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Increasing the EU's Energy Independence

Technical report

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Date: 20 October 2014

Project number: CLIDE15208

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1 Introduction

Current geopolitical circumstances, combined with depletion of domestic natural gas resources and the threat of climate change, raise the question of the extent to which the EU's dependence on natural gas imports can be decreased. Increasing domestic natural gas production could temporarily relieve dependence on imported energy, but reducing demand for natural gas will have a greater impact on energy security over the long term. This can be achieved with strengthened energy efficiency and renewable energy efforts, which would also reduce greenhouse gas (GHG) emissions.

This technical report addresses the potential for energy efficiency and renewable energy to displace natural gas use in the EU 28, and discusses the implications of this potential for energy security and climate change. It is accompanied by a separate Summary for Policymakers. This report lays out the analysis presented in the Summary, and the underlying assumptions and calculations in greater detail. After a brief overview of the current situation regarding natural gas dependence in Europe, this report focuses on the three main natural gas-consuming sectors: buildings, industry and energy supply. Each chapter discusses the current status and projected development of the sectors and lays out how energy efficiency and renewable energy can help reduce dependence on fossil fuel imports in the EU. Finally, we discuss the implications at EU-level, reviewing possible impacts on primary energy supply as well as GHG emissions until 2030.

The paper compares primary and final energy as well as natural gas consumption and GHG emissions under a number of scenarios (see also Section 7.1):

- Actual 1990 ("1990") and 2012 ("2012") figures taken from Eurostat (2014a) and Eurostat (2014b)
- Projections as reported by Primes ("2030-BAU") from European Commission (2013)
- projections for the EU 2030 Framework ("Current 2030 EU Framework") taken from the impact assessment by the Commission (European Commission 2014b)
- and our own analysis as described and undertaken for this report ("Energy Independence 2030")

2 Natural gas production and imports in the EU

In this section, we summarize the current state of natural gas production and expected developments to 2030. While Europe's primary energy consumption (gross inland consumption) did not grow substantially in the past two decades, Europe's net import dependency rate – the ratio of netimport to total consumption - did. The increasing share of natural gas in Europe's energy mix, combined with slowly declining domestic production, increased Europe's natural gas import dependency rate as well. Although under the current business-as-usual (BAU) scenario, natural gas demand increases only slightly through 2030, the net-import increase is greater. The proposed 2030 framework for climate and energy policies would mitigate this trend, resulting in a decrease in the net-import of natural gas relative to current imports, and a continuation of (but no decline in) the current net import dependency rate.

Historic developments

Energy consumption in Europe between 1990 and 2012 was relatively stable. However, Europe's domestic energy production decreased by 16 per cent over this period and net-imports[1] increased by more than 20 per cent. The import dependency[2] rate increased from 45 per cent in 1990 to 54 per cent in 2012(Eurostat, 2014b) (Figure 1).

[1] Net-import is defined as: gross inland consumption + supply to international maritime bunkers – domestic production

[2] Eurostat: "(D)efined as net energy imports divided by gross inland energy consumption plus fuel supplied to international maritime bunkers, expressed as a percentage." In case of natural gas, fuel supplied to international maritime bunkers is zero.

