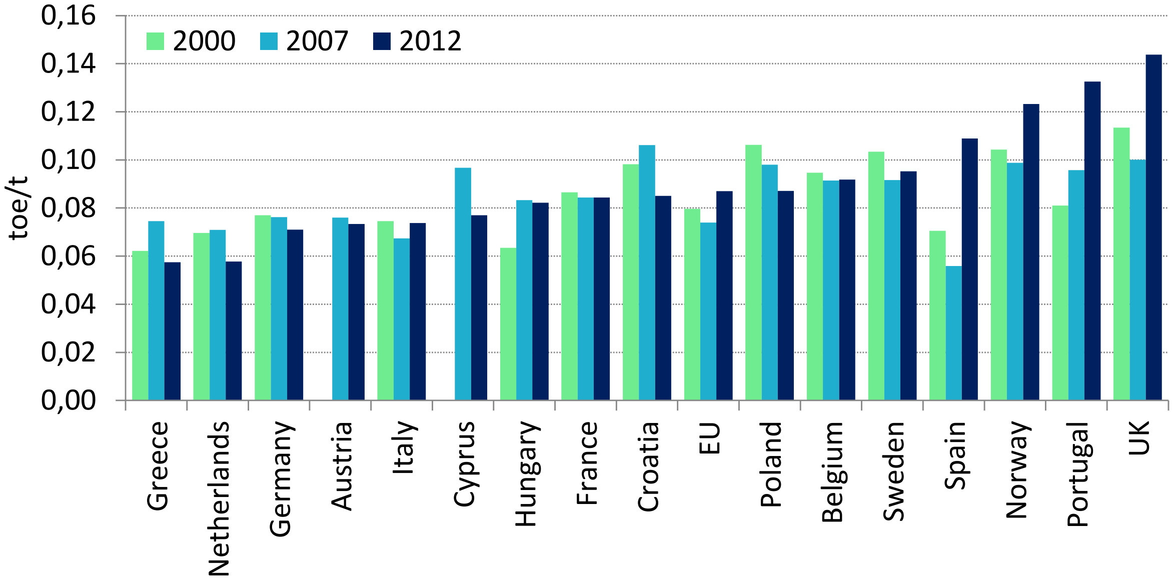
This specific consumption was higher in 2012 than in 2007 in 6 countries and at EU level (Figure 14). Such a trend is first of all explained by a deterioration of energy efficiency, especially significant in countries with a deep recession with plants operating at low capacity (e.g. Spain and Portugal, with a drop in production of 70% and 44% respectively). It also linked to an increase in the ratio production of clinker/cement: this is the case in Portugal and Spain where, because of the contraction of the domestic market, they increased significantly their

[6] Differences among countries may also arise from the fact that the energy consumption covers the whole iron and steel industry, not only the steel plants but also sintering, rolling mills, reheating furnaces.

exports of clinker (the ratio clinker/cement production increased from 59% to 105% in Spain and from 87 to 94% in Portugal).

The specific consumption per tonne of cement has kept decreasing in 7 countries and remained stable in 3 others. This reduction reflects energy efficiency improvements but reflect as well, for some countries a decrease in the ratio clinker/cement production linked to increased imports of clinker and more additives in cement (e.g. in Germany, Austria, Poland).

Figure 14: Trends in the specific consumption of cement in EU countries



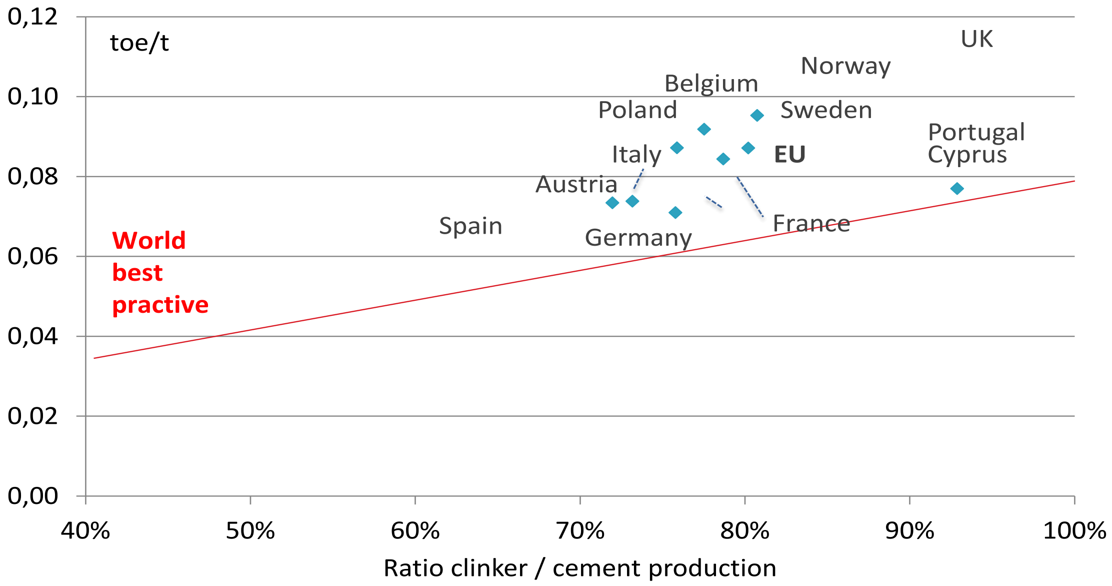
Source: Odyssee

Comparisons of energy efficiency for cement should take into account the ratio of clinker to cement production

Differences between countries in the average energy consumption per tonne of cement not only reflect different levels of energy efficiency, but also differences in the ratio clinker to cement production, i.e. in the composition of cement (% of additives) and in the share of clinker produced in the country[7].Therefore, **c**ross countries comparisons should take into account the ratio of clinker produced to cement production, as shown in Figure 15. Distance to the red line (which represents the world best practice) indicates the potential of energy efficiency improvements. For countries with a similar share of clinker, the country with the lowest values represents the benchmark: for instance, Germany for countries in the range 70-80%.

[7]Low values may be also due to the fact that for some countries energy consumption of non-conventional fuels (biomass, wood, tyres...) is not well known.

Figure 15: Energy consumption per tonne of cement produced



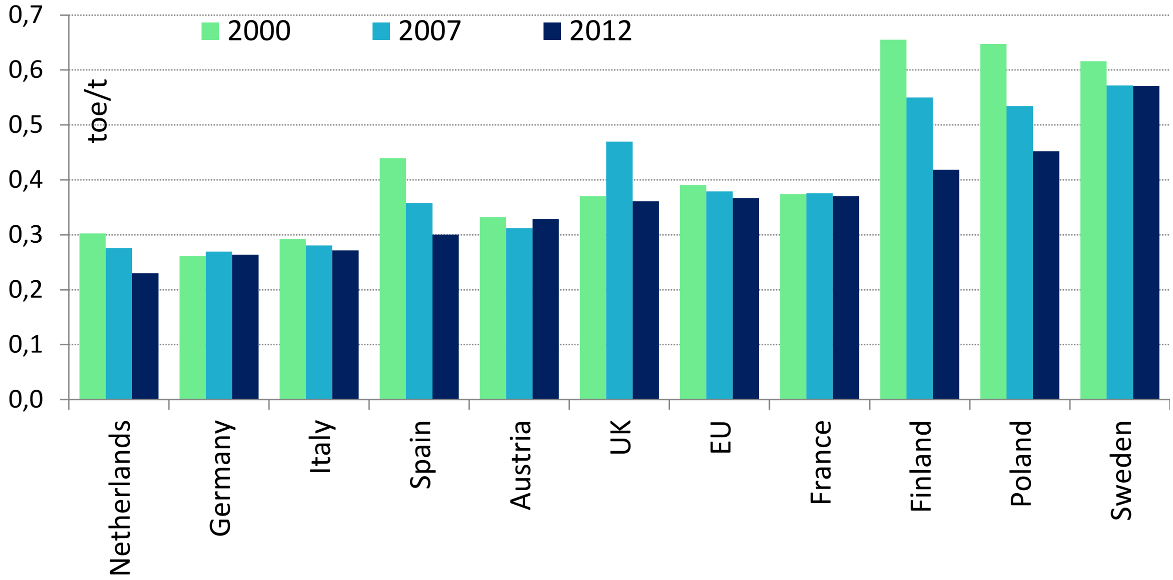
Source: ODYSSEE

The specific energy consumption per tonne of paper is generally decreasing

The energy consumption of pulp, paper and printing per tonne of paper has been generally decreasing in almost all countries since 2000 (-0.5%/year at EU level over the period 2000-2012) (Figure 16). Finland and Spain experienced the largest reduction, by more than 3%/year since 2000.

Differences among countries depend on the level of pulp production. Countries which are exporting pulp, such as Sweden and Finland, have the highest values.

Figure 16: Trends in the energy consumption per tonne of paper8



Source: ODYSSEE

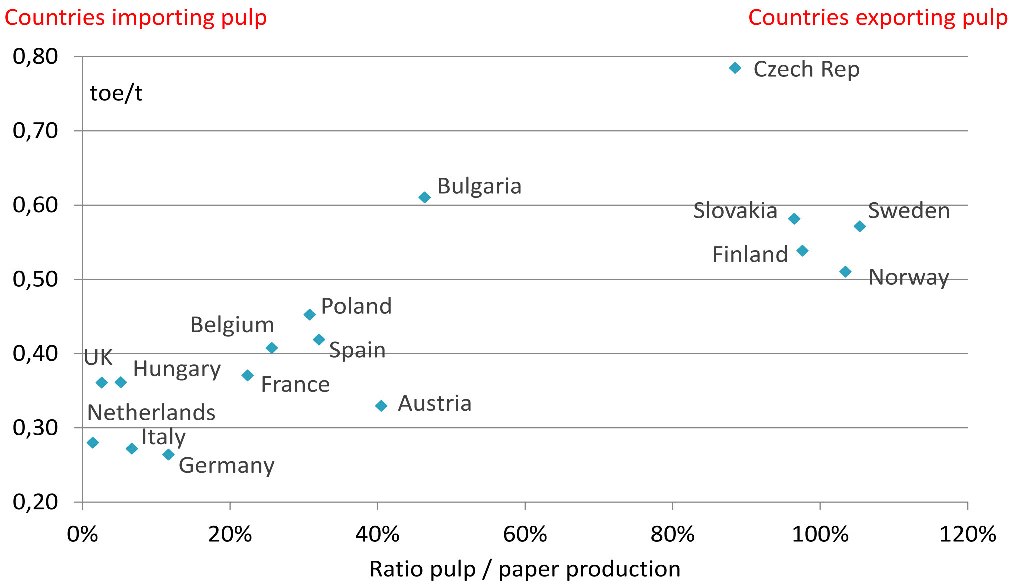
The energy performance of pulp and paper depends on the production of pulp

To explain the differences observed in Figure 16, it is necessary to take into account how the paper is produced. Paper is produced from raw pulp or from recycled paper. Pulp production[9] is energy-intensive. The pulp used in a given country may be produced in the country itself or be imported from other countries. If it is imported, this means that the energy consumption for pulp production has taken place in the exporting countries. Therefore, the energy performance of the paper industry of a given country is linked to the share of pulp produced in the country in relation to the paper production: the higher this ratio, the higher the specific consumption per tonne of paper. Energy efficiency performance can only be benchmarked among countries with a similar ratio of pulp/paper production. In countries exporting a large production of pulp (i.e. Finland, Sweden and Norway), Norway has the best performance: this may is due to a higher penetration of electricity use (around 60% in Norway, compared to 30% in Finland and Sweden), partly linked to a higher production of mechanical pulp.

[8]Only countries with a production over 2 Mt are shown.

[9]Pulp includes chemical and mechanical pulp.

Figure 17: Specific energy consumption in the pulp and paper industry10



Source: ODYSSEE

Energy efficiency has improved by 1.4%/year in industry in the EU since 2000.

Energy efficiency progress in the industry sector as a whole is measured in ODYSSEE with an index called ODEX that is calculated by weighting trends in the specific energy consumption indices of 14 individual branches[11]; for each branch, the weight used is their share in the total industry consumption including the three energy intensive branches (steel, cement and pulp & paper) for which the trends have been presented above.

As it is based on specifc energy consumtion in physical units, ODEX captures the energy efficiency development better than traditional energy intensities per unit of value added. For some branches, however, the trends shown include also some non-technical changes, especially, in the chemical industry, the shift to light chemicals such as pharmaceuticals, due to the fact that this sector is not sufficiently disaggregated.

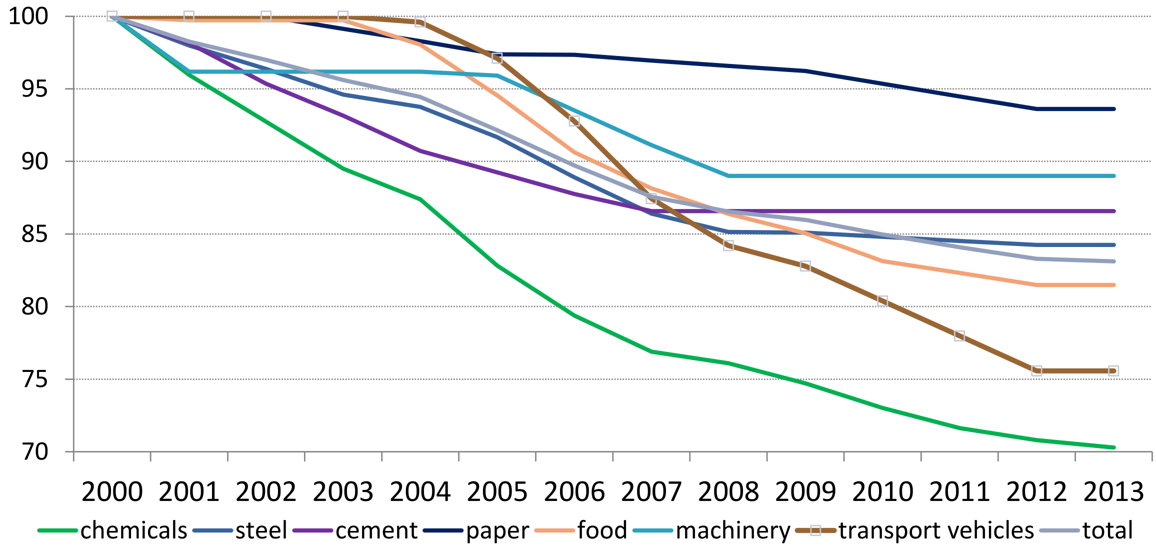
The average energy efficiency progress in industry, as measured by the rate of decrease of ODEX, has been 1.4%/year on average since 2000 (-17%)(Figure 18).

There has been a much slower energy efficiency progress since the recession in 2007 (0.9%/year from 2007 to 2013 compared to 1.9%/year from 2000 to 2007), because of a slower progress in most branches and even no more energy efficiency improvement for some of others (e.g. steel, cement, machinery).

[10] Specific energy consumption per tonne of paper produced.

[11]The 14 branches include the 3 energy intensive branches (steel, cement, pulp & paper) and 9 other manufacturing branches (chemicals, food, textiles, machinery, transport equipment, wood, other metals, other non-metallic minerals and others), mining and construction. Specific consumption is measured in toe per unit of production index for these other branches.

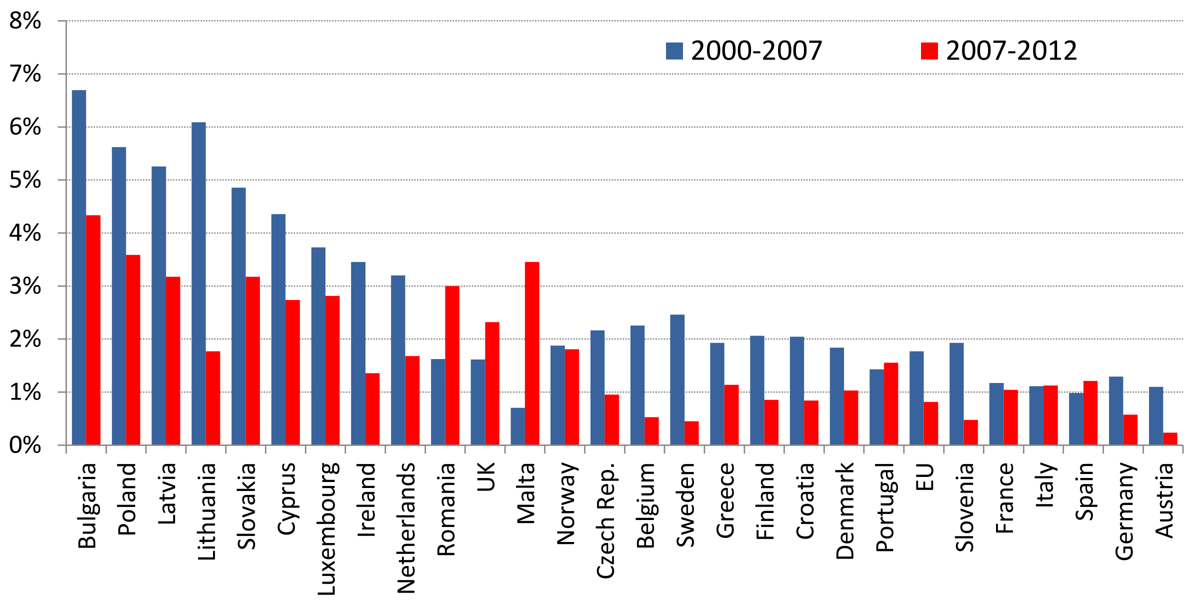
Figure 18: Energy efficiency index in industry (EU)



Source: ODYSSEE

Energy efficiency improved quite unevenly across countries over the period 2000-2012: from above 4%/year in Bulgaria, Lithuania, Poland and Estonia; in a range of 2 to 4% in 6 countries (e.g. Cyprus, Romania, The Netherlands, Norway, UK and Latvia). As for the EU as a whole, a deterioration of energy efficiency is observed since 2007 in almost all countries due to the recession (Figure 19).

Figure 19: Energy efficiency trends in industry in EU countries12 (%/year)



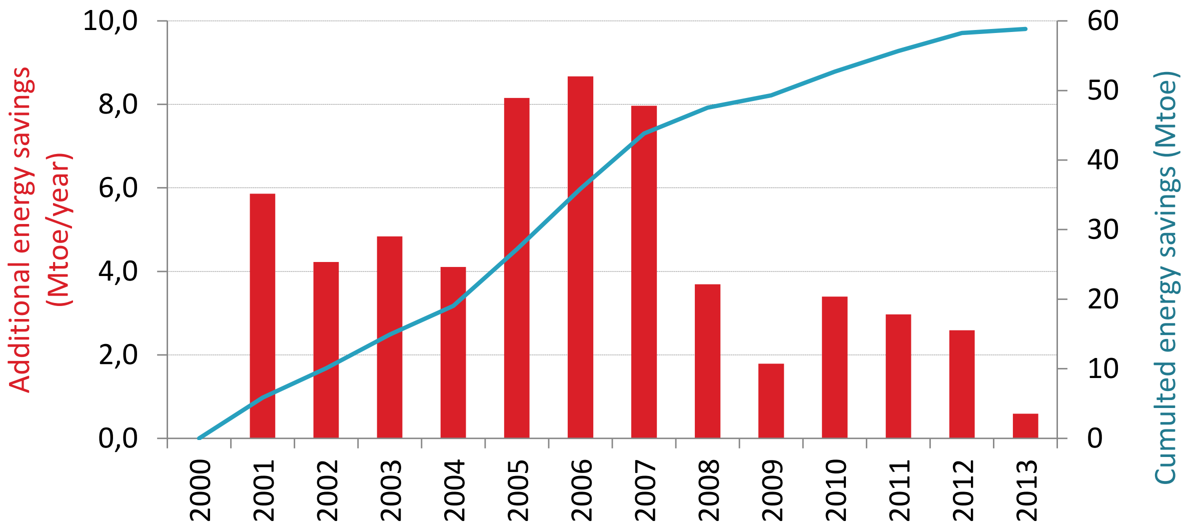
Source: ODYSSEE

[12] Based on ODEX

The annual additional volume of energy savings has been divided by 2 since 2007

The energy efficiency progress resulted in energy savings that reached 60 Mtoe in 2013 for the industry sector compared to 2000: without energy efficiency improvement, energy consumption would have been higher by 60 Mtoe. The annual volume of energy savings in industry has more than halved since 2007 from an average of 6.3 Mtoe/year over 2000-2007 to 2.5 Mtoe/year over 2007-2013 (Figure 20).

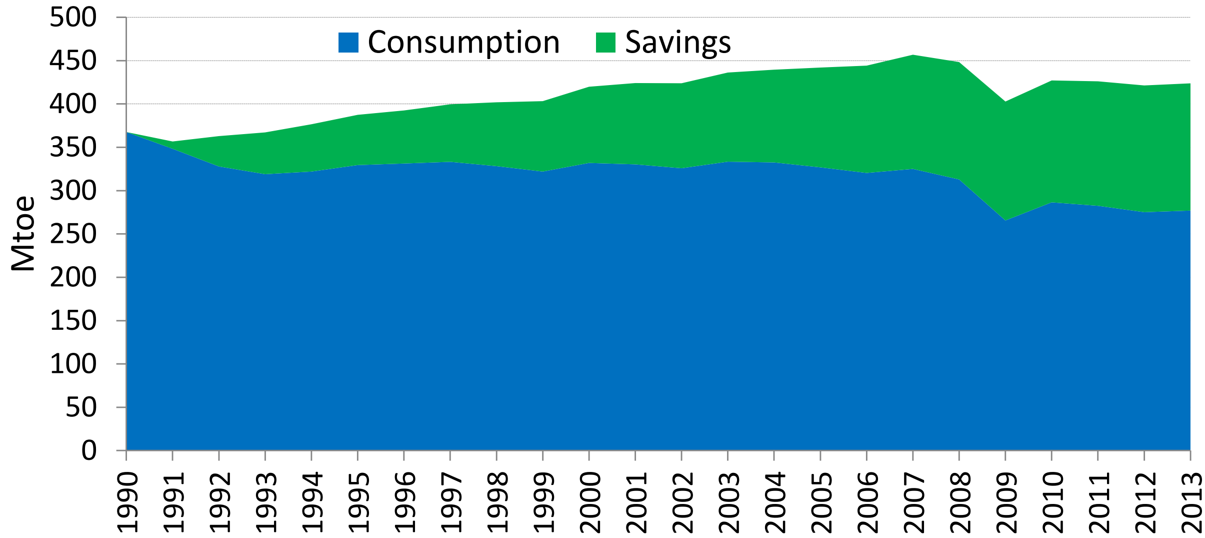
Figure 20: Energy savings in industry (EU)



Source: ODYSSEE

In 2013, energy savings in industry reached around 150 Mtoe compared to 1990: without energy efficiency improvement, energy consumption would have been higher by 150 Mtoe (Figure 21).

Figure 21: Energy consumption and energy savings in industry (EU

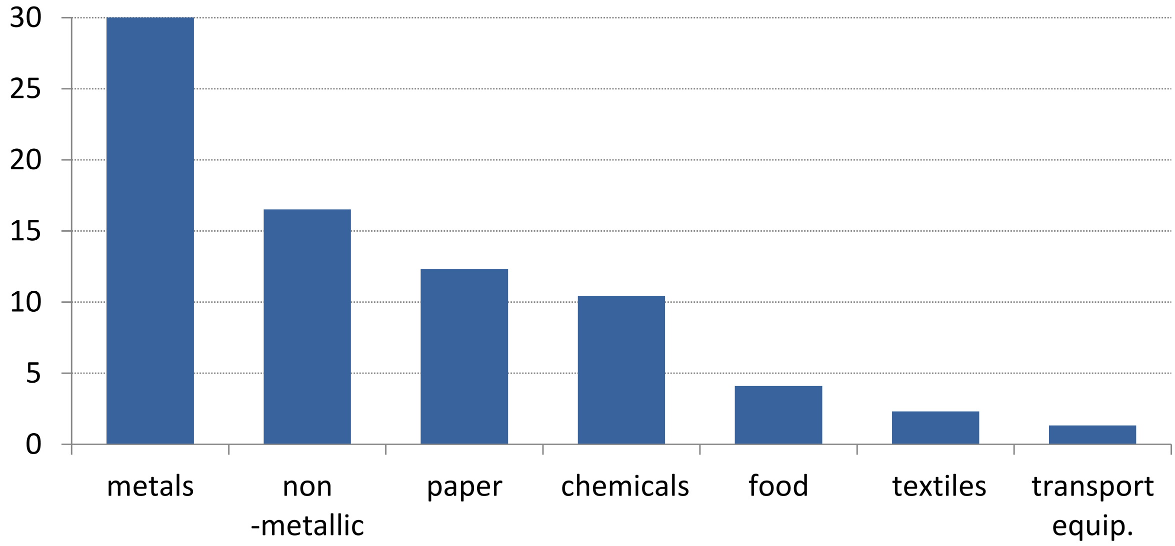


Source: ODYSSEE

1.3. IMPACT OF STRUCTURAL CHANGES

Industrial branches do not have the same energy intensity. Manufacturing is much more intensive than construction, which requires only negligible quantities of energy per unit of value added. In manufacturing, primary metals and non-metallic minerals require for instance 30 and 17 times more energy to produce one unit of value added than machinery, which is the least energy-intensive branch; paper and chemicals are respectively 12 and 10 times more energy intensive than machinery (Figure 22).

Figure 22: Energy intensities of manufacturing branches (machinery =1) (2012)



Source: ODYSSEE

If the share of construction in total industry value added is increasing, this will reduce, all things being equal, the average energy intensity of industry. This trend was significant before the economic crisis, especially in countries like Spain. In the same way, if the share of machinery is increasing in the total value added of manufacturing, this will reduce, all things being equal, the average energy intensity of manufacturing. Such reduction in energy intensity have nothing to do with energy efficiency but are caused by changes in the structure if industrial activity, the so called “structural changes”.

The assessment of the impact of these structural changes on the total intensity of industry or manufacturing can be done by comparing the variation in the observed energy intensity with a fictive intensity at constant structure[13]: the greater these structural changes, the wider the gap between these two intensities

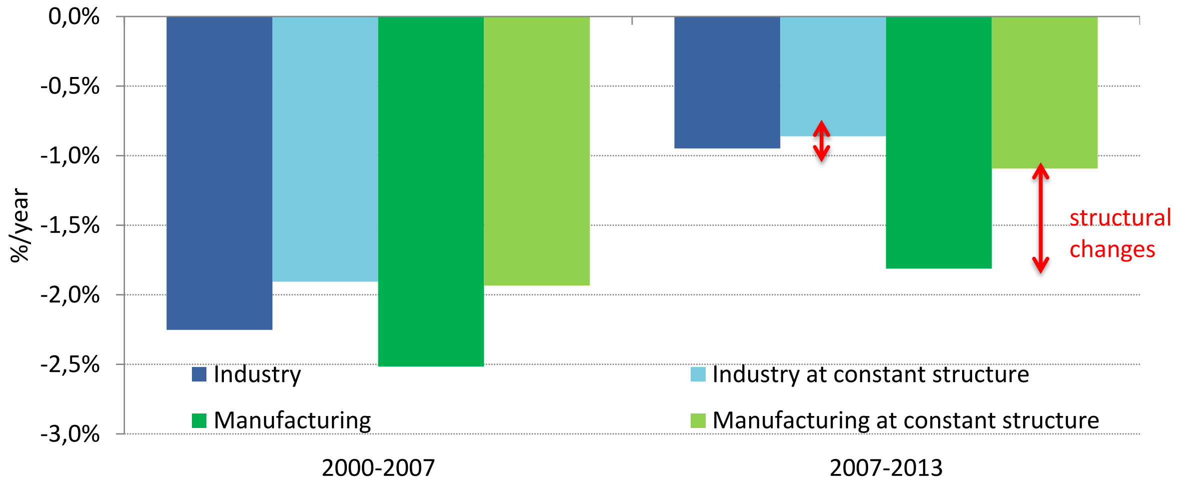
Since 2007, the contraction of the activity of construction has slowed down the decrease in the intensity of industry

Since 2007, the reduction of the intensity of industry as a whole was twice faster than for manufacturing (respectively 0.9%/year for industry and 1.8%/year for manufacturing) (Figure 23). This trend is mainly explained by the strong recession in construction (-3.3%/year between 2007 and 2013 for the value added) and

[13]The intensity at constant structure is calculated using the Divisia method at the level of 12 branches for manufacturing and 14 branches for industry as whole, using a moving reference structure (that of the previous year).

the increasing share of manufacturing, the energy intensive part of industry in the total valued added of industry (from 64% in 2007 to 66% in 2013).

Figure 23: Intensity trends and structural changes in industry and manufacturing (EU)



In the EU, energy intensive industrial branches have been hit more severely than other branches by the economic crisis: their share in the total valued added has decreased by 1.4 points[14] between 2007 and 2012, while the share of the least energy intensive branches (equipment[15] and food) increased by 1.5 points (0.7 and 0.8 points respectively) (Figure 24).

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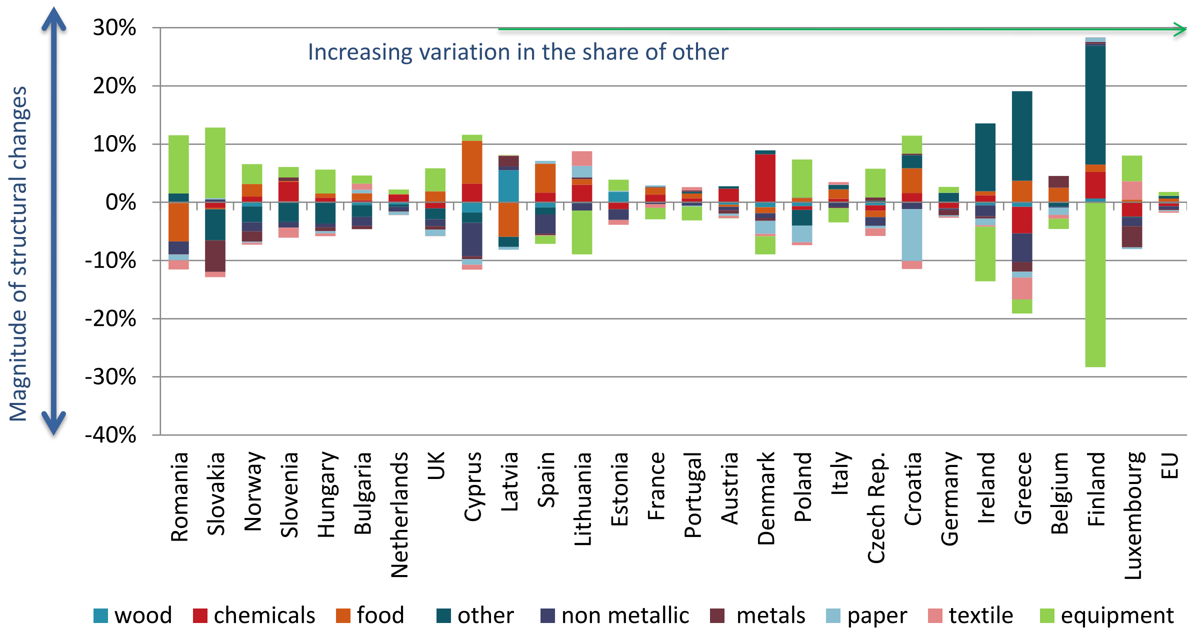
[14] Of which chemicals and non-metallic -0.5 points each and metal and paper by 0.2 points each.

[15] Equipment includes the production of fabricated metals, machinery and transport equipment.

Figure 24: Changes in the value added structure of manufacturing16 (2007-2012)



Source: ODYSSEE

Structural changes to less energy-intensive branches were significant in 10 countries.

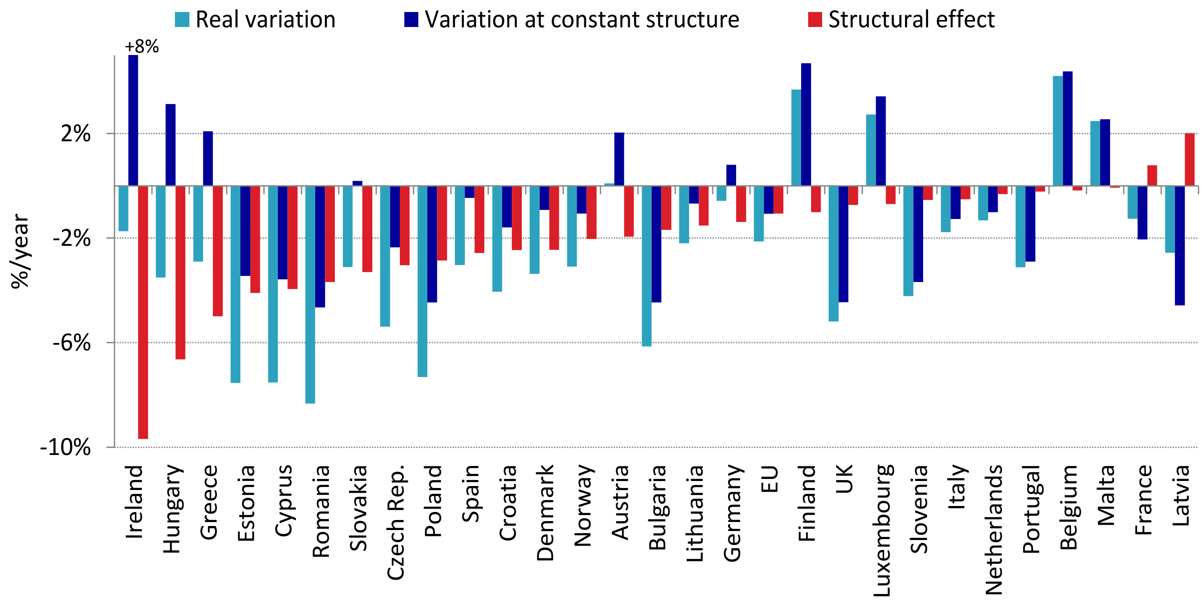
These structural changes towards less intensive branches had a significant impact as they contributed to 40% of the decrease in the intensity of manufacturing over 2007-2012 (Figure 25). At industry level structural changes were however marginal over the period because structural changes in manufacturing were offset by the decreasing share of construction in industry value added.

Since 2007, structural changes were quite significant in 10 countrieswhere they explain more than 60% of the intensity decrease from 2007 to 2012: Ireland, Hungary, Greece, Slovakia, Spain, Croatia, Denmark, Norway, Lithuania and Germany.

In three countries (Bulgaria, The Netherlands and UK), there was an increase in the contribution of energy-intensive branches (non-metallic minerals in Bulgaria and chemicals in The Netherlands and UK).

[16]This graph shows the variation in the share of each branch in the total value added of manufacturing industry: a value of +1% for instance indicates that the share of the branch increased by 1 points in the total value added. The sum of the variation is by definition equal to 0, as the total structure is equal to 100 %; therefore the bars are symmetrical along the horizontal axis. The larger the bars, the greater the structural changes.

Figure 25: Impact of structural changes in manufacturing on energy intensity (2007-2012)



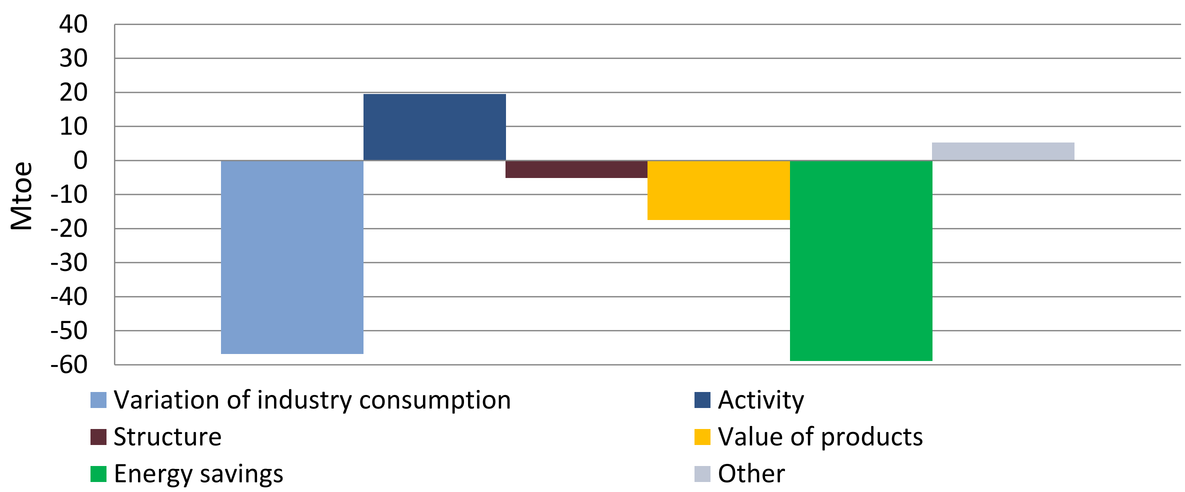
Source: ODYSSEE

1.4. DRIVERS OF ENERGY CONSUMPTION VARIATION

Energy savings explained most of the decrease in industrial since 2000

The energy consumption of industry in the EU has decreased by 57 Mtoe between 2000 and 2012, which is almost equivalent to the energy savings achieved (Figure 27). The moderate industrial growth only contributed to increase consumption by 20 Mtoe, all things being equal. This effect was almost completely balanced by the increasing value of production (higher value added per unit of production). Structural effects towards less energy intensive branches had a marginal effect, as explained above.

Figure 26: Drivers of the industry's energy consumption variation (2000-2012)



Source: ODYSSEE: decomposition facility17

[17] http://www.indicators.odyssee-mure.eu/decomposition.html

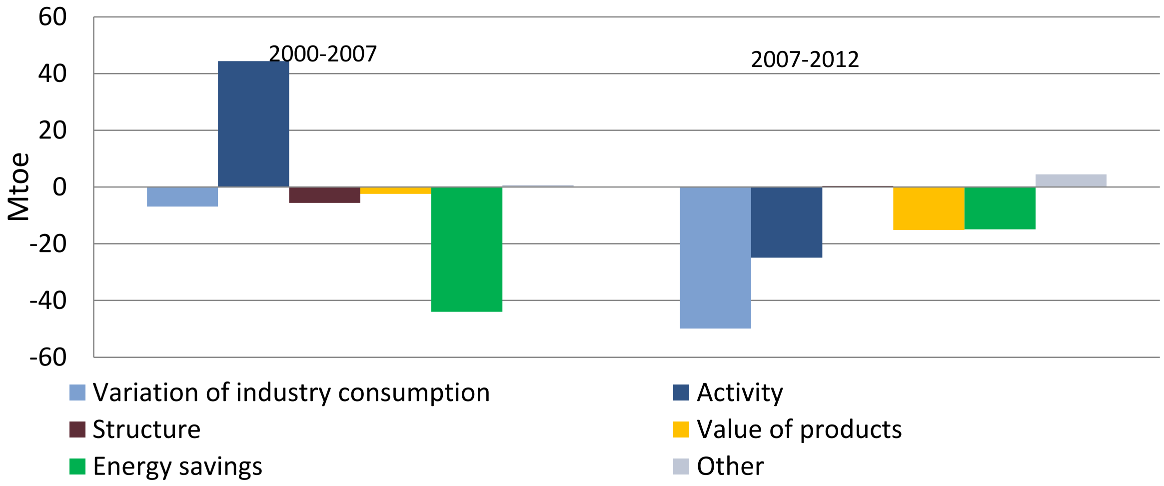
More than half of the reduction in consumption since 2007 linked to the decrease in industrial activity and one fourth to energy savings

Since 2007 most factors contributed to decrease industrial energy consumption: more than half of the 50 Mtoe consumption reduction between 2007 and 2012 is explained by the industrial recession and the rest equally by energy savings and higher production value Figure 27).

Energy savings had a much lower impact since 2007 (2.5 Mtoe/year compared to 6.3 Mtoe/year over 2000-2007).

Between 2000 and 2007, the stability of consumption was the result of the balance between the activity effect and energy savings of 44 Mtoe each.

Figure 27: Drivers of industry consumption variation: before and after the crisis



Source: ODYSSEE decomposition facility18

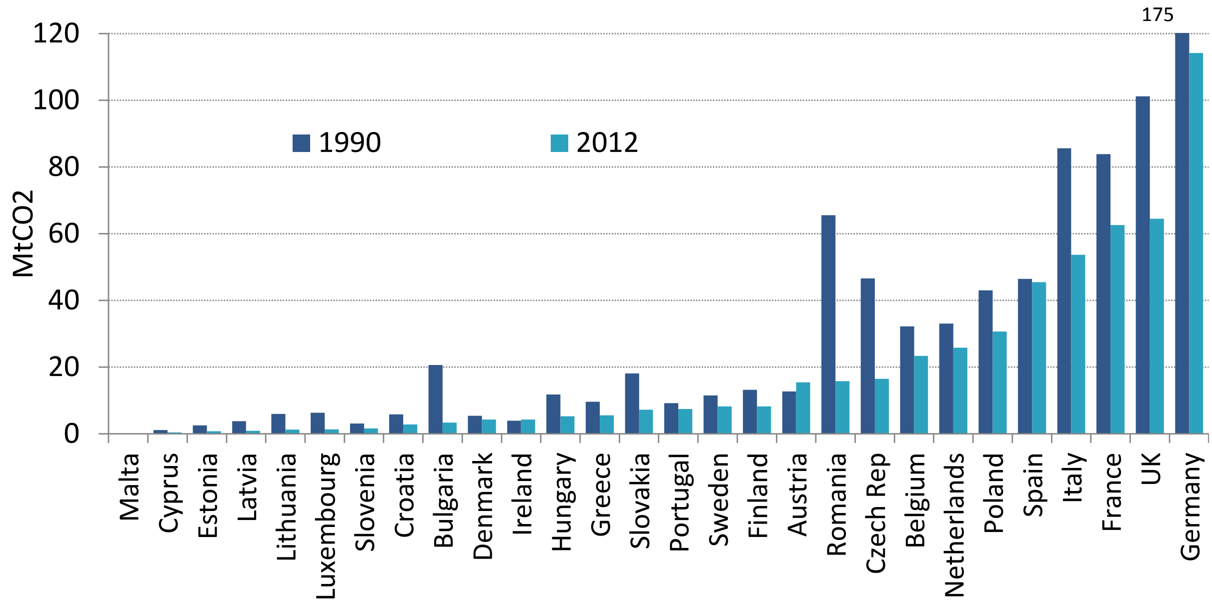
1.5. CO_2 EMISSIONS

Direct CO_2 emissions from industrial combustion of fossil fuels (oil, natural gas and coal) have decreased in all countries since 1990, except in Ireland, Austria and Malta[19]. There was a strong reduction by up to 50-80% in most new EU member countries, except in Poland(Figure28). For the EU, the reduction in CO_2 emissions reached 38%.

[18]http://www.indicators.odyssee-mure.eu/decomposition.html

[19] Emissions do not have the same boundaries as final energy consumption: emissions from the combustion of fuels used for own generation of electricity are included in industry but excluded from the final consumption.