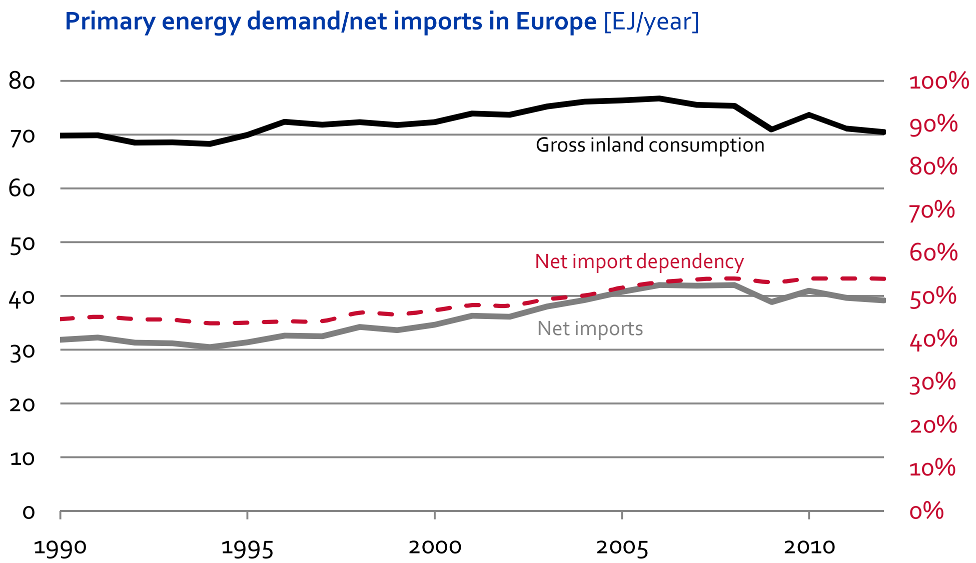

Figure 1 Primary energy demand and net imports in Europe between 1990 and 2012 [EJ/year].
***Source*: Eurostat 2014b**

Looking at natural gas consumption (Figure 2, the picture is different: while total primary energy demand has been stable, natural gas demand has increased by more than 30 per cent. A major driver of growth in demand was the increasing share of natural gas in electricity production. Furthermore, while natural gas production decreased by 19 per cent over the period 1990-2012, net imports nearly doubled (>90 per cent). This led to an increase in natural gas net import dependency from 45 per cent in 1990 to 66 per cent in 2012.

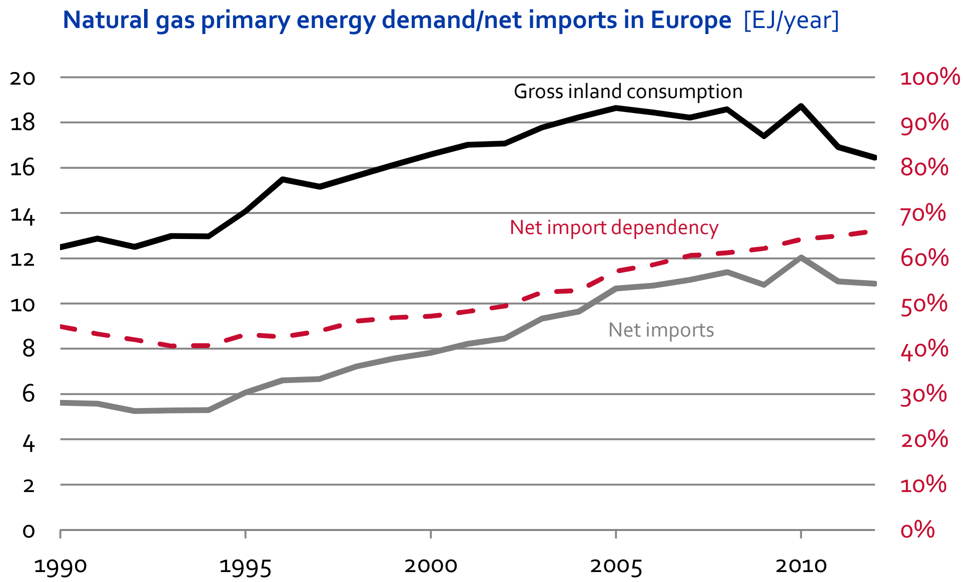

Figure 2 Natural gas primary energy demand and net imports in Europe between 1990 and 2012 [EJ/year].

***Source*: Eurostat 2014a**

Natural gas production in Europe in 2012 totalled 5.6 EJ, imports 14.4 EJ, and exports 3.6 EJ (Figure 3). Therefore, Europe's net imports neared 11 EJ. The largest exporter to Europe was Russia, closely followed by Norway. Both countries exported about 4 EJ in 2012 (Eurostat, 2014a).

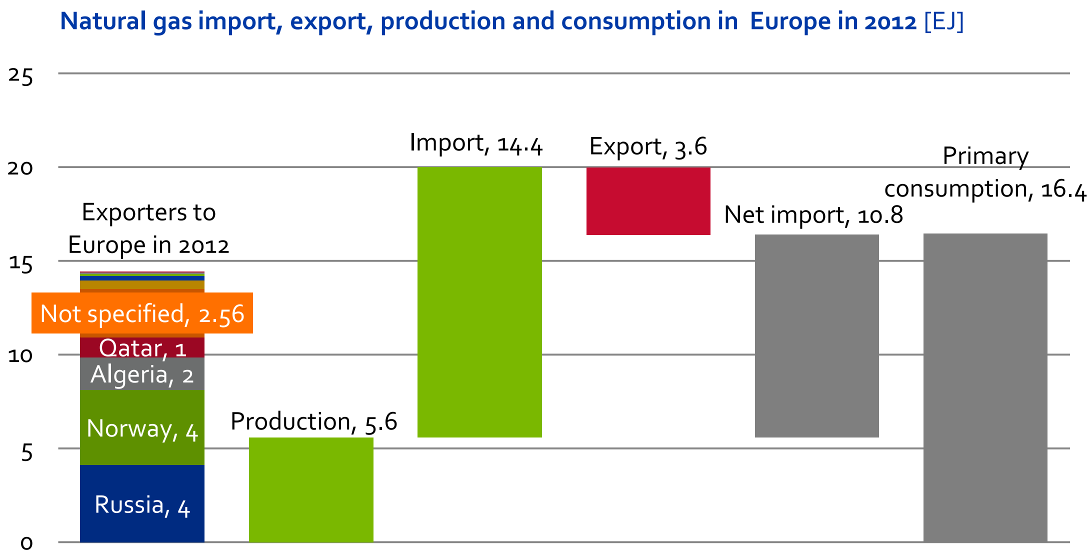

Figure 3 Key natural gas exporters to Europe, import, export, production and consumption in Europe in 2012.

Source: Eurostat 2014b[3]

The building sector was the largest consumer of natural gas in 2012 (6.4 EJ, or 39 per cent of total natural gas consumption), followed by electricity and heat generation (4.8 EJ, 29 per cent) and industry (3.7 EJ, 23 per cent).[4] Together, these sectors account for 91 per cent of all natural gas consumption in Europe. Chapter 3-5 provide further detail on how natural gas consumption in these core sectors might be reduced.

Future developments

In 2012, Europe's gross final energy consumption totalled 70 EJ of primary energy, of which natural gas accounted for 16.4 EJ (Eurostat, 2014b). The European Commission's 2013 PRIMES baseline scenario[5] (European Commission, 2013) projects a slight decrease in energy use to 68 EJ by 2030, while natural gas demand remains at the same level. However, the scenario also projects that natural gas production will decrease by 1 EJ. Consequently, net imports to Europe increase to 12 EJ and net import dependency increases to 73 per cent.

Recent analysis of future natural gas reserves in some of the leading European natural gas producing countries (namely the Netherlands and the UK), however, suggests that the decline in production will probably be larger than assumed in the PRIMES scenario. The Dutch energy forecast released in 2014 projects that production of natural gas will decrease from 2.4 EJ in 2012 to 0.7 EJ in 2030, a

[3] The total import from Eurostat table [nrg_124a] does not match with table [nrg_100a], the difference is included in the category non-specified in the left bar

[4] The remainder is being consumed in agriculture, transport and as feedstock (non-energy use)

[5] In the following referred to simply as "PRIMES scenario" in the text and in the graphs as "2030-BAU"

decrease of 70 per cent (Hekkenberg, Verdonk 2014). Projections for the UK foresee a decrease from 1.5 EJ to 0,7 EJ in the same time period, a reduction of 50 per cent below current levels (DECC 2014). Because these two countries currently account for 70 per cent of the EU's natural gas production, (Eurogas 2013), they have a remarkable influence on the EU's energy supply. If production in the Netherlands and UK declines according to the national projections cited above, their combined production will decline by 2.5 EJ, which is 1.5 EJ more than the decline projected under the PRIMES scenario.

Natural gas extraction from shale deposits could play a role in countering this trend. However, the future of shale gas is unclear. Firstly, techno-economic projections for shale gas production in Europe foresee only a minor role in primary production of energy, supplying less than 1 per cent in 2030 (Kersting et al forthcoming). Secondly, there are significant environmental concerns over hydraulic fracturing (fracking), including contamination of surface and groundwater with chemical and radioactive elements (PSE Healthy Energy 2014). This creates the need for stringent regulation to minimize environmental impacts, which might take a long time to establish. Low production forecasts and environmental issues suggest that shale gas from fracking will play only a small role in Europe in 2030.

The projected reduction in natural gas production in the Netherlands and the UK, combined with the probable limited role of shale gas in the future, suggest that domestic natural gas production will play an even smaller role in the future than forecast in the PRIMES scenario. However, to stay consistent with other EU analyses, we assume in this paper that natural gas production develops at the same rate that is assumed under the PRIMES scenario.