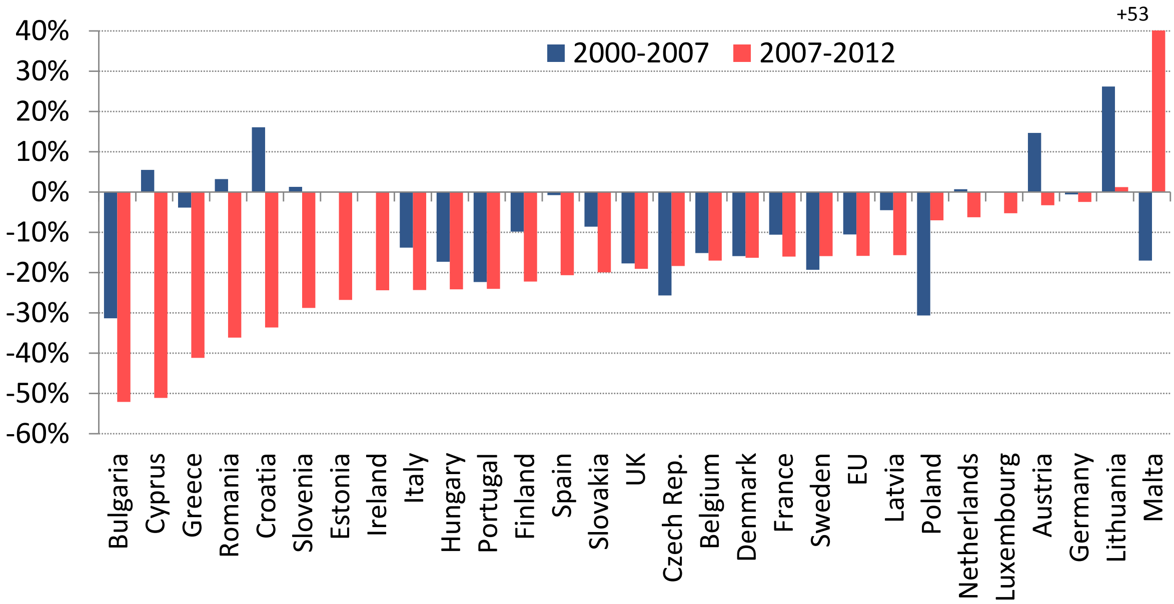
Figure28: CO_2 emissions of industry from fuel combustion



Source : EEA

Since 2000, a large part of the decrease in CO_2 emissions is explained by the economic crisis and took place since 2007 (60% of the whole variation between 2000 and 2012 at EU level). In 6 countries (Cyprus, Greece, Ireland, Romania, Slovenia and Spain), all the decrease of CO_2 emissions took place since 2007 (Figure 29).

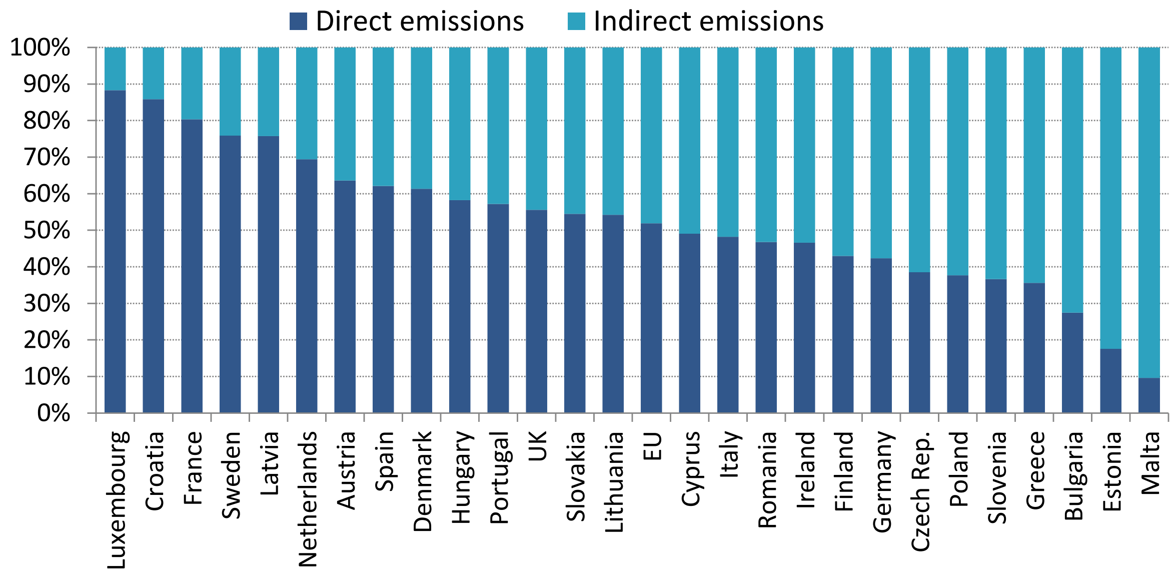
Figure 29: CO_2 emissions of industry from fuel combustion (%)



Source: EEA

In the EU as a whole, indirect emissions corresponding to the emissions in power generation induced by the electricity purchased by industry[20], are of the same magnitude as direct emissions in 2012 (Figure 30). There exist large differences among countries in the share of these indirect emissions in total emissions depending on the power mix (58% in Germany, but only 20% in France). At EU level indirect emissions represent slightly less than half of total emissions.

Figure 30: Share of direct and indirect CO2 emissions (2012)



Source: ODYSSEE based on EEA data

[20] Indirect emissions are based on an allocation of emissions of the electricity sector to industry in proportion to its share in electricity consumption.

2. OVERVIEW OF ENERGY EFFICIENCY POLICIES IN THE INDUSTRIAL SECTOR

The MURE database distinguishes between EU-related and national policies. Industry-related EU Directives and voluntary programmes at the level of the EU constitute in total 10 measures (Table 1).

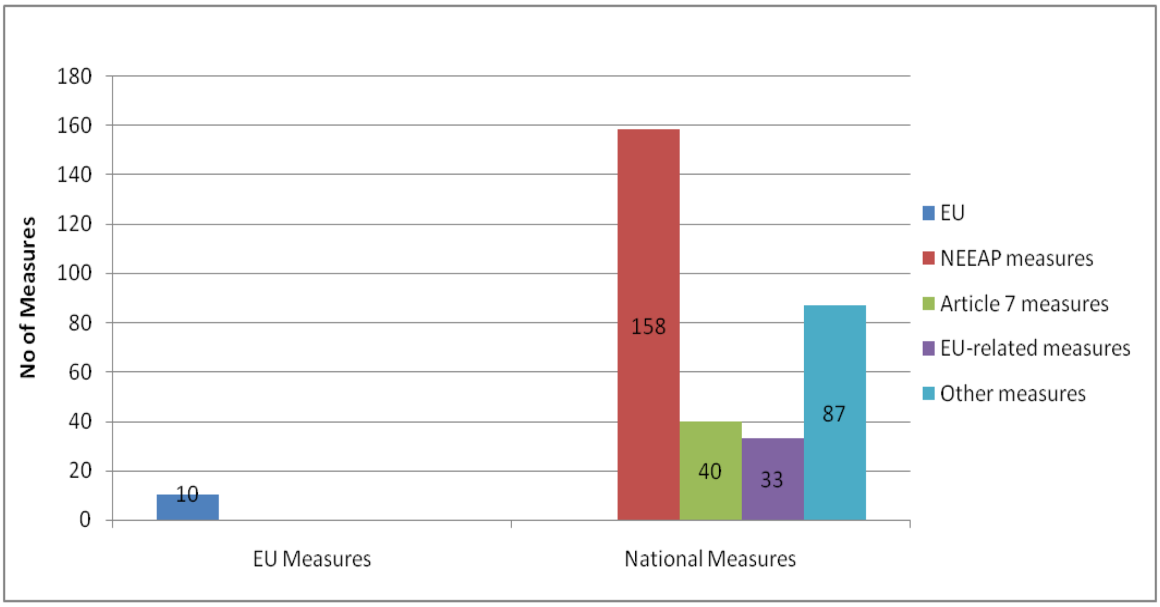
Table 1 : EU measures for industry in MURE

Title	Status	Type	Starting Year
Voluntary labelling of electric motors (CEMEP/EU Agreement)	Completed	Co-operative Measures, Information/Education/Training	2000
Motor Challenge Programme	Ongoing	Information/Education/Training	2002
E2MAS	Unknown	Legislative/Informative	2003
EU Emission Trading Scheme (2003/87/EC)	Ongoing	New Market-based Instruments	2003
Community framework for the taxation of energy products and electricity (Directive 2003/96/EC)	Ongoing	Fiscal/Tariffs	2003
Combined Heat Power (Cogeneration) (Directive 2004/8/EC)	Completed	Legislative/Normative	2006
Efficiency reference values for electricity and heat production	Ongoing	Legislative/Normative	2007
European Green Light Programme	Ongoing	Co-operative Measures	2007
Integrated Pollution Prevention and Control IPPC (Directive 2008/1/EC)	Completed	Legislative/Informative	2008
Amended EU Emission Trading Scheme (Directive 2009/29/EC)	Ongoing	New Market-based Instruments	2012

Source: MURE database, August 2015

An overview of the total number of industrial measures in MURE is given in Figure 31.The major portion of the national measures are NEEAP measures which were published by the Member States, mandated under the Directives ''Energy end-use efficiency and energy services'' of 2006 (2006/32/EU) and ''Energy efficiency directive'' of 2012 (2012/27/EU ; EED). In addition, 40 measures have been reported under the Article 7 of the Energy Efficiency Directive[21].

Figure 31: Overview of industry measures in MURE



Source: MURE database, June 2015

[21] Article 7 of Directive 2012/27/EU provides that either energy efficiciency obligations or alternative measures (or a combination of both) should be introduced by the Member States in order to achieve the 1.5 % annual energy savings target (also see Chapter 2.1.2).

2.1. POLICIES AT THE EUROPEAN LEVEL

This chapter discusses the most important European energy efficiency policies and measures in the industrial sector. These both include Framework Directives such as EU emissions trading scheme and voluntary agreements and programmes at the EU level.

2.1.1. EMISSIONS TRADING DIRECTIVES

EU emissions trading scheme (ETS) is basically governed by two Framework Directives i.e. Directive 2003/87/EC and Directive 2009/29/EC. The EU ETS is the world's largest emissions trading system and the first of its kind for CO_2 emissions trading. When it was first introduced, the EU ETS covered about 50% of Europe's CO_2 emissions and 40% of its total greenhouse gas emissions.

Member States were mandated to ensure that from January 1st, 2005, no installation commence any activity mentioned in directive 2003/87/EC resulting in emissions specified in regards to that operation unless its operator holds a permit issued by a responsible authority. The responsible authority issues a GHG emissions permit granting allowance to emit greenhouse gases from the installation.

For the three-year period beginning January 1st, 2005, each Member State was to make a decision about the total quantity of the allowances it would allocate for that period and the allocation of those allowances to the operator of each installation. For the five year period starting January 1st, 2008 and for each subsequent five year period, each member state would decide about the total quantity of the allowances it would allocate for that particular period and commence the process for the allocation of those allowances to the operator of each installation. According to the amended Directive 2009/29/EC, the Community-wide quantity of allowances which are issued each year starting in 2013, decreased in a linear fashion starting from the mid-point of the period from 2008 to 2012. The quantity shall decrease by a linear factor of 1.74 % compared to the average annual total quantity of allowances issued by Member states in compliance with the Commission Decisions on their national allocation plans for the period from 2008 to 2012. The box below shows two country examples for the national implementation of the EU-ETS.

BOX 2.1: EMISSIONS TRADING DIRECTIVE – EXAMPLES FOR NATIONAL IMPLEMENTATION

Austria Allocation Plan for Emissions Trading

The Austrian allocation plan for emission trading, the National allocation plan 2 for the period 2008-2012 provides for a reduction of CO_2 emissions by approximately 200 participating Austrian installations from the energy and industry sectors of about 7.43 million tonnes per year (or 19.5 %) compared to the figures of the expected trend for 2008-2012. A reserve share of 1 % (0.31 million certificates per year) as well as an auction share of 400,000 certificates are deducted from the total allocation quantity amounting to 30.73 million certificates per year. The quantity allocated to existing plants free of charge thus amounts to about 30.02 million allowances.

Cyprus National Allocation Plan 2008-2012

Cyprus under EU ETS was required to prepare National allocation plan (NAP) for setting out allocations of CO_2 emissions for the period 2008-2012. Allowances totalling 35.46 Mt CO_2, of which 29.67 million were made available over the second trading period to the 13 installations covered by the Directive, 4.63 million to the new entrants and 1.15 million were dedicated for the renewables. 20.47 Mt CO_2 (57.74%) were allocated to the three installations in the power sector over the 5-year period considering the increased use of more efficient generation unit of the Electric authority of Cyprus. A further 7.83 Mt CO_2 (22.08% of the total) was allocated to the two cement manufacturing installations. 1.37 Mt CO_2 (3.86%) was allocated to eight installations manufacturing bricks and tiles, taking into account the need to increase capacity to meet increasing demand from the Cyprus construction sector. A further allocation of 4.63 Mt CO_2 had been placed in the New Entrants' Reserve and was made available for the companies that either entered Cyprus' energy market or established new industrial installations that fell under the scope of emissions trading directives.

2.1.2. ENERGY EFFICIENCY DIRECTIVE

The Energy Efficiency Directive 2012/27/EU (EED) repealed both the Energy Services Directive (2006/32/EC) and the CHP Directive (2004/8/EC) on 4th December 2012. The EED establishes a common framework of measures for the promotion of energy efficiency within the Union in order to ensure the achievement of the 2020 20% target on energy efficiency and to pave the way for further energy efficiency improvements beyond that date. The energy efficiency target is that the Union's energy consumption should not exceed 1 474 Mtoe primary energy consumption or 1 078 Mtoe of final energy consumption in 2020. With the accession of Croatia the target was revised to 1 483 Mtoe primary energy consumption or 1 086 Mtoe of final energy consumption. The requirements laid down in the Directive are minimum requirements and it is not to prevent any Member State from introducing more stringent measures. However, such measures should be compatible with the Union law.

The EED addresses the industrial sector as well, both specifically and within cross-cutting provisions (see Box 2.2). The EED entered into force on 4 December 2012. For the transposition into national law, the Member States had a transposition period of 18 months, i.e. until 5 June 2014. The progress on transposing the Energy Efficiency Directive is examined by the European Commission in all Member States. Up to June 2015, 27 Member States (all except Malta) have received a letter of formal notice for failing to fully transpose the Directive by the June 2014 deadline (EU Commission 2015). So far, the Commission issued eight reasoned opinions to Member States where full transposition was still not achieved (Austria, Portugal, Bulgaria, Croatia, Ireland, Romania, Latvia and Germany) and has referred two Member States to EU Court of Justice for failing to transpose the Energy Efficiency Directive (Hungary and Greece).

BOX 2.2: PROVISIONS FOR THE INDUSTRIAL SECTOR IN THE EED

Specific provisions for the industrial sector

Energy audits (Article 8)

Article 8 of the Directive contains provisions about mandating the member states for a quality energy audit and the implementation of energy management system. Large enterprises are required in accordance with the directive, to carry out the first audit by 5th December 2015 and then atleast after every four years from the date of last audit. Large companies are required to make audits of their energy consumption to help them identify ways to reduce it (for more details see Chapter **Erreur ! Source du renvoi introuvable.**).

Cross-cutting measures with relevance to the industrial sector

Energy efficiency obligation schemes (Article 7)

Article 7 of EED requires Member States to put in place Energy Efficiency Obligation schemes (EEOs) and/or use alternative policy measures to deliver a targeted amount of energy savings amongst final energy consumers. The energy savings to be achieved by EEOs and/or alternative measures must be at least equivalent to achieving new savings each year from 1 January 2014 to 31 December 2020 of 1.5% of the annual energy sales to final consumers of all energy distributors or all retail energy sales companies by volume averaged over the previous three consecutive years where data is available. Both EEOs and alternative measures can also include measures delivering energy savings in the industrial sector. Up to now, only 2 countries (Denmark and Poland) rely solely on an energy efficiency obligation scheme. A total of 13 countries have reported to combine energy efficiency obligation schemes with additional policy measures (The Coalition for Energy Savings 2014). The other countries will only use other policy measures as authorised by the Directive, the so called “alternative policies”.

Other provisions

- The provision of the Cost/Benefit analysis also mandates the Member States to ensure that a cost-benefit analysis is carried out after 5th June 2014 when an industrial installation with a total thermal input exceeding 20 MW and is generating waste heat at a useful temperature level is planned or substantially refurbished, in order to assess the cost and benefits of utilizing the waste heat to fulfil economically justified demand, including through cogeneration, and of the connection of that installation to a district heating and cooling network
- Article 16 about qualification, accreditation and certification schemes encompasses that when a member state finds that the national level of technical competence, objectivity and reliability is insufficient, it should then ensure that by 31st December 2014, certification and/or accreditation schemes and/or similar qualification schemes including adequate training programmes are available for providers of energy services, energy audits, energy managers.
- The horizontal provision about information and training includes that Member States are to ensure that the information on existing energy efficiency mechanisms and financial and legal frameworks is transparent and widely disseminated to all the relevant market stakeholders, such as consumers, builders, architects, engineers, environmental and energy auditors, and installers of building elements.
- Energy services’ provision encompasses that Member States shall promote the energy services market and access for SMEs to this market by disseminating clear and easily accessible information on available energy service contracts, financial instruments, incentives, grants and loans to support energy efficiency service projects

2.1.3. ECO-DESIGN DIRECTIVE

The Eco-design Directive for energy-related products (Directive 2009/125/EC) was adopted on 21 October 2009. It is a Framework Directive which is implemented by regulations given by the Commission and by voluntary agreements with the manufacturers.

Several products which are covered by implementing decrees are utilized on the commercial scale and have therefore impact in the industrial sector as shown in the Table 2. However, in some product groups and in some countries the minimum requirements are equal to or very close to the market averages meaning that they do not change much and more stringent regulations are needed to induce market changes.

Table 2: Products being covered by the Eco-design directive

Product Groups	Preparatory Study Completed	Regulation (Enforced from)	Impact Assessment	Sector allocation		
				Industry	Services	Household
Lot- Simple Set Top Boxes	yes	25.01.2010	published			x
Lot 1 Boiler and Combi-boiler	yes	02.08.2013	published	x	x	x
Lot 2 Water Heater/Boiler	yes	02.08.2013	published		x	x
Lot 3 PCs and Computer Monitors	yes	26.06.2013	published		x	x
Lot 4 Imaging Devices	yes		published			
Lot 5 Consumer Electronic: Television	yes	07.01.2010	published			x
Lot 6 Standby and (off-mode) Losses	yes	07.01.2010	published			
Lot 7 External Power Supply Units	yes	27.4.2010	published			
Lot 8 Office Lighting	yes	13.4.2010		x	x	
Lot 9 Street Lighting	yes	13.4.2010		x	x	
Lot 10 Air Conditioner	yes	30.03.2013	published			x
Lot 10 Small Fans	yes	30.03.2013	published			
Lot 10 Ventilation Systems	yes					
Lot 11 Electric Motors (0,75kW - 200kW)	yes	27.01.2009	published	x		
Lot 11 Circulation Pumps	yes	01.01.2013	published	x	x	
Lot 11 Fans	yes	01.01.2013	published	x		
Lot 11 Water Pumps	yes	01.01.2013	published	x		
Lot 12 Commercial Refrigerator- and Freezers	yes					
Lot 13 Household Refrigerators and Freezers	yes	01.07.2010	published			x
Lot 14 Household Dishwashers	yes	01.12.2011	published			x
Lot 14 Household Washing Machines	yes	01.12.2011	published			x
Lot 15 Small Plants combusting Solid Fuels	yes					
Lot 16 Clothes Dryer	yes	03.10.2012	published			x
Lot 17 Vacuum Cleaner	yes	08.07.2013	published			
Lot 18 Complex Set top boxes	yes	voluntary	published			
Lot 19 Household Lighting: non-directional	yes	01.09.2009	published		x	x
Lot 19 Household Lamps. "Reflector Lamps"	yes	01.01.2013	published		x	x
Lot 20 Local Room Heating Products	yes					
Lot 21 Central Heating Products	yes					
Lot 22 Household and Commercial Ovens	yes	20.02.2014				
Lot 23 Hobs and Grills	yes	20.02.2014				
Lot 24 Washing Machines, Dryers Commercial	yes					
Lot 25 Coffee Machines for non-Commercial Purposes	yes					
Lot 26 Linked-up Standby-Losses	yes	22.08.2013				
ENTR Imaging Systems in Medicine	no					
ENTR Lot 1 Refrigerators and Freezers	yes					
ENTR Lot 2 Transformers	yes	21.05.2014	draft			
ENTR Lot 3 Devices for Sound and Image Processing	yes					
ENTR Lot 4 Combustion Plants and Ovens	yes					
ENTR Lot 5 Machine Tools	yes					
ENTR Lot 6 AC and Ventilation Systems > 12kW	yes					

Relevance
Very high (>10%)
High (5-10%)
Medium (1-5%)
Low (<1%)
Per definition excluded
No data

Source : Compilation by Fraunhofer ISI

The product groups which have substantial relevance for the industrial sector i.e. medium and above and have Implementing Regulations in force are:

- Electric motors (0.75 kW and 200 kW), Reg # 640/2009 and Reg # 4/2014;

- Lot 1: Boiler and Combi-boiler, Reg # 813/2013;
- Lot 8 and Lot 9: Office lighting and Street lighting, Reg # 245/2009 and Reg # 347/2010
- Circulators, Reg # 641/2009 and Reg # 622/2012;
- Water pumps, Reg # 547/2012;
- Air conditioners and comfort fans, 206/2012 of 25 June 2012;
- Fans, Reg # 327/2011;
- Lot 2: Transformers, Reg # 548/2014

2.1.4. RENEWABLE ENERGY DIRECTIVE

The Directive 2009/28/EC covers (large scale) renewable energy production, as part of the energy supply sector, as well as (small scale) production at the end-users place. For industry, the Directive contains a few provisions such as including the consumption of other energy from renewable sources in industry in calculating the gross final consumption of energy from renewable sources for heating and cooling in a member state. This renewable production decreases the delivery of (fossil) energy through the grid, in the same way as energy savings do.

Article 14.3 of the Directive requires Member States to ensure that certification schemes or equivalent qualification schemes are were in place for installers of small-scale renewable technologies by 31 December 2012. They also need to recognize each other's certification. Information must be given on the certification/qualification schemes a list of certified/qualified installers may be published.