In 2014, the European Commission proposed an energy and climate package that comprised an energy efficiency target[6] of 30 per cent and a renewable energy target of 27 per cent for 2030.[7,8] According to the impact assessment published in July 2014 (European Commission 2014b), a combination of these targets would lead to a decrease in gross final energy consumption to 65 EJ, and a decrease in natural gas consumption to approximately 13 EJ.[9] The resulting import dependency rate decreases relative to business-as-usual (BAU), but does not improve compared to 2012 levels.[10]

To reduce energy import dependency, therefore, natural gas consumption needs to be further reduced. This is feasible through more rapid deployment of energy efficiency measures and renewable energy sources. The effects of such additional efforts are analyzed in the next three chapters.

[6] At the time of publication, the energy efficiency target had not been specified further.
[7] The first target means a 30% savings with respect the 2007 PRIMES baseline scenario the latter a share of 27% in Europe's gross final energy consumption..
[8] Renewable energy production is in case of a 27% target at the same level as in the PRIMES 2013 reference scenario.
[9] The impact assessment mentions 60 EJ, but this excludes non-energy consumption. To align this with the definition of gross inland consumption, the non-energy consumption of 2030 in the 2013 baseline scenario (European Commission, 2013)(European Commission, 2013)
[10] Depending on the assumed/modelled domestic production, the net-dependency would lie in the range 65-70%.

3 Natural gas demand in buildings

In 2012, the built environment was the largest consumer of natural gas and final energy in Europe. Buildings account for 6.4 EJ, or 39 per cent, of total natural gas consumption. Of all economic sectors, buildings have the greatest energy efficiency potential; by 2030, improved efficiency measures could reduce natural gas demand to 3.6 EJ. Enhanced renewable energy capacity could further reduce natural gas demand by an additional 0.9 EJ to 2.7 EJ.

3.1 Current status and outlook

In Europe, buildings use approximately 18 EJ per year, equivalent to 40 per cent of total final energy consumption. Two thirds of this energy is consumed in residential, and one third in non-residential buildings (Eurostat, 2014b). Energy is consumed for space heating, water heating, space cooling, cooking, and electric appliances. In residential buildings, 85 per cent of the energy is used for heating, cooking and cooling; in non-residential buildings, these uses account for about 80 per cent of energy consumption. These shares are expected to decrease slightly, owing to increased use of electric appliances and improvements in the thermal performance of buildings.

In 2012, natural gas consumption in buildings was 6.4 EJ, primarily accounted for by heating and cooking. The PRIMES scenario [11] projects a decrease by 2030 to 5.9 EJ (European Commission, 2013).

Under the PRIMES scenario the thermal performance of buildings is expected to improve in the coming decades. Because existing energy efficiency policies that are considered in the PRIMES scenario are mainly aimed at new buildings and not the retrofit of existing buildings, the overall energy intensity of households is expected to decrease slowly. In the PRIMES scenario, energy consumption in buildings remains at 18 EJ because, while energy requirements for heating, cooling and cooking decline per household, the number of households increases.