There are also other provisions for information dissemination. Guidance must be available for planners, architects and other relevant actors, so they are able to plan for and design the optimal combination of renewable energy, energy efficiency, district heating and cooling for new and renovated industrial and residential buildings and areas. The countries shall develop suitable information, awareness-raising, guidance and/or training programmes for citizens about the benefits and practicalities of acquiring and using renewable energy installations.

Box 2.3 gives a country example for a measure addressing the use of renewable energies in industrial production processes.

BOX 2.3: DENMARK: RENEWABLE ENERGY FOR PRODUCTION PROCESSES (INDUSTRY)

In the political agreement of 22 March 2012 the Danish Parliament decided that renewable energy must account for 35 per cent of the final energy consumption in 2020. Due to domestic tax policy toward the industry, fossil fuels are less expensive than renewables and incentives to convert to renewable are absent. To compensate the industry a subsidy scheme have been set up to promote energy-efficient use of renewable energy in industrial production processes.

The new investment scheme will bridge the price gap between renewable and fossil fuels. The state subsidy scheme will support industries to convert to renewable energy sources or district heating:

- Replace fossil fuels with renewable energy
    - such as wind, solar, biogas or biomass
    - to power manufacturing processes.
- Replace fossil fuels by district heating e.g, horticulture will be able to change from coal-fired boilers to district heating.
- Invest in energy-efficiency measures.
- Replacing fossil fuels with Renewable Energy

  The first part of the scheme is investment aid for projects in businesses, replacing fossil fuels with renewable energy in production processes. The grants will support all forms of renewable energy, but most of the projects are expected to be converted to biomass e.g. a company rebuilds from coal to wood chips.
- Replacing fossil fuels by district heating

  The second part of the scheme is for businesses that replace fossil fuels with heating for process purposes. This could be a horticulture, which would scrap its own individual coal-fired plants and instead connect to district heating.
- Energy-efficiency measures

  The third part of the scheme involves support for energy efficiency improvements made in direct connection with the conversion to renewable energy or district heating. By providing investment aid for energy-efficient equipment, it will ensure that the projects are as energy efficient as possible.

Source : MURE database, June 2015.

2.1.5. INDUSTRIAL EMISSIONS DIRECTIVES

The Industrial Emissions Directive 2010/75/EU (repealing the Industrial Pollution Prevention Directive (2008/1/EC) covers industrial activities with a major pollution potential, defined in Annex I to the Directive (energy industries, production and processing of metals, mineral industry, chemical industry, waste management, rearing of animals, etc.). The Directive shall contain special provisions for the following installations:

- combustion plants (≥ 50 MW);
- waste incineration or co-incineration plants;
- certain installations and activities using organic solvents;
- installations producing titanium dioxide.

The Directive mandates that any industrial installation which carries out the activities listed in Annex I to the Directive should meet certain basic obligations such as:

- preventive measures are taken against pollution;

- the best available techniques (BAT) are applied;
- no significant pollution is caused;
- waste is reduced, recycled or disposed of in the manner which creates least pollution;
- energy efficiency is maximised;
- accidents are prevented and their impact limited;
- sites are remediated when the activities come to an end.

The Directive mandates the industrial installations for the use of the best available technologies to achieve a high general level of protection of the environment as a whole, which are developed on a scale which allows implementation in the relevant industrial sector, under economically and technically feasible conditions. The European Commission is responsible to adopt BAT conclusions containing the emission levels associated with the BAT. These conclusions will serve as a reference for the drawing up of permit conditions. The permit must provide for the necessary measures to ensure compliance with the operator's basic obligations and environmental quality standards. These measures should include at least:

- emission limit values for polluting substances;
- rules guaranteeing protection of soil, water and air;
- waste monitoring and management measures;
- requirements concerning emission measurement methodology, frequency and evaluation procedure;
- an obligation to inform the competent authority of the results of monitoring, at least annually;
- requirements concerning the maintenance and surveillance of soil and groundwater;
- measures relating to exceptional circumstances (leaks, malfunctions, momentary or definitive stoppages, etc.);
- provisions on the minimisation of long-distance or transboundary pollution;
- conditions for assessing compliance with the emission limit values.

Box 2.4 shows as an example the transposition of the Directive into UK law.

BOX 2.4: INTEGRATED POLLUTION CONTROL UK

In December 2010, the Directive on industrial emissions (integrated pollution prevention and control) (Recast) (2010/75/EU), was published in the Official Journal and was subsequently transposed into UK law in 2013. It represents a combining of seven directives, including the Waste Incineration directive, into one piece of legislation.

In the UK, the Pollution Prevention and Control Act 1999 provides powers to make regulations to implement the Directive, Regulations for England and Wales (The Pollution Prevention and Control (England and Wales) Regulations 2000) came into force on 1st August 2000 and the Environmental Permitting Regulations 2010 came into force on 10th March 2010. A parallel but separate system of IPPC is used in Scotland and enforced by the Scottish Environment Protection Agency, SEPA.

If an entity carries out an activity covered by the IPPC regime, it must have an IPPC permit from an environmental regulator or local council and comply with the conditions it contains. IPPC is divided into different categories in each part of the UK. In England and Wales it is divided into Part A(1), Part A(2) and Part B. Larger industrial installations are subject to integrated controls upon all likely significant emissions and are regulated by the Environment Agency, These are often referred to as "Part A(1)" activities. Local authorities regulate some 400, these are often referred to as "Part A(2)" activities. Smaller installations, some 19,000, are subject to controls on emissions to air and are regulated by more than 300 local authorities in England. These activities are often referred to as "Part B". In Northern Ireland it is divided into Part A, Part B and Part C. In Scotland it is divided into Part A and Part B.

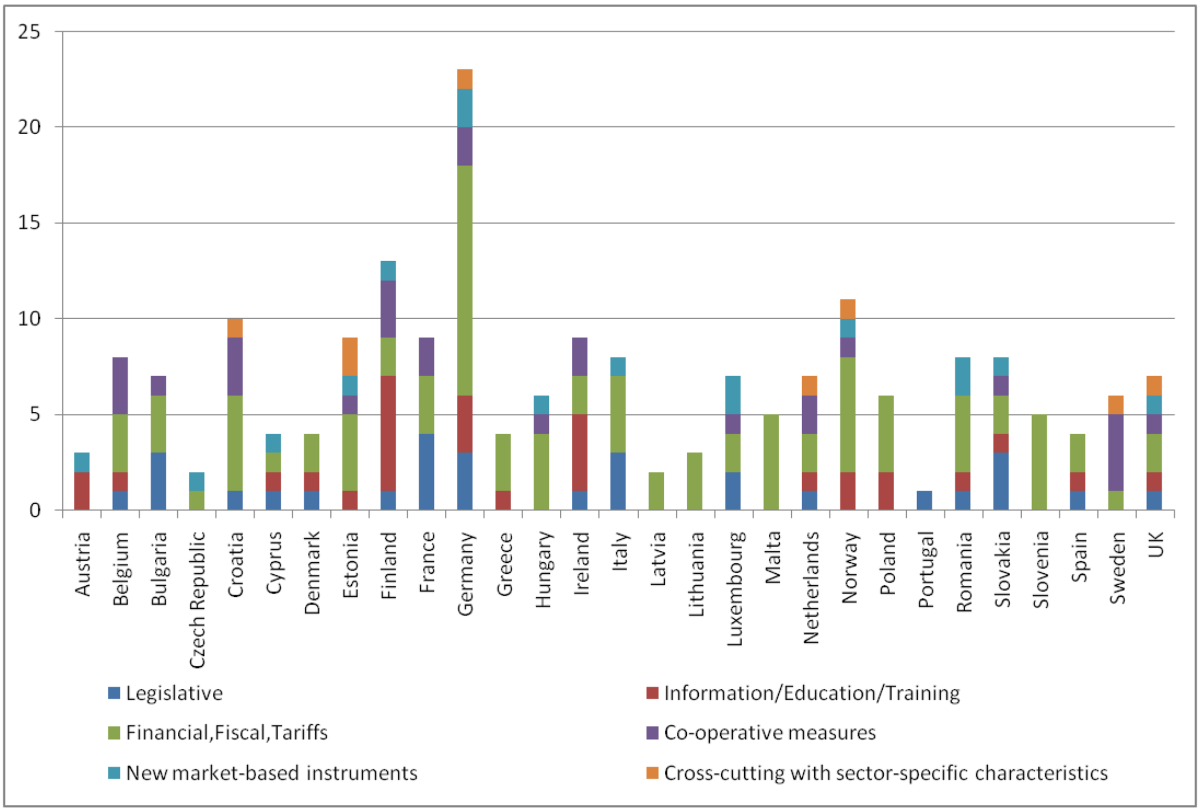
Source: MURE database, June 2015

2.2. OVERVIEW OF POLICIES BY MEMBER STATES

2.2.1. MEASURES BY TYPE

The MURE database contains around 320 measures in the industrial sector, out of which about two-third are in operation[22]. Economic measures, i.e. mainly financial and some fiscal measures, dominate in the industrial sector. Notable exception is Austria where the majority of measures are information/educational. These educational measures are also the second most common type of measures. Sweden is another exemption with a high share of co-operative measures. Most countries have also reported at least one new market-based instrument but there are a few countries which have not reported measures of this kind.

Figure 32: Ongoing measures by type and by country in industry[23]



Source : MURE database, June 2015

Energy efficiency improvements in industry are hindered by various barriers, each of which need to be addressed by different types of measures (for a more detailed discussion see Chapter 4.1). This is done best by developing a balanced policy mix which includes several types of measures. The adopted policy mix varies significantly from country to country (Figure 32). Only Germany and United Kingdom apply all types of measure

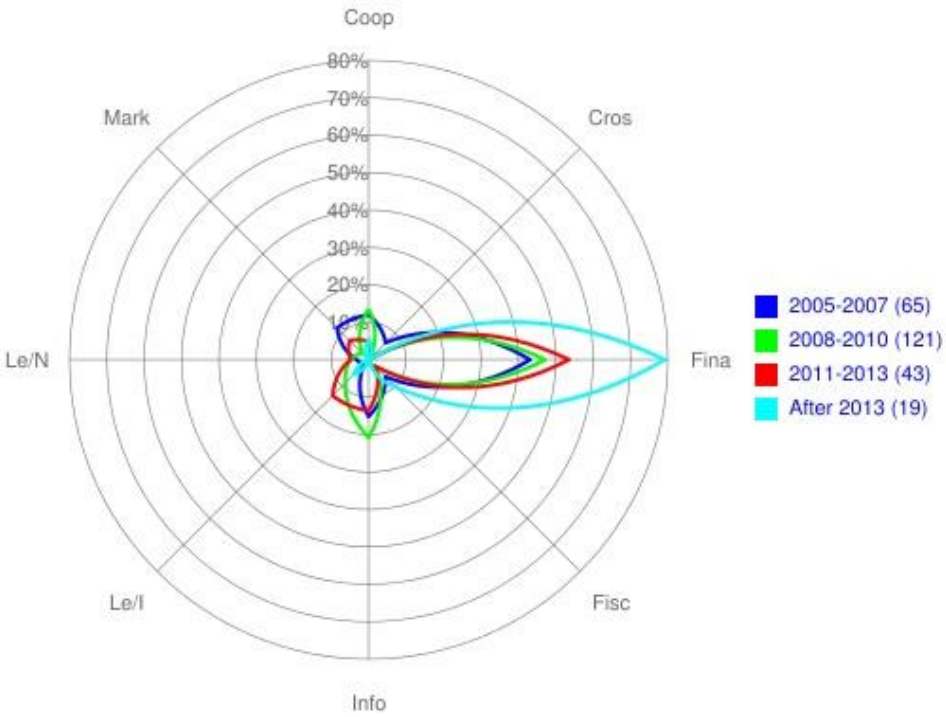
[22] As the number of measures is constantly evolving we can provided rounded numbers. As of 25th June 2015, the database contained 318 measures for industry, of which 199 were in operation. The others are either no longer applied or being planned.

[23] The Figure only includes ongoing measures. Some caution is needed while interpreting the pure number of measures because there is some variety in how countries package their measures. Some countries have reported larger packages of measures while others split them into several independent measures. Measures of "unknown measure type" are excluded.

in their energy efficiency policy mix for industry. Five more countries (Estonia, Finland, the Netherlands, Norway, and Slovakia) apply almost all measure types. About half of the countries implement co-operative measures. As many as twelve countries have not reported any information, education or training activities in industry at all.

Figure 33 shows the changes in policy mix over time. Financial measures have been in the core of the policy mix for industry over the last decade. Even after the financial and economic crisis from mid 2008, they were still dominating the policy mix and became even more important since 2013. Information measures are diverse measures ranging from information campaigns to voluntary energy audits and training. Their role has grown during the last years. Legislative and fiscal measures are less often implemented in industry, but there is a slight increase in legislative measures, driven both by national implementation of EU measures and by new national measures. When cross-sectoral measures in industry are analysed in more detail, energy and environmental taxes and pollution charges listed within this group of measures augment the relative importance of fiscal measures. EU Emissions Trading is an important market-based instrument applied in industry in all EU Member Countries.

Figure 33: Pattern of measures in industry by type and period of introduction



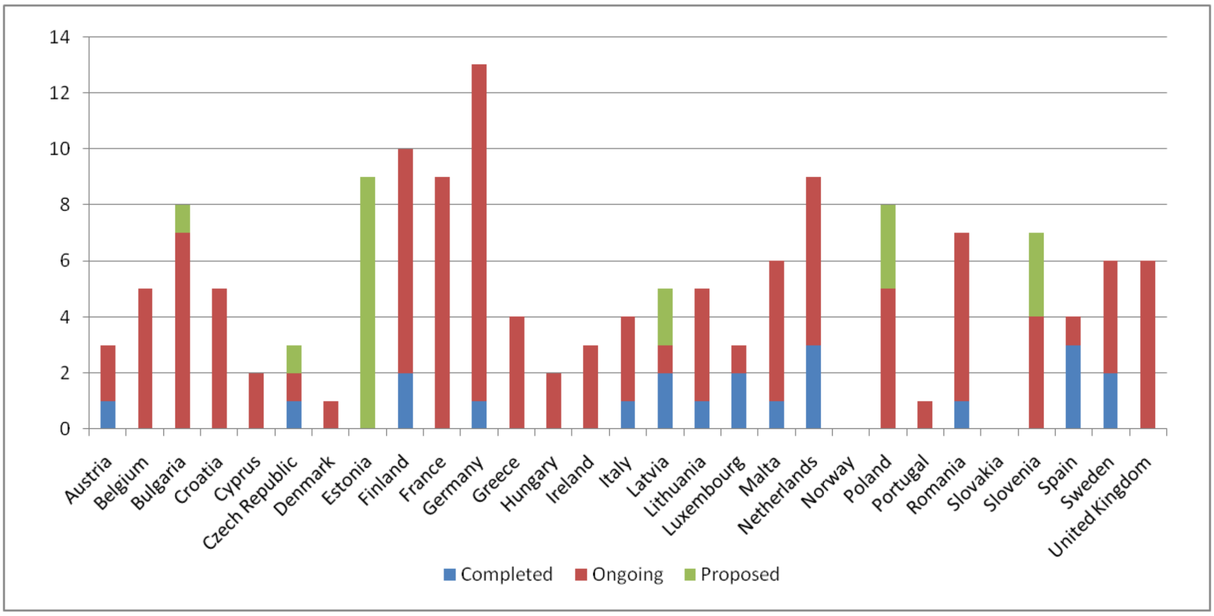
Legend:
Coop: Co-operative Measures (e.g. agreements among enterprises on energy efficiency)
Cros: Cross-cutting with sector-specific characteristics (e.g. eco-tax with reduced rates for the industry)
Fina: Financial (for e.g. subsidies for energy audits and efficiency investments)
Fisc: Fiscal/Tariffs (for e.g. tax deduction for energy saving investments in businesses)
Info: Information/Education/Training (for e.g. advice programs for industry, energy management systems)
Le/I: Legislative/Informative (for e.g. Mandatory execution of enery audits in large enterprises)
Le/N: Legislative/Normative (for e.g. CO2 emission fee for large emitters)
Mark: New Market-based Instruments (for e.g. Emission trading scheme)

Source: MURE database, June 2015

2.2.2. ROLE OF NEEAP MEASURES

NEEAP measures, i.e. measures reported in the NEEAP 1 and/or NEEAP 2 and/or NEEAP 3, constitute about 50% of the total measures in the industrial sector. In total, 158 NEEAP measures are included in the MURE database (as of 25th June 2015). Figure 34 depicts the distribution of NEEAP measures with respect to their status by individual countries. It shows that most of the measures reported in the NEEAP are already implemented and still ongoing. Only a few countries report planned measures.

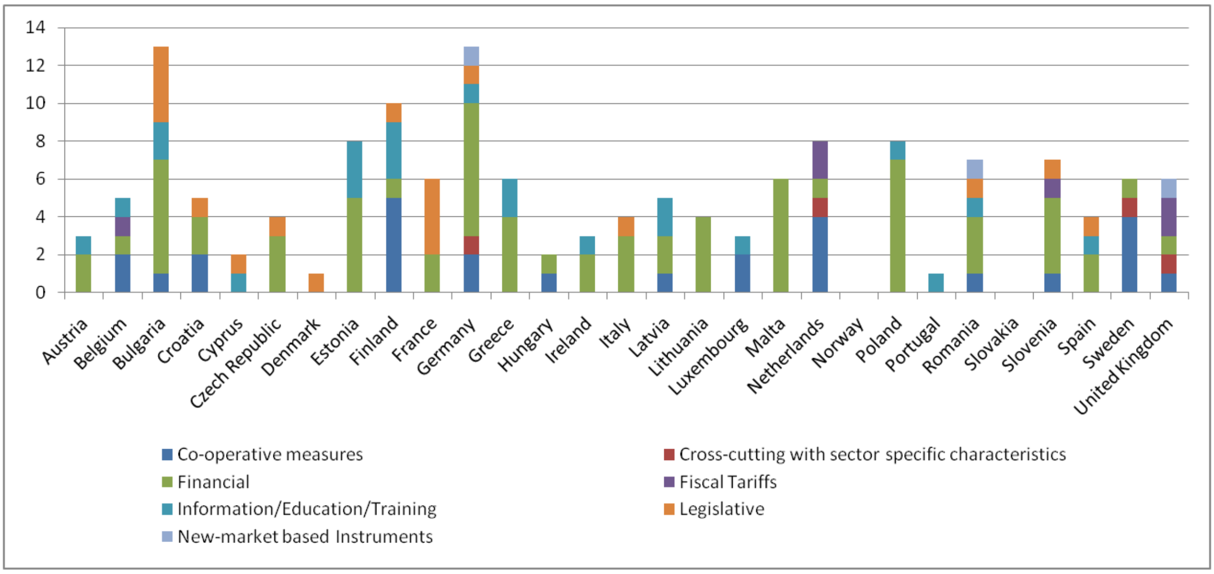
Figure 34: NEEAP measures by country and status



Source : MURE database, June 2015

With respect to the type, also in the NEEAP financial measures are the dominating instrument to improve energy efficiency in industry (Figure 35).

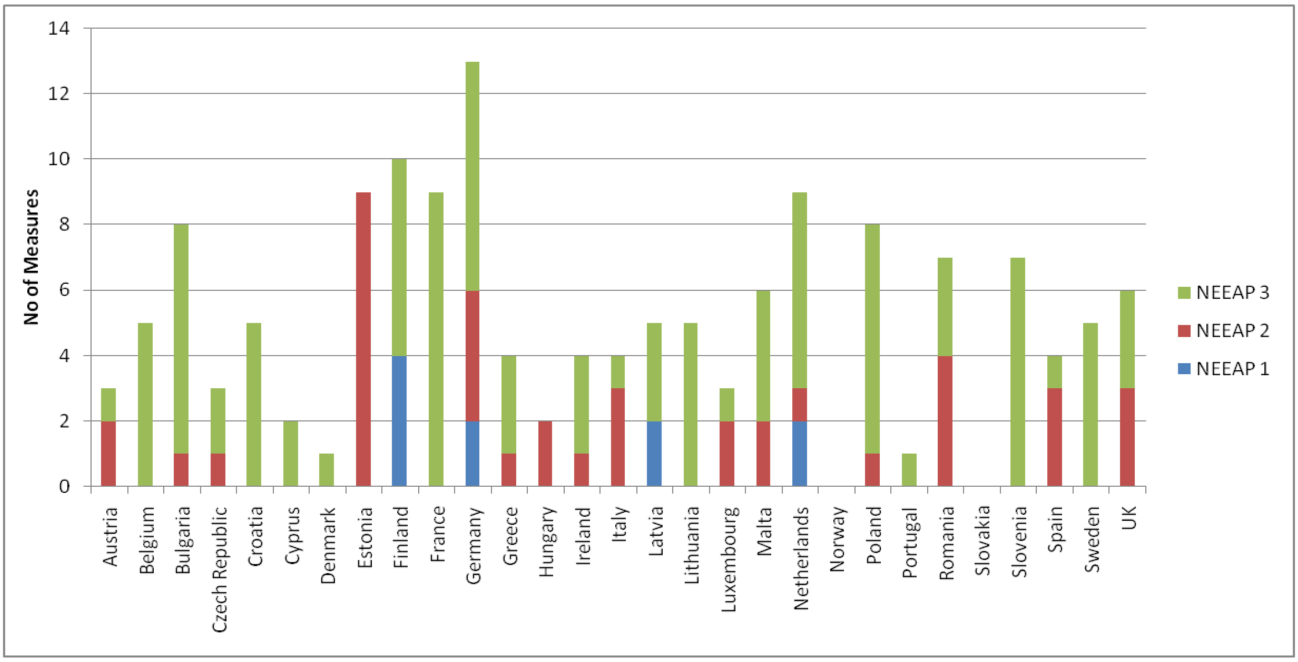
Figure 35 : NEEAP measures in industry by country and by type



Source : MURE database, June 2015

The distinction of NEEAP measures in NEEAP 1, NEEAP 2 and NEEAP 3 is shown in Figure 36. To avoid the repetition, a measure has been classified as the latest version of the NEEAP if it has also been reported in the earlier versions of the NEEAP. An overwhelming number of measures have been reported as NEEAP 3 measures. Therefore NEEAP 3 measures need aditional analysis. Estonia and Hungary have been the only countries which have not so far reported NEEAP 3 measures in the MURE database. Finland, Germany, Latvia and Netherlands have a few 1st NEEAP measures which were not continued in the 2nd and 3rd NEEAP.

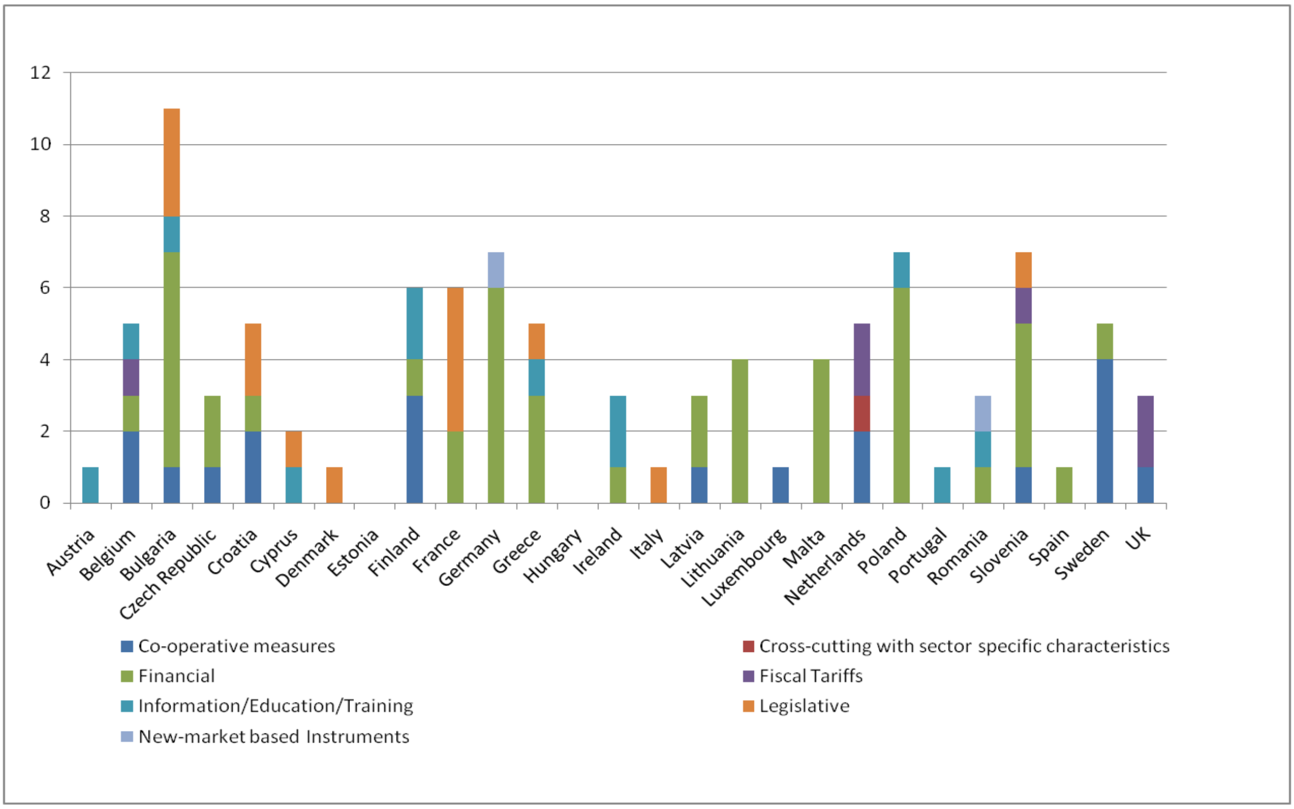
Figure 36: Distinction of NEEAP 1, 2 and 3 measures in industry



Source : MURE database, June 2015.

In the following, the NEEAP 3 measures are again shown according to their type (Figure 37). Financial measures still dominate, followed by co-operative measures. Only a few new-market based instruments have been reported as NEEAP 3 measures. Except for Netherlands, no country has reported any cross-cutting measure with sector specific characteristics in the NEEAP 3.

Figure 37 : NEEAP-3 measures in industry by country and by type

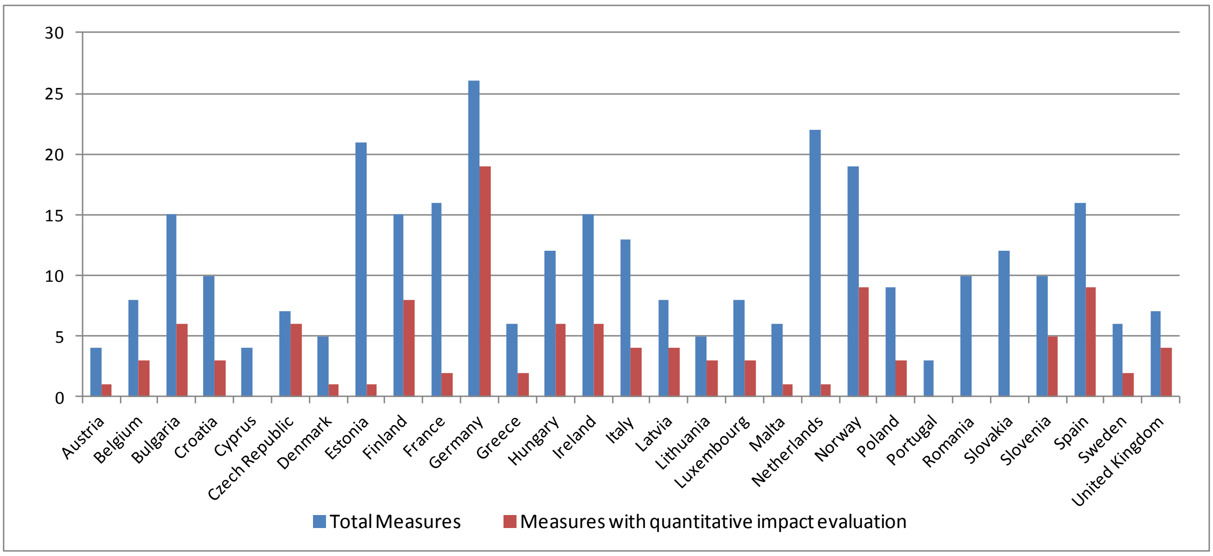


Source : MURE database, June 2015

2.2.3. MEASURES BY IMPACT

Out of the 318 measures contained in the MURE database for the industry sector, around 35% have a quantitative impact evaluation. For the 158 measures covered in one or more of the three NEEAP, this share is around 50%. Figure 38 depicts the availability of measures with quantitative impacts by country. The Czech Republic has the highest share of quantified measures (85%), followed by Germany (73%) and Finland (53%). Germany has the highest count of measures with quantified impacts (19), followed by Norway and Spain with 9 measures each. Cyprus, Portugal, Romania and Slovakia have no measure with quantified impact.

Figure 38: Measures with quantitative impact by country



Source: MURE database, June 2015

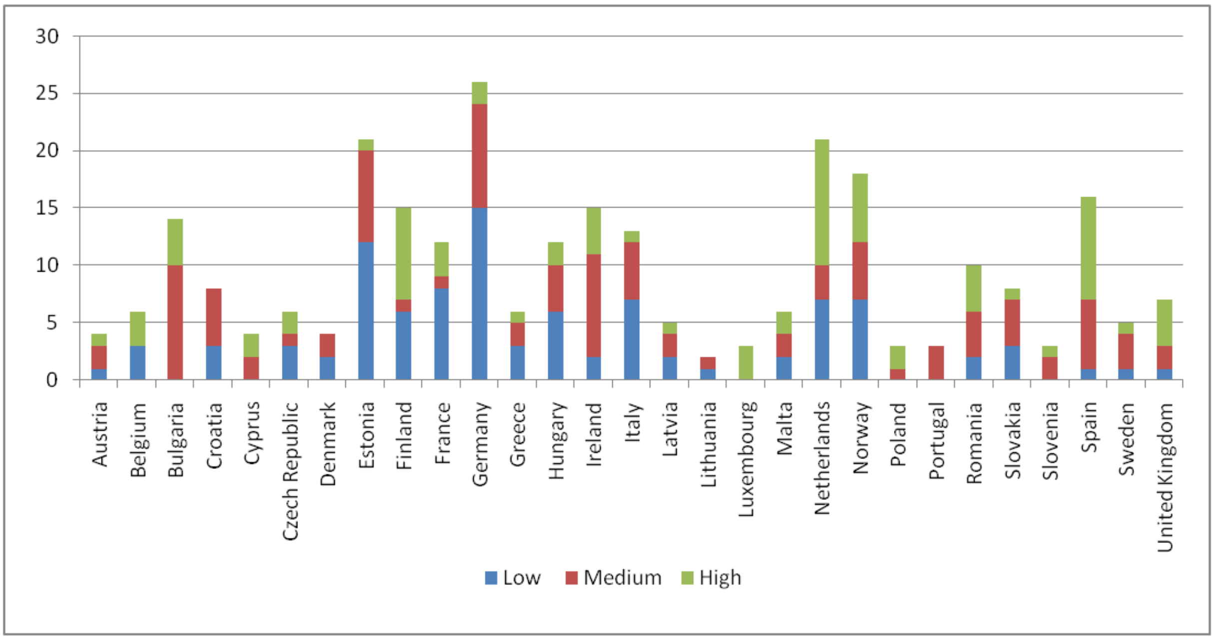
Besides the quantitative impact evaluation, measures are categorized in three levels of semi-quantitative impact (low, medium and high). The categorization is linked to the aggregate electricity or energy consumption of the sector (see Box 2.5).

BOX 2.5: DEFINITION OF THE SEMI-QUANTITATIVE IMPACT IN MURE

- In general: definition of the impact in terms of final energy. All electricity savings should be linked only to electricity consumption, all other savings (except for those involving fuel substitution and CHP) to the overall final energy consumption.
- Fuel substitution and CHP savings: the savings should be linked to the primary energy, calculated with a fixed factor of 2.5.
- The categories (low, medium, high) should be linked to the aggregate electricity or energy consumption of the sector to which the measure is assigned (households, transport, industry or tertiary), and not to a particular targeted end-use, because statistical data are often missing at the level of end-uses.
- The following limits (in each case in % of the overall electricity or final energy consumption of the respective sector; in case of fuel substitution and CHP: of primary energy consumption) are defined for the three impact levels:
    - low impact: <0.1%
    - medium impact: 0.1-<0.5%
    - high impact: ≥0.5%)

About 25% of all measures for the industry sector are rated as "high impact measures" on average. However, the share varies considerably within the countries (see Figure 39). Whereas in some countries, only a few (as in Estonia, Germany, Greece, Italy or Slovakia) or even no measure (as in Croatia, Denmark or Portugal) are rated as "high", in other countries the share is 50% or more (as in Finland, Luxembourg, the Netherlands and UK). For measures covered in at least one of the three NEEAP the share of measures rated as "high" is slightly higher on average (about 31%). However, when only taking into account NEEAP 3 measures, the share falls again to the average of 25%.

Figure 39: Measures with the semi-quantitative impact for each country

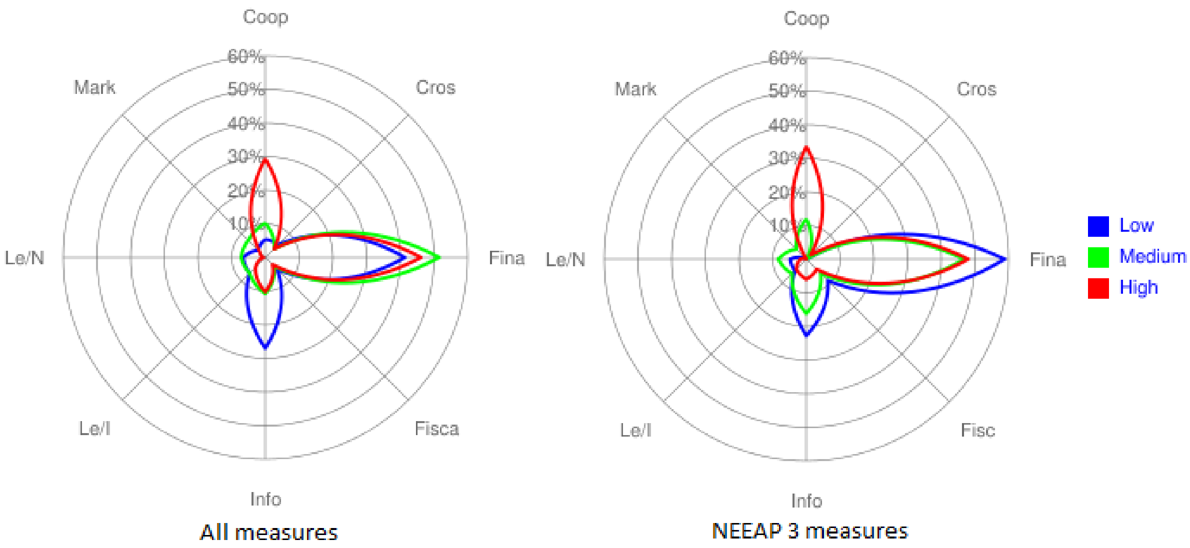


Source: MURE database, June 2015

Figure 40 shows that the most high rated measures in industry are "Financial" (Fina) or "Co-operative" (Coop) measures while measures rated as low are of a financial or informational (Info) type. Medium rated measures are mostly financial again. A similar distribution can be found for measures from the NEEAP 3. Low rated measures (21) are mostly financial or informational while high rated measures (26) are mainly co-operative or financial.

In total about 10% of all measures of the industry sector are EU-related (representing 7% of NEEAP 3 measures). Of those about 2% are rated as high impact measures (NEEAP 3: 1%), 4% are rated medium (NEEAP 3: 3%) and 3% are rated as low impact measures (NEEAP 3: 2%). So especially measures rated with a high impact are primarily national measures not related to an EU Directive at least in the industrial sector.

Figure 40: Levels of semi-quantitative impact evaluation by measure type



Legend: see Figure 33

Source: MURE database, June 2015

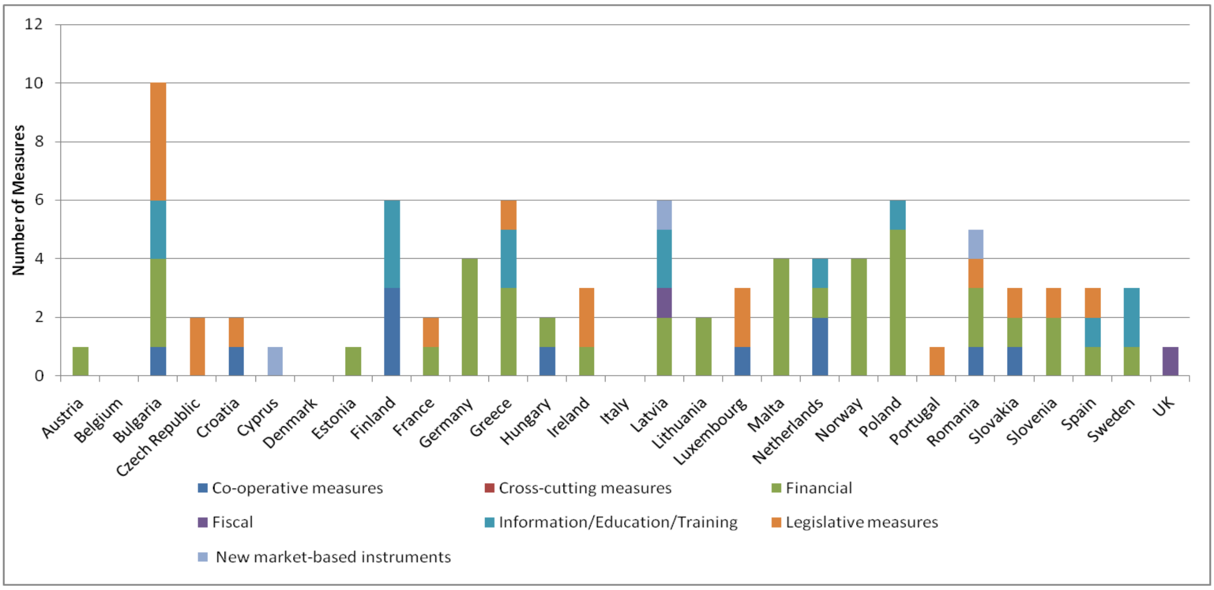
3. SPECIFIC POLICY ISSUES IN THE INDUSTRIAL SECTOR FROM A EUROPEAN AND NATIONAL PERSPECTIVE

3.1. DYNAMICS AND INNOVATION OF POLICY DEVELOPMENT IN THE INDUSTRIAL SECTOR

Possible impact of the economic crisis and the recovery on the policy mix

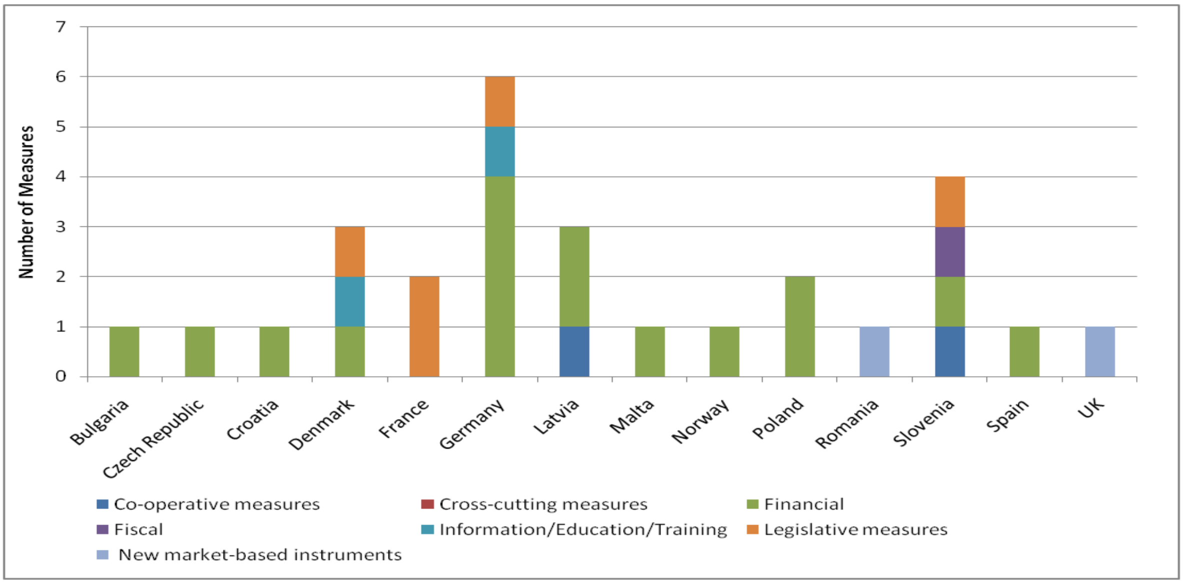
The recent economic and financial crisis, lasting from 2008 to2012, had a profound effect on the general policy making within Europe. Figure 41 below depicts how the energy efficiency policies were packaged by the different countries during this period. Those countries hardest hit Ireland, Portugal, Italy, Spain and Greece added merely one financial measure except for Greece which despite being well engulfed by the financial crisis added a few financial measures. Overall, financial measures represent 45% of all measures started during the financial crisis; i.e. even during this time the dominating role of financing still went on for the average of the EU countries. Measures implemented after the financial crisis, i.e over 2013-2015, have been packaged by several countries in an order depicted in Figure 42, with a further increasing share of financial measures as in the years before (55%).

Figure 41: Measures added during the economic crisis (2008-2012) by type



Source : MURE database, June 2015

Figure 42: Measures added since 2013 (after the financial crisis)



Source : MURE database, June 2015

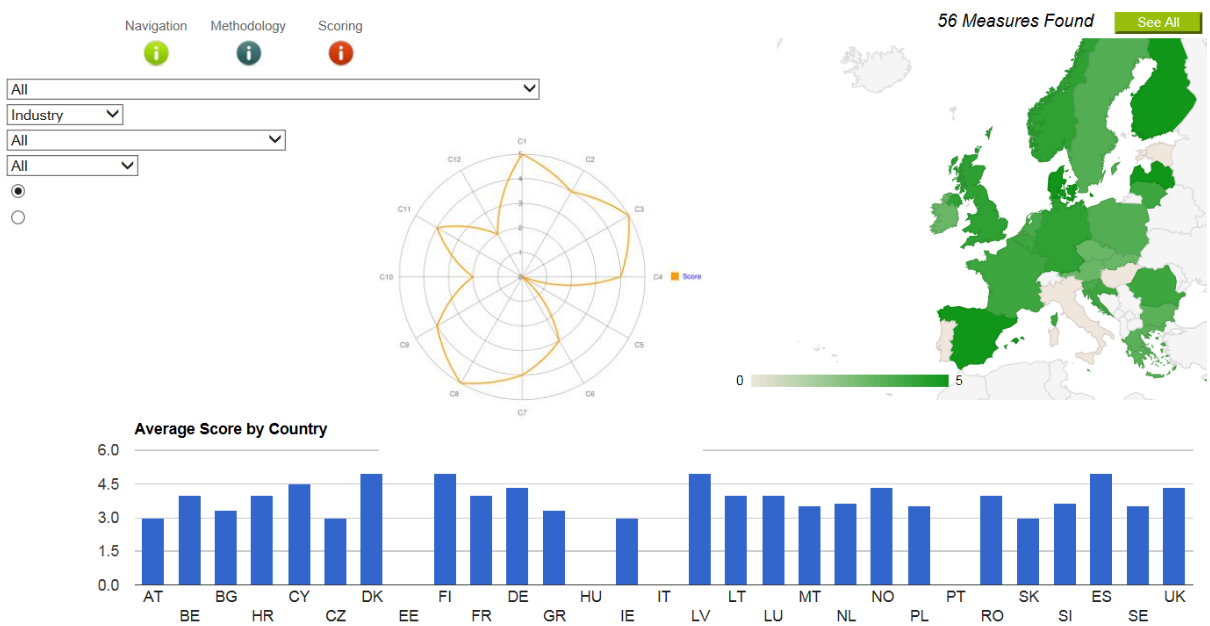
What are the most successful energy efficiency policies in industry? The "Successful Policies" tool

In order to make the identification of successful national energy efficiency measures easier and to base it on homogenous criteria, the "Successful Policies" was developed in MURE (see Figure 1). The successful policies are chosen and scored based on the following criteria.