[11] The PRIMES scenario assumes existing policies will be implemented

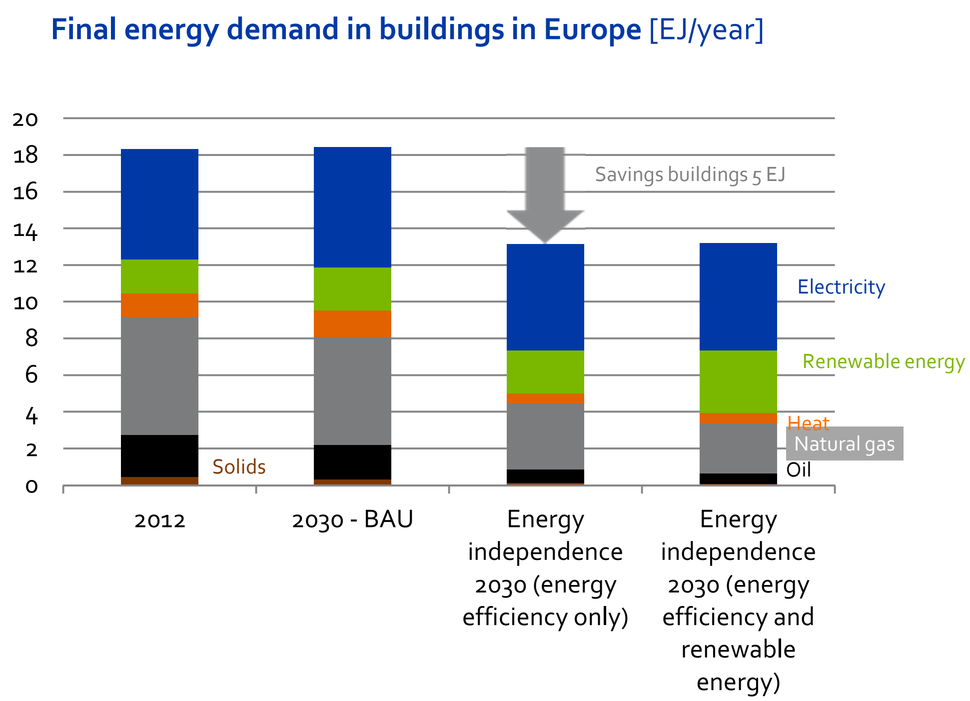

Figure 4 Final energy demand in buildings in Europe in 2012 and 2030 under different scenarios.
***Source*: Eurostat 2014b, European Commission 2013, Ecofys analysis**

3.2 The impact of energy efficiency and renewable energy

In Europe, the built environment has a greater potential for energy saving than any other sector; significant reductions can be made in energy demand for heating, in particular, through improvements to the building envelope and heating systems. The largest untapped potential is in the refurbishment of existing buildings: while European legislation enforces that Nearly Zero-Energy Buildings (NEZB) will be standard from 2020 onwards for new buildings, existing buildings are not subject to higher standards.[12]

Energy demand for heating and cooling can be cost-effectively reduced by around 4-5 EJ in 2030, [13] compared to BAU (Boßmann, Eichhammer, & Elsland, 2012; Ecofys, 2014). About 70 per cent of this potential can be realized by improving the building envelope (insulation and improved glazing) whilst the remaining 30 per cent can be achieved through the implementation of more efficient heating technologies, most notably heat pumps. In 2030, 30-36 per cent of the heat in buildings could be delivered by heat pumps, which would decrease gas demand while slightly increasing electricity demand.

[12] The EPBD asks European Member States to set minimum requirements for buildings and buildings components undertaking major renovation (European Commission 2010). These renovations, however, are not mandatory as in the NEZB for new buildings.
[13] For a definition of cost-effectiveness see Section 7.2

Additionally, electricity demand for appliances can be reduced by nearly 0.7 EJ (Boßmann et al., 2012). In total, energy demand in buildings can be reduced by around 5 EJ, compared to BAU (see Figure 4), of which natural gas would account for 2.3 EJ.[14]

In the built environment, additional renewable energy (for example, solar thermal, biomass) could displace fossil fuels used for heating.[15] If historic growth rates (2000-2010) were continued, 1 EJ of additional biomass would be used in buildings compared to BAU, reducing demand for natural gas-fuelled energy by an additional 0.9 EJ.

To summarize, cost-effective improvements in energy efficiency and realistic increases in renewable energy use could enable Europe to reduce its demand for natural gas in buildings by more than 3 EJ in 2030 compared to the BAU. This represents a reduction of 58 per cent relative to demand for natural gas in buildings in 2012.

[14] We assume the energy saving potential for heating is distributed equally among fossil fuels: this means that the share of each fuel in the fossil fuel mix remains the same. Additional electricity use for heat pumps is accounted for.
[15] In this study, heat pumps are regarded as energy efficiency measures and not as renewable energy. In the European target, the heat extracted from the air and ground is accounted (under conditions) as renewable energy.

4 Natural gas demand in industry

In 2012, the industry sector was the third largest consumer of final energy as well as natural gas in Europe. Industry accounted for 3.7 EJ, or 23 per cent, of total natural gas consumption. Of all three sectors investigated here, industry has the smallest energy efficiency potential; by 2030, improved efficiency measures could reduce natural gas demand to 3.1 EJ. Enhanced renewable energy capacity could further reduce natural gas demand by an additional 0.1 EJ to 3.0 EJ.