- High impact/ high number of applicants
- Cost of the implementor/ necessary administrative support
- Potential for market transformation and for promotion of energy service market
- Suitability to overcome barriers for energy efficiency
- Ease and stability of re-financing (only relevant for financial measures)
- Persistency of the savings induced by the measure
- Transferability between countries
- Link to other measures/ policy packages
- Previous experience with measure
- Avoidance of negative side-effects
- Support of positive side-effects
- Ease of acceptance by relevant stakeholders

For industry, the MURE database shows 56 successful measures which have been accessed by the criteria above. The scores of the policies with regard to a specific criterion or the sum of all criteria can be shown by a spider graph or by bars (Figure 43). The darker green-shade depicts the higher score. Highest score is "5" which is achieved by policies in Denmark, Finland, Latvia and Spain. Score of "4.5" was achieved by Cyprus followed by the score of "4.3" by Germany, Norway and the UK.

Figure 43: Successful measures in industry by country



Source: MURE database, May 2015

Figure 44 gives an overview of all measures assessed as successful policies in MURE.

Figure 44 : List of successful policies by country and total average score

Code	Title	Avg Score	Type	Starting Year
IND-AU8	EU-related: EU Emission Trading Scheme (2003/87/EC)	3.8	New Market-based Instruments	2005
IND-AU9	Energy efficient companies	3.5	Information/ Education /Training	2005
IND-BEL4	Flanders - Energy efficiency criteria in environmental permits	3.7	Legislative/ Informative	2004
IND-BG14	Financing of projects for energy saving technologies and RES	3.8	Financial	2007
IND-BG5	Distribution of the National Indicative Target for energy savings as individual targets for the obligated under Energy Efficiency Law	3.5	Legislative/Normative	2009
IND-BG1	Energy Efficiency Act (EEA) – Mandatory Industrial Audits for Energy Efficiency	3.3	Legislative/ Informative	2008
IND-CR1	FZOEU energy efficiency programme	3.8	Financial	2004
IND-CY3	Governmental grants/subsidies scheme for the promotion and development of RES. energy saving technologies and the creation of a special fund for financing or subsidising ...	3.9	Financial. Information/Education/Training	2003
IND-CY4	EU-related: Amended EU Emission Trading Scheme (Directive 2009/29/EC)	3.9	New Market-based Instruments	2008
IND-CZ9	Operational Programme Industry and Innovation	3.2	Financial	2007
IND-CZ5	EU-related: EU Emission Trading Scheme (2003/87/EC) - Emission trading scheme and National Allocation Plan of the Czech Republic	2.8	New Market-based Instruments	2005
IND-DK5	Renewable energy for production processes	3.9	Financial	2013
IND-FIN14	Energy Efficiency Agreement of Industry 2008-2016	4.5	Co-operative Measures	2008
IND-FIN3	Energy Auditing Programme in the Industry and Energy Sectors. the EAP	4.4	Financial. Information/Education/Training	1994
IND-FRA15	Loans for small and medium sized enterprises	3.6	Financial	2010
IND-GER36	Special fund for energy efficiency in SMEs	3.7	Financial	2008
IND-GER18	Voluntary agreement with German industry II	3.5	Co-operative Measures	2000
IND-GRE6	Incentives for obligatory implementation of Energy Management Systems	3.6	Financial. Legislative/Informative	2008
IND-GRE10	Promotion of Combined heat and power (CHP) and district heating systems- Industry Sector	3.5	Financial	2009
IND-GRE7	GRE7-Promotion of voluntary agreements in industrial sector	3.4	Co-operative Measures	2010
IND-IRL12	Energy Agreements	3.5	Co-operative Measures	2006
IND-IRL17	Tax Relief for Energy Saving Equipment - Accelerated Capital Allowance	3.2	Financial	2008
IND-IRL15	SME Energy Efficiency	3.1	Information/ Education/Training	2007
IND-LV24	Complex Solutions for GHG Emissions Reduction in Industrial Buildings	4	Financial	2010
IND-LT3	Structural funds for more effcient cogeneration and heat supply systems	3.3	Financial	2007
IND-LT6	Special Programme for Climate Change: Energy efficiency improvement in industry	3.2	Financial	2010
IND-LT5	Lithuanian Environmental Investment Fund	2.8	Financial	1999
IND-LUX10	Voluntary Agreements (2011-2016)	3.5	Co-operative Measures	2011
IND-MAL3	Energy audits for industry	4	Financial	2006
IND-MAL5	Modernisation of Agricultural holdings	3.3	Financial	2009
IND-NLD19	Long Term Agreements with the industry. third phase; LTA3	4.2	Co-operative Measures	2008
IND-NLD7	EIA: Energy Investment Allowance	3.7	Fiscal/Tariffs	1997
IND-NLD6	Energy Tax. Industry	3.6	Cross-cutting with sector-specific characteristics	1996

IND-NOR14	Energy management – companies in networks	3.9	Financial	2003
IND-NOR15	Support to energy measures in industry	3.8	Financial	2003
IND-NOR8	Energy efficiency in industry	3.2	Co-operative Measures. Fiscal/Tariffs	2005
IND-PL11	Support for enterpreneurs on low-emission and resource-saving economy. Part 2.	3.5	Financial	2014
IND-PL10	Support for enterpreneurs on low-emission and resource-saving economy. Part 1.	3.1	Information/ Education/Training	2014
IND-RO5	Improvement of energy efficiency in industrial operators through the implementation of investment projects co-financed by community funds	4.2	Financial	2007
IND-RO7	Grant-supported credit line for Romania by the European Commission and the European Bank for Reconstruction and Development.	4.1	Financial	2008
IND-RO3	Management of demand for energy and the drawing up of energy balance sheets	4	Legislative/Informative	2008
IND-SK12	Promotion of energy efficiency in industry - EU Structural Funds	3.4	Financial	2004
IND-SK11	Promotion of energy efficiency in industry	3.4	Financial	2007
IND-SLO5	Financial incentives for efficient electricity consumption	4.3	Financial	2008
IND-SLO2	Energy audits and feasibility studies subsidies	4.2	Financial	2003
IND-SLO8	Subsidy for introducing energy management systems in industry	3.9	Financial. Legislative/Informative	2012
IND-SPA12	Third Party Financing	3.7	Financial	1985
IND-SWE17	Energy efficiency networks for the industry	3.7	Co-operative Measures. Information/ Education/Training	2009
IND-SWE3	The Programme for Energy Efficiency in Industry	3.2	Co-operative Measures	2005
IND-UK5	The Enhanced Capital Allowance Scheme	4.3	Financial. Fiscal/Tariffs	2001
IND-UK17	EU-related: Combined Heat Power (Cogeneration) (Directive 2004/8/EC) - Combined Heat and Power (CHP)	4.3	Fiscal/Tariffs. Information/Education/Training	2008
IND-UK16	EU-related: Community framework for the taxation of energy products and electricity (Directive 2003/96/EC) - Climate Change Levy	3.8	Cross-cutting with sector-specific characteristics	2001

Source: MURE database. August 2015

The average score of these measures ranks between 2.8 and 4.5. Almost half ofthe successful measures in industry are financial measures, but the other half constitutes a broad policy mix including all types of policy measures. With regard to the starting year of the measures, the list does not only include very new measures starting from 2008 onwards, but also some longstanding measures ongoing for 15 years or more, which are, however, still regarded as very successful in enhancing energy efficiency in the industrial sector.

New policy approaches for energy efficiency in industry

Though the "Successful policies" tool shows that a successful measure must not be new in order to be successful, the MURE database contains several new inititiatives being launched by Member States towards enhancing energy efficiency. These new measures especially include

- Mandatory Industrial Energy Audits
- Energy Efficiency Management in the industrial enterprises and annual reporting of its implementation
- Development of public-private partnership for implementation of energy efficiency measures
- Industrial Energy Efficiency Network
- Promotion of Energy Management Systems
- Intelligent metering in the industrial enterprises
- Creation of Business Parks

Many of these new approaches refer to a wider spread and improvement of energy management in industrial enterprises. Therefore, these approaches will be discussed more detailed in the following Section 3.2.

Recent policy measures started since 2013

As evident from the MURE database, the most recent policy measures (since 2013) mainly aimed at accelerating the implementation of the following actions in the EU Member States and Norway:

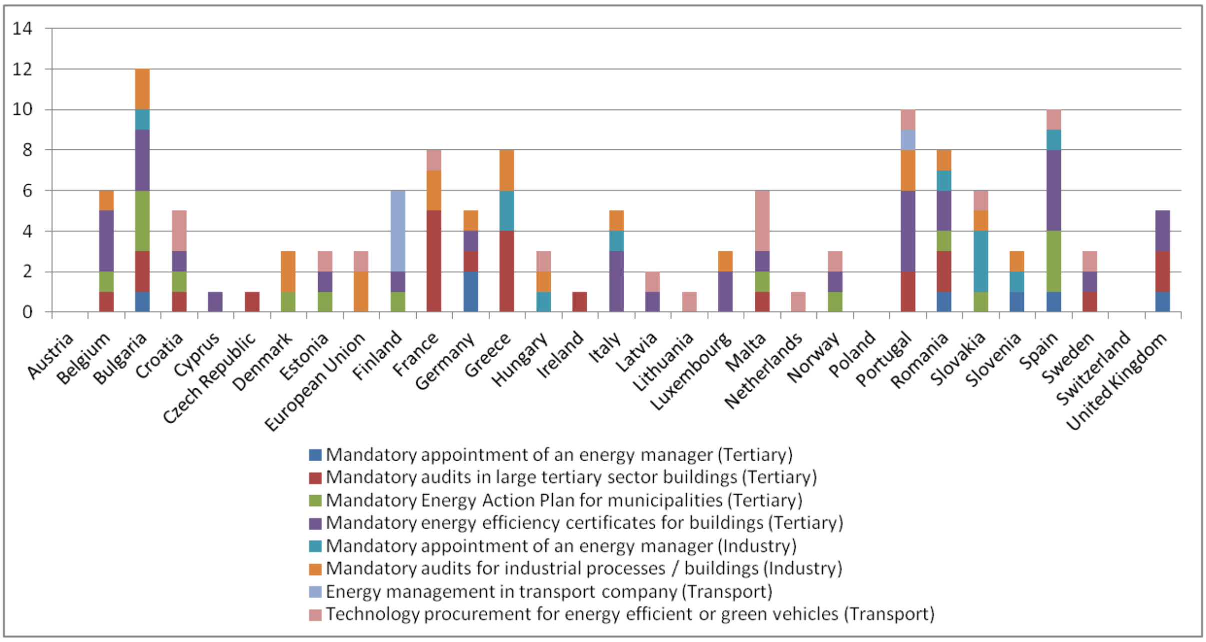
- Grants for energy efficiency measures in agriculture and animal animal, as in Bulgaria
- Energy audits in enterprises, as in Croatia, Denmark, Czech Republic, France, Germany, Latvia and Slovenia;
- Development of Cogeneration and efficient Heat Networks as in France;
- Implementation of Energy Management Systems, as in Germany and Latvia;
- Energy efficiency investments in the SMEs, as in Poland;
- Schemes for efficient utilization of electricity and heat, as in Germany and Slovenia;
- Emissions reducing under EU-ETS, as in Romania and UK;
- Financial and technical aids to SMEs and large companies in the industrial sector as in Spain.

3.2. THE ROLE OF ENERGY MANAGEMENT IN INDUSTRY

Energy audits and managements can be seen as such instruments to recognise and observe existing potentials by systematic procedures to gain knowledge and developing a strategy to achieve energy efficiency targets. One central element to wider spread this kind of instruments in Europe is the implementation of Article 8 of the Energy Efficiency Directive (see Chapter 2.1.2). In the following, this Article and some best practices already established in the the Member States will be analysed more detailed.

For an easier query of measures in specific topic areas (as e.g. energy management, buildings, consumer behaviour or specific target groups as small and medium enterprises SMEs), the "Policies by Topic" tool was developed in MURE (see Figure 1). Regarding policies in the topic area of energy management, most countries conducted this kind of measures, with Bulgaria, Portugal and Spain a little ahead of others (Figure 45). All these policies refer to companies as target group. Some of them, however, are not only directed to enterprises in the industrial sector, but also to the tertiary and transport sectors. While the most frequent ones are mandatory energy efficiency certificates for buildings (tertiary, 27%) and mandatory audits in large tertiary sector buildings (20% of all measures), followed by mandatory audits for industrial processes / buildings (17%), energy management in transport company (4%) and mandatory appointment of an energy manager (tertiary, 6%) are rare.

Figure 45: Energy management policies by county

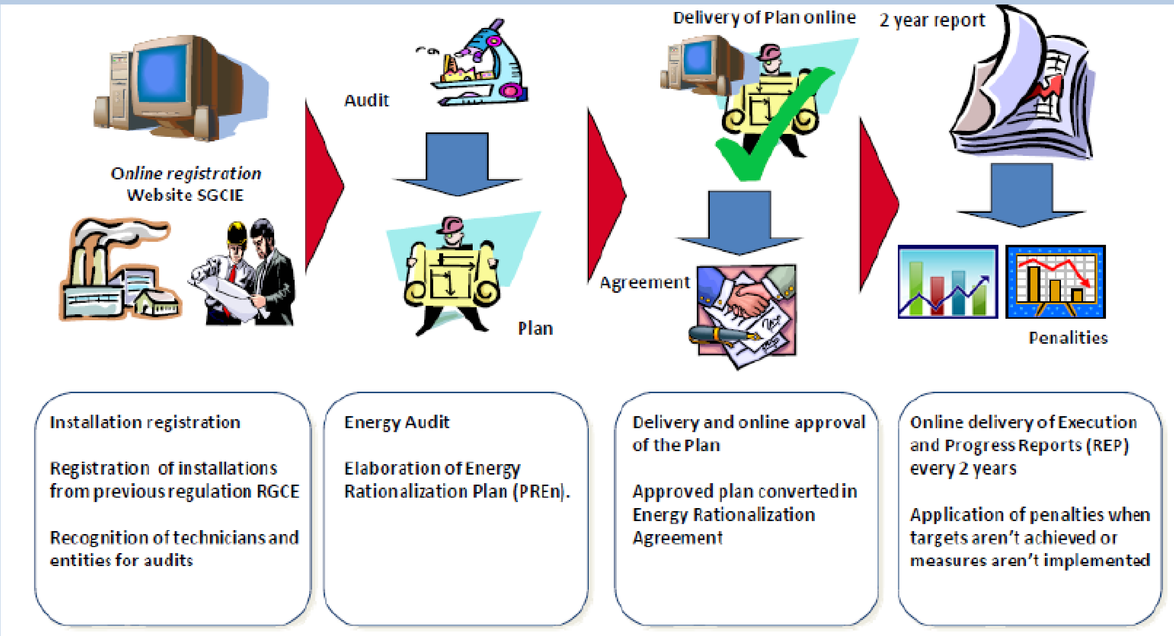


Source : MURE database, July 2015

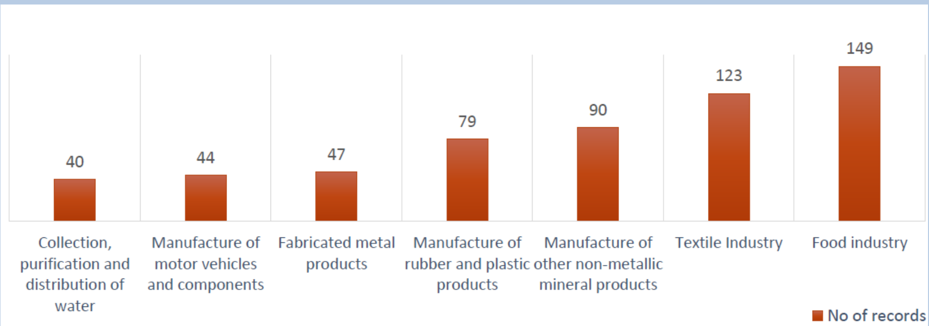
As best practice example, Box 3.1 describes a programme for the introduction of energy management systems in the Portuguese industry. Further examples from the European Union and Germany are described in the following Chapters 3.2.1and 3.2.2.

BOX 3.1: PORTUGAL – SGCIE: INTENSIVE ENERGY CONSUMPTION MANAGEMENT SYSTEM

The SGCIE was published in 2008 as a measure of the National Plan for Energy Efficiency (PNAPE) and promotes the increase of energy efficiency by changes in production processes, technologies and behaviour. The measure applies for all companies and includes binding energy audits in different periods, depending on the energy intensity of the company or facility. Those with high energy intensity are obliged to deliver an Energy Consumption Rationalization Plan (PREn) to the Directorate Genereal for Energy and Geology (DGEG) and the PREn becomes a Rationalization Agreement for Energy Consumption (ARCE). The plan contains target indicators which shall be reduced within the process, while the ARCE provides incentives on audit costs or investments in energy management and monitoring equipment. The Portuguese Energy Agency (ADENE) is in charge for monitoring and evaluation of the PREn.



Currently, 1017 operators are registered in SGCIE, mostly from industrial activities. They totalize 1560 ktoe and represent 31% of final energy consumption in the sectors of agriculture and fisheries, extractive industry, manufacturing industry and public works and construction.



Source: ADENE 2015

3.2.1. ARTICLE 8 ENERGY EFFICIENC DIRECTIVE

As already described in Chapter 2.1.2, Article 8 of the EED requires Member States

- to implement a four-yearly energy audit obligation for large enterprises and
- to develop programmes to encourage small or medium-sized enterprises (SME) to voluntarily undergo energy audits and to implement audit recommendations.

In the EED, energy audits are seen as essential tool to achieve energy savings. In the Guidance note of the European Commission (2013) on Article 8 of Directive 2012/27/EU, energy audits are defined as "systematic procedure with the purpose of obtaining adequate knowledge of the energy consumption profile of a building or group of buildings, an industrial or commercial operation or installation or a private or public service, identifying and quantifying cost-effective energy saving opportunities, and reporting the findings" (section 1). Article 2 (11) EED delivers a definition for energy management systems as "a set of interrelated or interacting elements of a plan which sets an energy efficiency objective and a strategy to achieve that objective". Usually energy management systems contain a continuous energy monitoring process to reduce energy use, which is often equivalent to an energy audit. Therefore the implementation of an energy management system can sometimes satisfy the criteria for audits Article 8 (4) so that enterprises can be exempted from this obligation (Art. 8 (6)).

Some main obligations are stated in the Guidance note, like the promotion of the availability of audits and qualified auditors, supervision, awareness rising programmes and minimum criteria for audits. Those minimum criteria shall be based on Annex VI, describing guidelines, including requirements like measurable, traceable data as basis, a detailed review of energy consumption profiles, life-cycle cost analysis (LCCA) instead of Simple Payback Periods (SPP) and the proportionate and sufficiently representative description of overall energy performance to identify the most significant opportunities for improvements. Concerning the high quality of the energy audit and energy management systems, those criteria do not go beyond the relevant European or International Standards for example, EN ISO 50001 (Energy Management Systems) or EN 16247-1 (Energy Audits) or, if including an energy audit, EN ISO 14001 (Environmental Management Systems).

In the industrial sector, voluntary agreement programmes are not uncommon (Figure 32). Sometimes the implementation of an energy management system is a precondition to participate to the programme. Energy audits under those voluntary agreements can also fulfil the requirements of Article 8 (4).

The Directive clearly distinguishes between small and medium-sized enterprises (SMEs) and large enterprises: While Member States are required to encourage SMEs to undergo audits and implement the recommendations and set up support schemes e.g. to cover the costs, large enterprises are obliged to regular audits at least every four years, starting 5th December 2015 at the latest. Small and medium-sized enterprises are made up of enterprises with less than 250 employees and which have an annual turnover not exceeding EUR 50 million and/or an annual balance sheet total not exceeding EUR 43 million (Guidance note, Section 19). The main criterion is the number of employees, both of the financial criteria must not be fulfilled. All "non-SME" are obliged to conduct energy audits, the definition does not refer to energy intensity/ consumption and no sectors are excluded.

Although this differentiation seems clear and the general obligations should not differ too much between the Member States, the interpretation of "large enterprises" differs, especially concerning which or how many of the given criteria have to be fulfilled for the enterprises to fall in the SME or the large enterprise category. Other aspects, like required qualifications for auditors or the treatment of transport, vary between countries, too. This might especially be challenging for enterprises operating in different Member States, which will have to look carefully on the applicable criteria each and – regarding the timeframe – will have to be ready soon. Penalties for non-compliance might carry business risks. But to the date of June 2015, some Member States did not even deliver a national response to article 8. 27 Member States have now received a letter of formal notice for failing the transposition of the Directive by the June 2014 deadline (EU Commission 2015).

The Guidance note also gives hints on the treatment of multinational enterprises. For the calculation of data it is necessary for each enterprise to state in the country it is registered if it is autonomous, partner or linked enterprise. The data of related enterprises have to be included to decide if they are treated as SME or not. Partner or linked enterprises are those which hold over 25% of capital or voting rights in another enterprise or vice versa. But concerning the valid obligations for each State, enterprises will have to stay updated as transposition process is evolving to the end of this year.

3.2.2. LEARNING ENERGY EFFICIENCY NETWORKS

In Germany, the „Energiewende“ is associated with ambitious targets for energy savings and efficiency (also see Chapter 4.3). Taking companies into the focus, a considerable potential can be expected, as industry still presents a share of about 28% in final energy consumption in Germany (see Figure 3).

The Learning Energy Efficiency Networks (LEEN) is a concept targeting energy efficiency in companies from different sectors. The concept was originally developed in Switzerland in the late 1980s (Bürki 1999; Kristof 1999) and is now widely applied in Switzerland due to the possibility that companies can get out of the payment of the CO_2-surcharge (presently 60 CHF per tonne of CO_2), if the company joins an energy efficiency network (EnAW 2014; Köwener 2011). In Germany, these networks are one of the immediate actions within the National Action Plan on Energy Efficiency (NAPE; BMWi 2014). In the NAPE, the idea is to extend these networks from presently around 60 to 500 in 2020. The outcome of the networks running so far in Germany, is that energy efficiency progress is doubled compared to the autonomous progress[24]. Around 75 PJ of energy savings per year are expected by the 500 energy efficiency networks in 2020 (about 3% of total industrial energy use in Germany) and avoided CO_2 emissions of around 5 million tonnes.

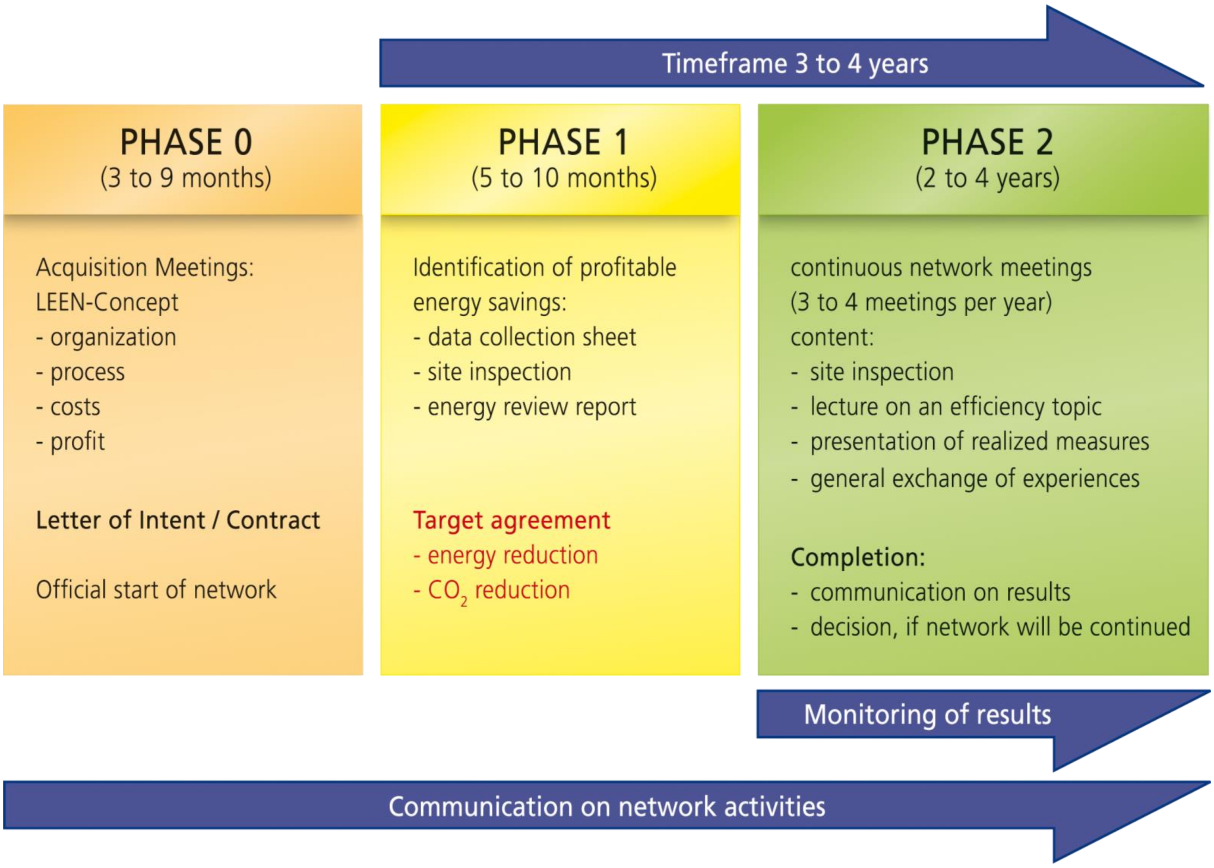
A LEEN is usually formed with 10-15 companies operating in different sectors, which are recruited by the network operator (e.g. utilities, industrial associations and platforms, Chamber of Commerce and Industry, city governments, or consulting engineers). There are presently two types of networks in Germany: for medium sized and large companies with yearly energy cost between 0.5 and 50 Mill. €/a and a slightly modified form for small and medium sized companies with yearly energy cost between 30.000 and 500.000 €/a (called "Mari:e – Mach's richtig: Energieeffizient!" – Do it right: Be energy-efficient!). The focus of the energy audit and the information and exchange of experience is on a set of common cross-cutting technologies, and in order to secure an open exchange of ideas plans and experiences the companies participating in the network should not be in competition in the same sector. The actual network process begins with an energy review phase 1 (Figure46). The companies fill in a data form concerning their energy situation and the certified consultant engineer carries out the energy audit. On that basis, the participants decide individually on an efficiency target (confidential) and commit themselves to a voluntary energy saving target of the network and regular exchange of experiences in their network for at least the next 3 – 4 years.

The targets which are set in the first phase are to be reached in the network operating phase 2. A LEEN-certified moderator plans and conducts the meetings. All network participants report on planned or implemented measures so that the other participants can benefit from their experiences. Within the process, the participants have the chance to benefit from exchange of information and experience, site visits during the meetings, and the possibility to utilize synergies in the networks (Köwener et al 2014). Additionally, the peer

[24]ie progress that occurs on the average for non-participants; klimaschutz.de, 2014

pressure concerning the common network target promotes progress towards the common goal (Jochem et al, 2007) and facilitates the diffusion of energy-efficiency innovations as an informal competition in achieving energy efficiency progress among the companies and the energy managers can be observed (Jochem et al, 2012).

Figure46: LEEN network process



Source: www.leen.de

The costs for participating companies are approximately € 35,000 to € 40,000 for a four-year network operating period. These costs cover the 10-12 day energy review, 16 network meetings and three assessments of the monitoring results (Köwener 2011). The success is measured through the monitoring once a year and documented by the consultant engineer. Those results are fed back to the companies' management.

Participation in the LEEN can also be used as a preparation of the implementation of energy management systems, as some requirements of DIN 16001 or (today) ISO 50001 are met (Di Nucci 2012).

In the pilot project "30 Pilot Netzwerke", energy efficiency networks were conducted under the lead of Fraunhofer ISI. The project of the 30 pilot network was funded within the National Climate Protection Initiative NKI since November 2008 until March 2014. The funding covered the cost of further development of the LEEN management system, including 17 investment calculation tools for cross cutting technologies, the evaluation of the performance of the 30 networks with its 366 companies as well as public relations to report the successes to a broader audience of the German industry. The participants were predominantly (about 75%) from the manufacturing sector (NACE sector C). A little more than half of the companies reported to be a location of a greater enterprise, the remaining are independent companies. The companies rated their own energy consumption as "rather high" (3.7 on a scale from 1 to 5). 18% of the companies already made experiences with comparable networks on different topics. For over half of the companies, energy savings have always been a relevant issue, according to their own declaration. 49% realized energy consulting within the last 5 years. 2/3 of those were satisfied with the consultation and over 60% thereupon even conducted according measures (Fraunhofer ISI, own calculations).

The participants' motivation to participate the networks was, besides the final aim to reduce energy costs, to gather information about the energetic status quo in their production sites and to find suitable measures – the practical orientation is obviously highlighted. Those expectations were well satisfied, as calculations revealed comparing those expectations and according experiences. Especially information deficits and a lack of market overview were stated as barriers to implement energy efficiency measures which significantly decreased during the network process. Although, participants criticize the small share of energy costs in production costs – a barrier which is intangible by the means of the network aspects.

Most of the identified measures addressed cross-cutting electrical technologies, more than 30% of the measures addressed process heat and space heating. The major part (about 85%) of the recommended measures required investments below 50.000€, but a share of about 17% require investments above. While measures concerning process heat and energy carrier change deliver highest expected savings, they are also the most costly ones (Rohde et al. 2015).

The major share of participants (over 90%) stated that they accomplished the suggestions drawn out of the network process. 75% reported that a part of those measures would not have been implemented without the networks. Additionally, about 75% of the participants rated the benefits of network participation as "rather high" or "very high". Over 60% indicated that contacts gained within the network were used beyond the meetings (Fraunhofer ISI, own calculations).

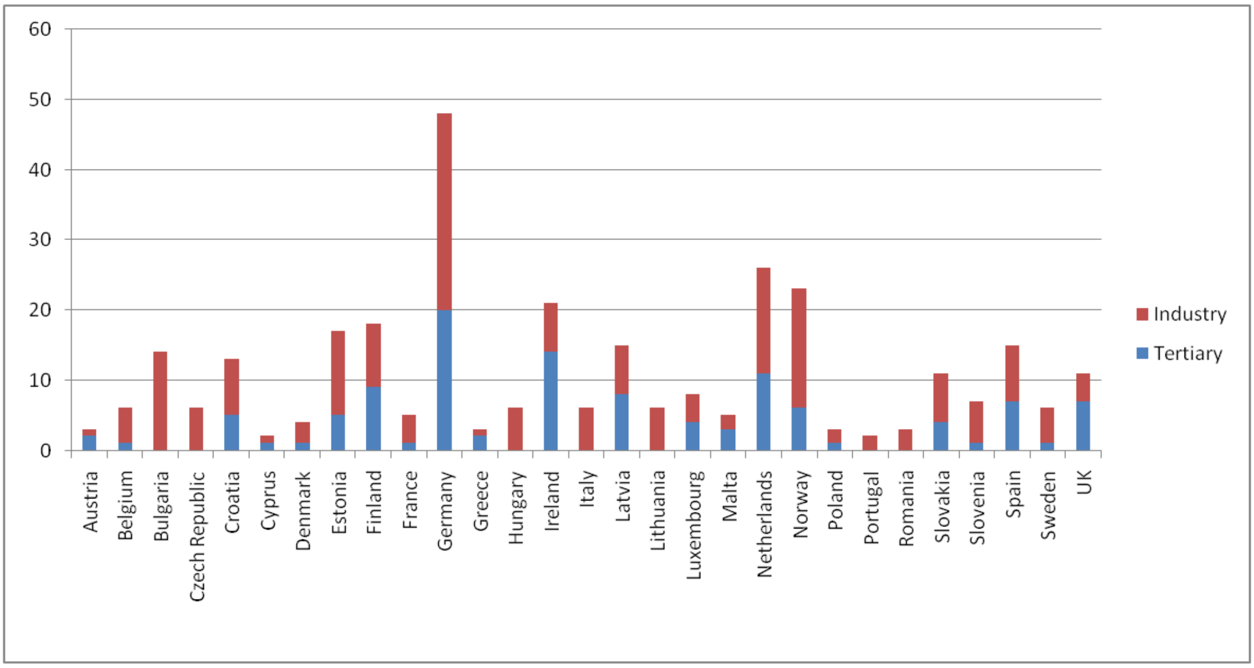
The quantitative monitoring performed jointly by the energy manager and the consulting engineer came to the conclusion that the annual average efficiency improvement of the participants was 2.1% per year in average. In absolute terms this resulted in energy savings of about 5 PJ/a after 4 years of the duration of the 30 networks (Jochem/Idrissova 2014).

In December 2014, a voluntary agreement was signed by the German Government and 18 associations of industry to generate 500 energy efficiency networks until 2020. As further enrichment, information about financing possibilities to overcome possible financial barriers and the topics of demand side management and flexible electricity production of company owned electricity units will be added to the concept in 2015 in order to react on the increasing importance of fluctuating electricity generation by renewables which open up new energy services.

3.3. POLICIES FOR SPECIFIC TARGET GROUPS IN INDUSTRY – SMALL AND MEDIUM ENTERPRISES (SMEs)

With the new "Policies by Topic" tool, the MURE database provides a tool to get a quick overview of policies specifically addressing target groups as e.g. small and medium enterprises (see Figure 47). This target group is both addressed by measures in industry and the tertiary sector. As Figure 47 shows, the number of measures addressing SMEs differs a lot between the countries. Whereas in Germany, the Netherlands or Norway there are a lot of measures addressing SMEs, in some other countries, such as Austria, Cyprus, Czech Republic, Greece or Romania SMEs are only targeted with very few or no measures.

Figure 47 : Policies in the MURE database addressing SMEs



Source: MURE database, July 2015

Policy measures inMURE specifically targeting SMEs can be categorized in two broad classes:

i. Financial Measures:
Majority of the measures related to SMEs fall in this category. It includes measures dealing with funds, loans, subsidies, financial support schemes,consulations, financial incentives and aids for SMEs. Several measures provide financial support in the form of subsidies, loans and aid for Energy audits in SMEs. Such measures have been reported by Austria, Croatia, France and Spain. These measures provide technical and financial support to conduct comprehensive energy audits within SMEs.Measures related to energy-related advice and consulation have been reported by Germany, Austria, Spain and Malta.

ii. Information/Educational/Training Measures:
These measures encompass education and training activities for SMEs on how to enhance energy efficiency, resource planning and management and the behavorial-training of the employees of the enterprise towards more responsible energy-related actions. Such measures have been reported by Finland and Ireland. UK reports a "Smart Metering" measure for the SMEs. The UK Department of Energy and Climate Change (DECC) is leading a roll-out (links below) of smart meters with support from the industry regulator, Ofgem. DECC estimates that over the next 20 years the installation of smart meters will provide £6.7 billion net benefits to the UK: the programme will cost £12.1 billion and provide £18.6 billion in benefits. Since 2009, where suppliers have replaced or newly installed a meter at a medium-sized non-domestic site, that meter has had to be an advanced meter. Since April 2014, all supplies to these sites have to be provided through advanced meters.

In Table 3, the policies targeting SMEs are listed below under the above mentioned two categories.

Table 3 :Policy measures specifically tailored for SMEs

	Information/Education/Training	Financial
Austria		SME-Energy Cheque
Croatia		Energy audits of SMEs
Finland	Energy Advice to SMEs	
France		Loans for SMEs
Germany		a. Special fund for energy efficiency in SMEs b. KfW Energy consultations for SMEs c. Promotion of energy efficient cross-cutting technologies in SMEs
Ireland	SME Energy Efficiency	
Malta		Support schems for Industry and SMEs
Poland		Energy efficiency investments in SMEs
Slovenia		Financial incentives for investment in energy efficiency and renewable in SMEs
Spain		a. IDEA-ERDF Programme for SMEs b. Aids to SMEs and large companies in the industrial sector
Sweden	Energy efficiency in SMEs	

Source: MURE database, June 2015

3.4. POLICIES FOR SPECIFIC TARGET GROUPS IN INDUSTRY - THE ENERGY-INTENSIVE INDUSTRY

The most important policy addressing the energy-intensive industry is the EU ETS which was already described in Section 2.1.1. Only a few countries have introduced additional national policies specifically addressing the energy-intensive industry. In the following, some examples are given which were all taken from the MURE database.

Belgium - Voluntary agreements in energy intensive industry

This is a measure of the Region of Flanders. Up to now, it has had two components: Audit covenants and Benchmark covenants. Besides, new energy policy agreements are currently under preparation for the period 2015-2020 ('Energiebeleidsovereenkomsten 2015-2020").

1) Audit covenant

The companies involved undertake to carry out an energy audit and draw up an energy plan to improve energy efficiency. In the first phase, (not later than 4 years after acceptance of the energy plan), they must implement all cost-effective measures with an IRR of at least 15% after tax. In the second phase, not later than 4 years after the acceptance of the updated energy plan, companies must implement energy efficiency measures with an IRR of at least 13.5%.

2) Benchmarking covenant

The companies involved are bound under a benchmarking covenant to achieve and maintain the world benchmark performance in terms of energy efficiency up to 2012. A business undertakes to be inspected once every four years by a consultant to check to what extent the specific energy consumption of its process installations achieves world benchmark levels and also to produce an energy plan aimed at achieving that goal.

Hungary - Voluntary agreements with energy intensive industries and manufacturers

The state concludes agreements with major groups involved in energy, such as;

- Energy-intensive industries,
- Energy-industry,
- Manufacturers of individual end-user appliances.

Within the framework of the agreement, the above-named groups will undertake efficient energy utilisation, for instance;

- Reduction of energy use
- Application of more efficient energy supply technologies,
- Development of products with better energy efficiency indicators.

In order to provide a remuneration of these undertakings, the state will provide favourable publicity to the groups signing the agreement, give exemption from applying "mandatory" rules and provide financial support for implementation of energy efficiency measures. For implementation of voluntary measures, negotiating partners with proper mandates and credibility are needed on both sides.

Norway - Energy efficiency in industry

The objective of the programme for energy efficiency in industry (PFE) was to save electricity in the pulp and paper industry. The programme was in operation for 10 years, from 1 July 2004 to 1 July 2014.

Companies within the pulp and paper industry, chemical reduction processes, metallurgical processes and cement production could apply for participation in a programme for energy efficiency and the approved companies would be given a full exemption (i.e. a zero tax rate) from the electricity tax. The general electricity tax rate in Norway was NOK 0.1161/kWh in 2013. However, certain industries (in particular the manufacturing and mining sector) only paid a reduced tax rate of NOK 0.0045 per kWh (0.00055 €).

Energy intensive companies (pulp and paper industry, chemical reduction processes, metallurgical processes and cement production) were offered the possibility to participate in a five-year programme, which required that certain energy efficiency obligations should be fulfilled, and stipulated penalty arrangements in case the obligations were not fulfilled.

Portugal - Intensive Energy Consumption Management System (SGCIE)

The Intensive Energy Consumption Management System (SGCIE), which was already described in Box 3.1, has specific provisions for energy-intensive companies. The SGCIE applies for all companies and facilities (also named "Operators") that have an annual consumption over 500 toe/year, imposing binding energy audits, with a 6-year periodicity, in energy intensive facilities with consumption above 1000 toe/year, and a 8-year periodicity for energy audits to facilities with energy consumption between 500 and 1000 toe/year.Intensive energy users are obliged to elaborate and execute Energy Consumption Rationalization Plans (PREn), establishing targets for Energy and Carbon intensity and Specific energy consumption, which also outlines energy rationalization measures.

Sweden - The Programme for Energy Efficiency in Energy Intensive Industry

The Programme for Energy Efficiency, PFE, was introduced 1st January 2005 and the Swedish Energy Agency is the supervisory authority. The Swedish National Tax Board administers the tax reductions. In 2012 the

European Commission informed that the tax reduction for participating companies, which is a crucial component of the programme, violates EU rules for state aid and therefor the programme will be wound down gradually with no new entrants as of 2012. Participants already registered for the programme will nevertheless be allowed to continue as scheduled until 2017.

PFE is a voluntary programme directed towards the energy intensive manufacturing industry to improve the electricity efficiency in the production process. A firm is defined as energy intensive if energy costs make up at least 3 % of the production value, or the energy, carbon dioxide and sulphur tax compiled make up at least 0.5 % of the company's added value. The start of the programme is related to the introduction of an energy tax on electricity consumption (0.5 Euro/MWh), which came into force on the 1st July 2004. Firms that go through with the Programme for Energy Efficiency where the efficiency goal is reached, are exempted the energy tax.

A programme period lasts for five years, divided into two periods. During the first two years the firm needs to implement and certify a standardized Energy Management Systems (EMS), perform Energy Mapping and analyses over energy consumption, introduce energy efficiency routines for projections, plan changes and renovations of its plants and for the purchase of electricity consuming equipment.

4. DESIGNING AN EFFECTIVE ENERGY EFFICIENCY POLICY MIX FOR THE INDUSTRIAL SECTOR

4.1. BARRIERS TO ENERGY EFFICIENCY AND THE ROLE OF POLICY PACKAGES

The European Union both set energy efficiency targets for 2020 and 2030 which have to be achieved by existing and new policies both at the European and the national level. The energy efficiency target for 2020 established in the Europe 2020 strategy demands for a 20% increase in energy efficiency compared to a baseline development which was set by the PRIMES 2007 projections (EU Commission 2008). The target was further specified in the Energy Efficiency Directive (EED; 2012/27/EU) that the EU-27/28 2020 energy consumption has to be no more than 1,474/1,483 Mtoe of primary energy or no more than 1,078/1,086 Mtoe of final energy. A recent evaluation on behalf of DG ENER (Fraunhofer ISI et al. 2014) which was based on three different methods (bottom-up policy analysis, decomposition analysis and modelling analysis) found for both primary and final energy a gap of 3% to 0% points for 2020, the latter for the bottom-up policy analysis. Nevertheless, some effort is still necessary in order to finally achieve the energy efficiency target for 2020. This is also true for the new 2030 target, which was decided by the European Council on 23 October 2014. With regard to energy efficiency, the new 2030 Climate and Energy Policy Framework provides an indicative target at the EU level of at least 27% for improving energy efficiency in 2030 compared to projections of future energy consumption based on the current criteria (PRIMES 2007). The energy efficiency target is planned to be reviewed before 2020, having in mind an EU target of 30%.

In order to achieve these targets, all energy consumption sectors have to make contributions, also the industrial sector with a share of around 25% in total final consumption in the EU on average (Figure 3).The energy saving potentials in order to reach these targets are already there. They are well documented in several studies. These studies also show that many of these potentials are cost-effective for a company from a social perspective, and even that of an individual private investor (see e.g. IEA 2012a, Fraunhofer ISI 2012, Eichhammer 2013, Fraunhofer ISI et al. 2014). Cost-effective saving potentials in industry are especially available in the field of cross-cutting technologies as motors used in industry (fans, pump systems, cooling devices, compressed air systems), electricity-driven system optimisation or CHP.

The cost-effectiveness of energy efficiency measures is further improved if taking into account the significant co-benefits of energy efficiency such as increases in GDP and employment, and an improvement in competitiveness (see e.g. IEA 2012b, eceee 2013, Cambridge Econometrics 2013, IEA 2014). In addition, the reduction of energy consumption through energy efficiency is one of the most effective means of reducing the dependence on imported energy and thus increasing energy security.

In reality, there is still a gap between the market potential for energy efficiency in industry and the cost-effective potential from an individual or social point of view. Even the profitable potential is not fully exploited, primarily because of persistent barriers to the deployment of energy efficiency measures. Such barriers prevent industrial companies from realising energy savings potentials even though they are cost-effective under current economic conditions (se e.g. IEA 2012a, Fleiter et al., 2013). Important barriers in industry – which are partly economic and partly non-economic – are:

- Information and knowledge deficits both with regard to the existing saving potentials in the company and to existing financial support programmes for investments in energy efficiency (especially relevant in SMEs).
- Fear of negative impact of energy efficiency measure on the quality of products and processes.
- Uncertain economic and legal framework and uncertainty in planning.
- Low share of energy costs in total costs of the company and therefore low priority for energy efficiency investment.
- Lack of own capital to undertake the necessary investments and no willingness to use borrowed capital (especially in owner-run companies).
- High transaction costs of energy

On the other hand, there are also driving forces which facilitate the implementation of energy efficiency measures in companies. These are e.g. the use of energy efficiency as an image factor for the company, the use of an energy or environmental management system or the existence of an internal efficiency benchmarking, or motivated employees with an own interest in energy efficiency.

A suitable policy mix in the field of energy efficiency should not only be able to break down these barriers, but also make use of the driving forces which facilitate the implementation of energy saving measures in companies. This means:

- Regulatory instruments as especially the EU Ecodesign Directive generally define the technological baseline for the technical energy improvement measures in companies. That way they also implicitly raise the priority for energy efficiency investment.
- Financial and fiscal instruments play a crucial role for the reduction of the economic barriers, especially the lack of capital and the transaction costs. In industry, these instruments are therefore especially important for SMEs.
- However, there still remain non-economic barriers which cannot be successfully tackled by regulatory and financial instruments alone. Therefore, informational and advisory instruments are an important completion of such a package since they can address barriers and driving forces which do not lie in economic reasons (as e.g. information and knowledge deficits, uncertainties or energy efficiency as an image factor). In order to adress these barriers and driving forces, there is a wide range of additional policy measures ranging from energy management systems, labelling and benchmarks, or energy audits in companies. Many good examples for this kind of policy measures have been described in the Chapters before and can be looked at in the MURE database.

Every policy package for industry should therefore comprise regulatory as well as the other incentivising instruments (“stick and carrot”), where the regulatory instruments define the technological baseline. The other instruments may then either encourage the investor to undertake measures complying with this baseline or they may set incentives to even exceed the standards significantly and make use of more advanced technologies.

If this kind of policy package is designed for industry, a specific energy use in industry (as e.g. lighting, electric motors, electrical processes) will usually be targeted by several policy measures. In that case, measure interactions can occur, i.e. measures in the package may reinforce each other but they could also counteract against each other. These measure interactions have to be taken into account in order to assess the impact of the policy actions on the EU (or national) energy efficiency targets in a realistic manner.

4.2. HOW THE MURE DATABASE CAN HELP TO DESIGN SUITABLE POLICY PACKAGES FOR INDUSTRY

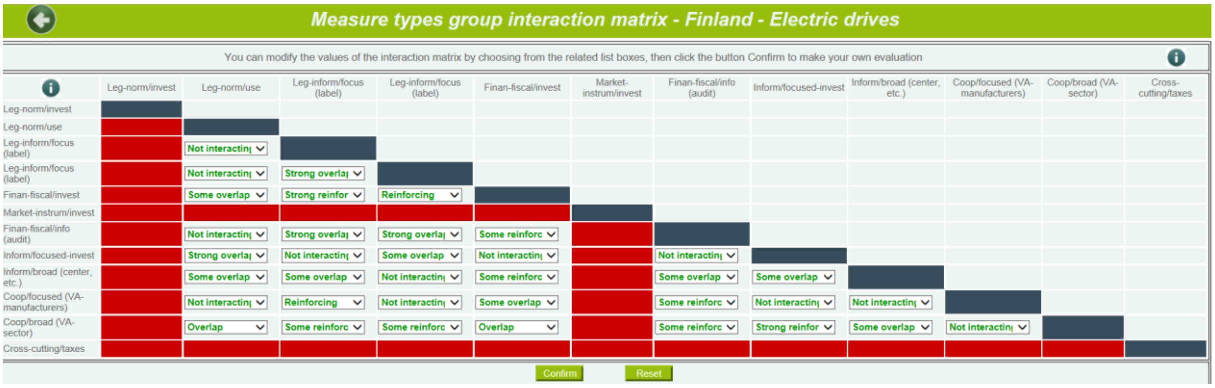
The MURE database itself describes individual energy efficiency policies at the level of the EU and in the EU Member States and Norway. However, in order to design and analyse suitable policy packages addressing a specific sector or end-use, some of the new tools can be used which have been developed for MURE (see Figure 1): the “Policy Interaction” facility and the “Policy Mapper” and. In the following, the use of these tools for the design and analysis of policy packages will be described using examples from the industrial sector.

Measure interaction in the industrial sector

As already stated above, measure interactions (overlap or reinforcing) can occur when designing a policy package to remove the different barriers in the companies to the deployment of energy efficiency measures. The new facility enables the user to characterize packages of measures and their interactions in a quantitative way. Methodogically, it is based on an interaction matrix which assesses the interaction between different types of policy instruments (Figure 48) and the semi-quantitative measure impact of the measures given in MURE (see Chapter 2.2.3). The semi-quantitative impact is re-calculated into a quantitative energy saving and – based on the assumptions in the interaction matrix – the interaction impact is calculated. In the example for measures addressing electric drives in Finland, which is shown in Figure 49, the calculated interaction is relatively small since there is only a slight overlap between the different policies.

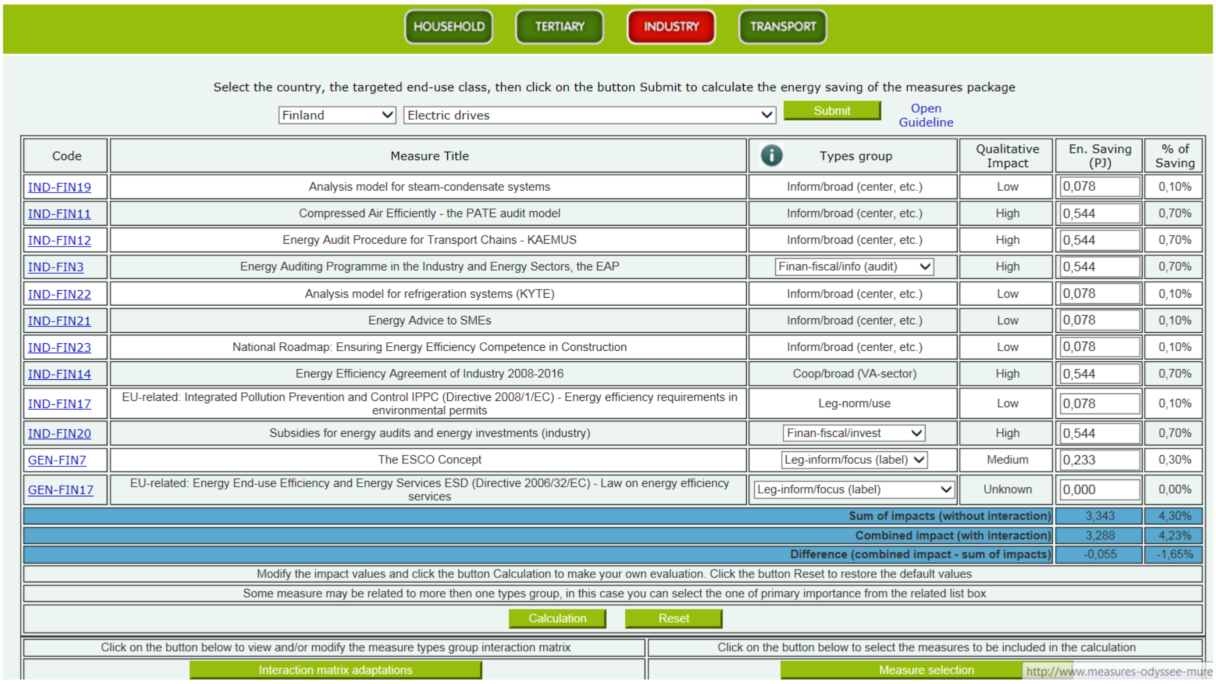
The tool is set up completely interactive, so that the user can change the assessment in the interaction matrix, the measure package itself and the semi-quantitative impact evaluation.

Figure 48 : Interaction matrix for measures addressing electric drives



Source: MURE database (policy interaction facility)

Figure 49 : Assessment of the policy interaction– Example : measures addressing electric drives in Finland



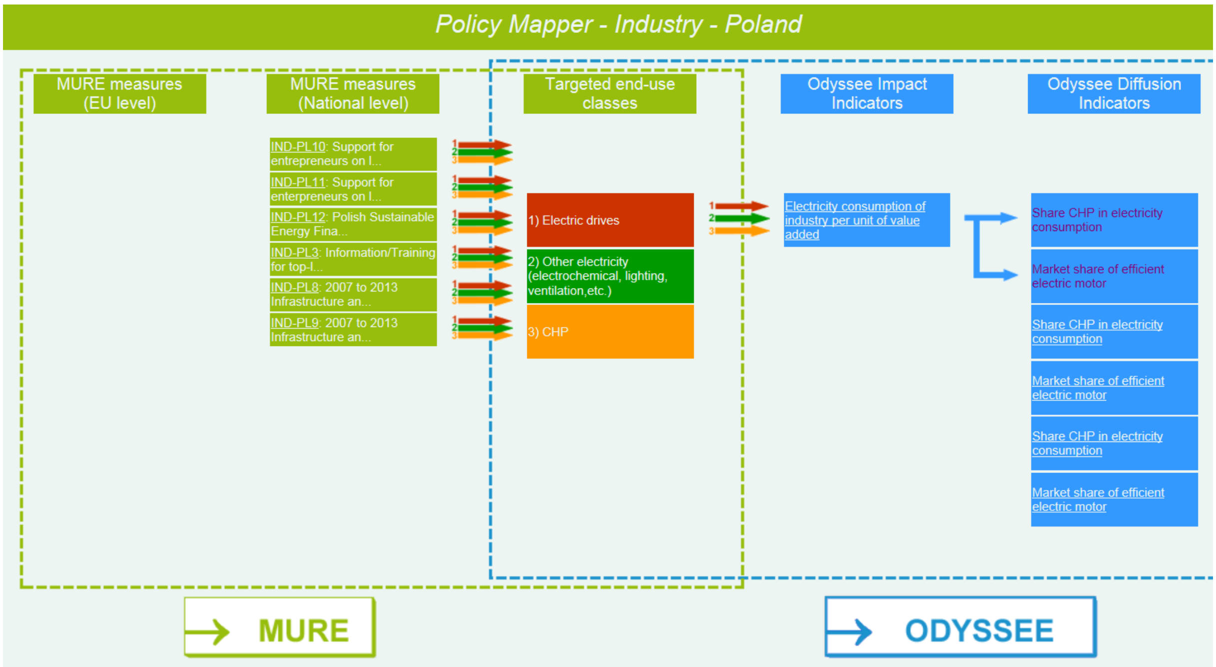
Code	Measure Title	Types group	Qualitative Impact	En. Saving (PJ)	% of Saving
IND-FIN19	Analysis model for steam-condensate systems	Inform/broad (center, etc.)	Low	0,078	0,10%
IND-FIN11	Compressed Air Efficiently - the PATE audit model	Inform/broad (center, etc.)	High	0,544	0,70%
IND-FIN12	Energy Audit Procedure for Transport Chains - KAEMUS	Inform/broad (center, etc.)	High	0,544	0,70%
IND-FIN3	Energy Auditing Programme in the Industry and Energy Sectors, the EAP	Finan-fiscal/info (audit)	High	0,544	0,70%
IND-FIN22	Analysis model for refrigeration systems (KYTE)	Inform/broad (center, etc.)	Low	0,078	0,10%
IND-FIN21	Energy Advice to SMEs	Inform/broad (center, etc.)	Low	0,078	0,10%
IND-FIN23	National Roadmap: Ensuring Energy Efficiency Competence in Construction	Inform/broad (center, etc.)	Low	0,078	0,10%
IND-FIN14	Energy Efficiency Agreement of Industry 2008-2016	Coop/broad (VA-sector)	High	0,544	0,70%
IND-FIN17	EU-related: Integrated Pollution Prevention and Control IPPC (Directive 2008/1/EC) - Energy efficiency requirements in environmental permits	Leg-norm/use	Low	0,078	0,10%
IND-FIN20	Subsidies for energy audits and energy investments (industry)	Finan-fiscal/invest	High	0,544	0,70%
GEN-FIN7	The ESCO Concept	Leg-inform/focus (label)	Medium	0,233	0,30%
GEN-FIN17	EU-related: Energy End-use Efficiency and Energy Services ESD (Directive 2006/32/EC) - Law on energy efficiency services	Leg-inform/focus (label)	Unknown	0,000	0,00%
Sum of impacts (without interaction)				3,343	4,30%
Combined impact (with interaction)				3,288	4,23%
Difference (combined impact - sum of impacts)				-0,055	-1,65%

Source: MURE database (policy interaction facility)

The “Policy mapper”

As the interaction facility, the policy mapper addresses policy mixes for a specific end-use. The policy mapper enables to identify policy packages for a given targeted end-use and relates them to the suitable energy efficiency indicators from the ODYSSEE database. As an example, Figure 50 shows the policy measures addressing three end-uses (electric drives, other electricity uses and CHP) in industry in Poland.

Figure 50 : Policy mapper – Example : measures addressing several targeted end-uses in industry in Poland



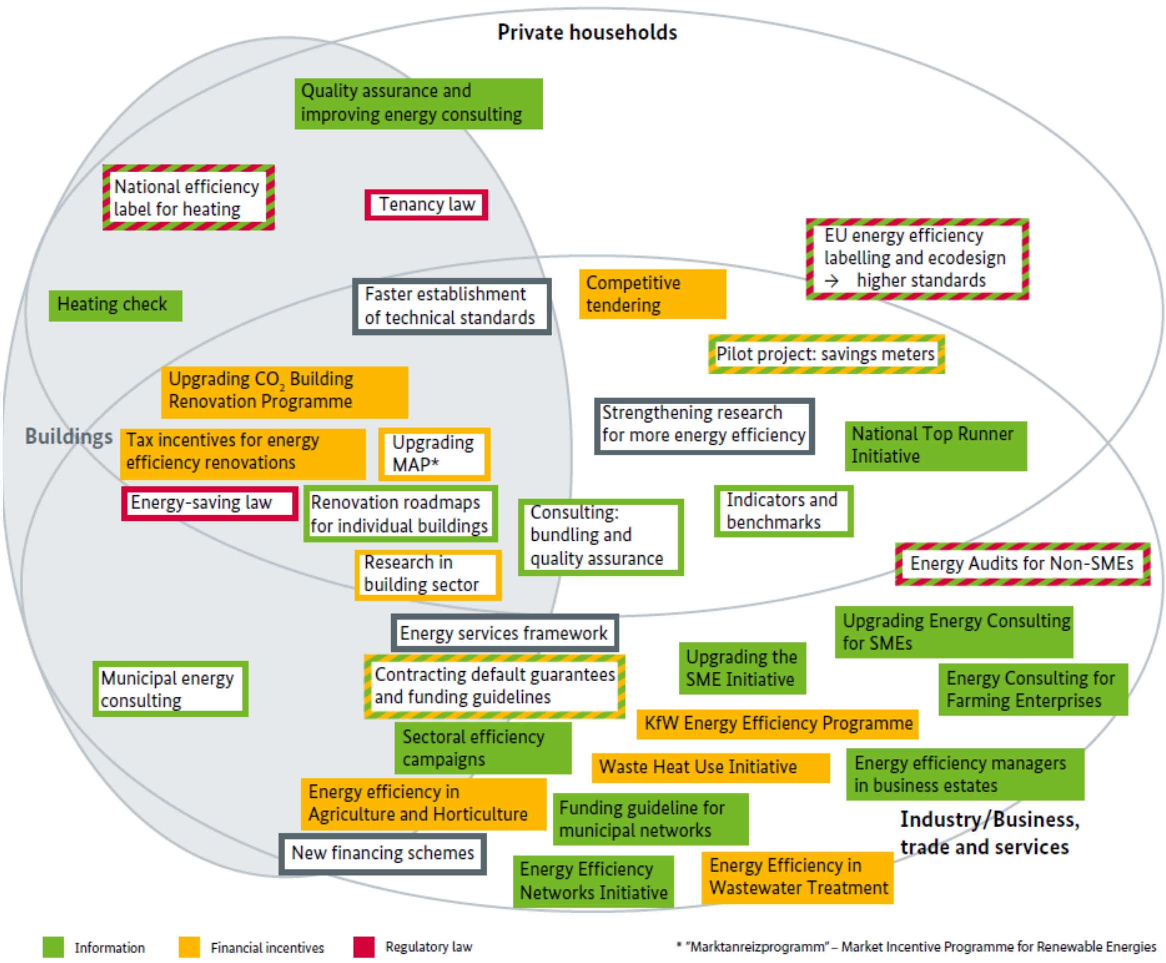
Source: MURE database (policy mapper)

4.3. CASE STUDY: THE GERMAN "NATIONAL ENERGY EFFICIENCY ACTION PLAN" (NAPE)

With its Energy Concept from September 2010 (BMWi/BMU 2010) and the decisions from summer 2011, Germany initiated a far-reaching transformation of its energy system, the so-called "Energiewende". Alongside intensifying the use of renewable energies, reducing energy consumption by increasing energy efficiency is a key pillar of the Energiewende. The Energy Concept also includes ambitious energy efficiency targets for Germany: primary energy consumption shall be reduced by 20% until 2020 and by 50% until 2050. Electricity consumption is planned to be cut by 10 % until 2020 and by 25 % until 2050 (all compared with 2008). Though there is no specific target for the industrial sector, due to its relatively high share in final energy consumption of almost 30% (see Figure 3), this sector will have to contribute to the national target, too. This is increasingly so as a remaining shortfall to meeting the primary energy target in 2020 was estimated to be around 10 to 13% based on current forecasts and an extrapolation of the statistical development of primary energy consumption observed up to 2013 (Fraunhofer ISI/IFAM et al. 2014). This is equivalent to a decrease in primary energy consumption of between 1440 and 1870 PJ which is necessary to reach the 2020 target. In order to fill this gap, the German Federal Ministry for Economic Affairs and Energy (BMWi) presented the "National Action Plan on Energy Efficiency" (NAPE) in early December 2014 (BMWi 2014).

The NAPE includes new and further developed policy measures to increase energy efficiency in private households, buildings, and industry. The NAPE identifies the main fields of activity in these sectors and specifies short-term measures and long-term work processes for each. It combines instruments for information and transparency, financial incentives and regulatory law in a broad policy mix (see Figure 51). This mix of instruments is intended to ensure that the different barriers hindering the exploitation of cost-effective efficiency potentials are addressed comprehensively and that the factors promoting the implementation of efficiency measures are further enhanced.

Figure 51 : Measures of NAPE for buildings, private households and industry



Source: BMWi 2014

The highest contributions to energy and CO_2 savings are expected from a newly introduced competitive tendering scheme for energy efficiency, the establishment of up to 500 energy efficiency networks in industry (also see Chapter 3.2.2), and the national implementation of Article 8 EED (Table 4). These measures – among others – totally or at least partly address energy efficiency in the industrial sector.

Table 4 : Main policies of the NAPE addressing industry and their impact

Sector	**Key policy measures of the NAPE (partly) addressing industrial companies**	**Impacts** Final energy [PJ]	Primary energy [PJ]	CO_2 emissions [Mt $CO_{2eq.}$]
Cross-sectoral	Introduction of a competitive tendering scheme for energy efficiency	10.7-21.5	25.7-51.6	1.5-3.1
	Support of Energy Performance Contracting	3.2	5.4	0.3
Industry & Tertiary	Energy Efficiency Networks Initiative	50.0	75.0	5.0
	Upgrading the KfW efficiency programme	10.9	29.4	2.0
	Obligation to perform energy audits for non-SMEs (implementation of Art. 8 EED)	33.3	50.5	3.4
Appliances & Products	National Top Runner Initiatives	15.8	37.9	2.3

Source: BMWi 2014; Fraunhofer ISI/Ifam et al. 2014

A completely new instrument for Germany in the policy mix of the NAPE is the introduction of a **competitive tender scheme**. Within a competitive tendering scheme, the top-down approach of a classical funding scheme is replaced by a market based bottom-up process to find the most cost-effective solutions. The underlying assumption is that the market actors are able to identify the most cost effective energy-efficiency potentials. Thereby the effectiveness of the expeditors for funding will increase. Based on the experiences with competitive tendering schemes in Switzerland (Bühlmann 2014), Germany will introduce the pilot project for competitive tendering late in 2015 with a planned funding volume of €15M. This amount will increase continuously until 2018 with the maximum volume of €150M. The pilot project will consist of two different types of tenders. Open tenders will be open to different technologies, actors and sectors. Within the open tenders of the pilot project, eligible measures will be restricted to electrical applications only. The closed tenders will address specific technologies or actors with large potentials for energy demand reduction linked to specific barriers which might hamper their inclusion in the open tenders. For both types of tenders, the most cost-effective measures in terms of saved energy per Euro spent will be funded.

It must be noted that the financing of the new tender scheme, as well as of all other NAPE measures, is exclusively done by government spending, i.e. the money which is used to trigger energy savings only comes from the public budget. Rather than following this trail it might be promising to search for additional instruments that do not rely on public spending but rather use auto-financing of private actors for triggering energy saving and economic growth effects. As some studies show (see e.g. Schlomann et al. 2013) there is a possible role for energy efficiency obligations in Germany, too, though up to now Germany only opted for alternative measures when implementing Article 7 EED (see Chapter 2.1.2).

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