4.1 Current status and outlook

The final energy demand of the industry sector in Europe was nearly 12 EJ in 2012, or 26 per cent of total final energy demand (Eurostat, 2014b). The chemical subsector and iron and steel production consume the largest shares of energy, each accounting for 20 per cent of total industrial energy consumption. Although coal is the primary energy source for iron and steel production, natural gas is important in many industrial processes. The chemical industry is the sub-sector with the largest consumption of natural gas (20 per cent of industrial gas consumption), followed by non-metallic mineral production (15 per cent) and food and tobacco (15 per cent).

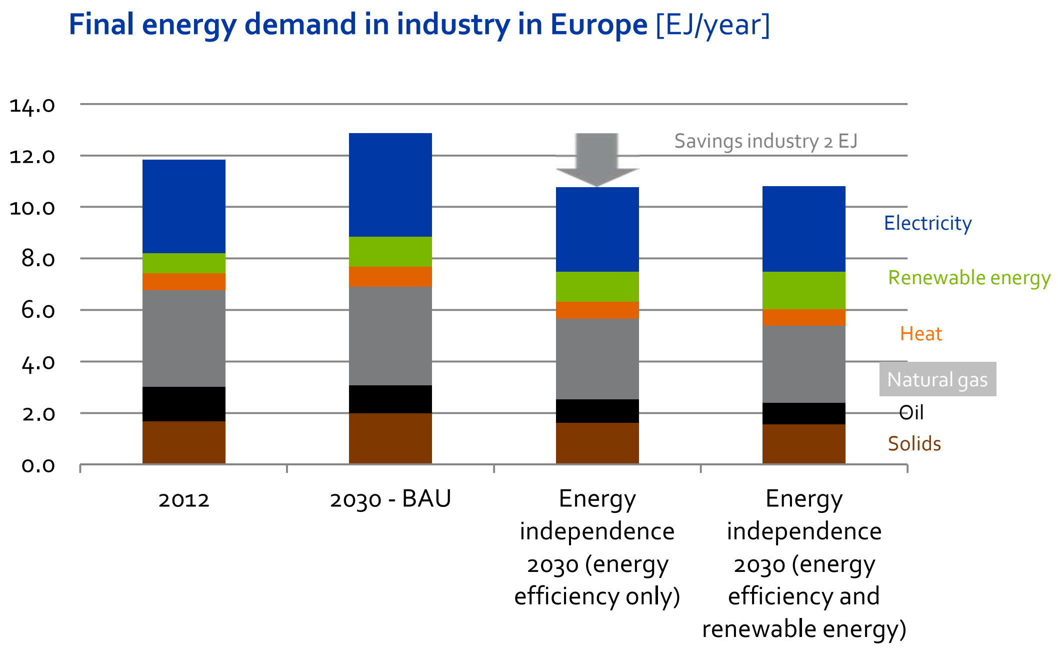

Figure 5 Final energy demand in industry in Europe in 2012 and 2030 under different scenarios.
***Source*: Eurostat 2014b, European Commission 2013, Ecofys analysis**

Although the energy intensity of industry will decline in the future, the extent of the decline is not sufficient to compensate for the increase in output expected under the PRIMES scenario. Industrial energy consumption is expected to increase 1 EJ by 2030; a notable exception to the sector-wide growth in energy demand is the chemicals subsector, where energy demand is projected to decrease slightly, despite a growth in added value (Boßmann et al., 2012).[16] The sub-sectors engineering and non-metallic minerals experience the highest growth rates of energy demand in the BAU scenario.

4.2 The impact of energy efficiency and renewable energy

Industrial energy demand can be reduced firstly by implementing technical measures to save energy, such as best practice technologies, and secondly by shifting production to less energy-intensive products or processes, for example by increasing production of recycled steel. In this study, we consider only the first option, that is, we assume that the structure of the industry sector remains the same as in the BAU scenario. Intensifying recycling and increasing the production of secondary steel and aluminium could save even more energy. Thus, the potential energy savings presented here represent a conservative estimate.

Two thirds of industrial final energy use is supplied by fuels. These fuels are mainly used for heating processes at different temperature levels. The remaining third of energy is supplied by electricity, of which two thirds is consumed by drive motors, for example for pumping and ventilation. About 70 per cent (1.4 EJ) of the cost-effective[17] energy savings potential applies to fuels and can be realized by improving processes (for example, by re-using heat) and improving heating systems (Boßmann et al., 2012). According to Fraunhofer (Boßmann et al., 2012), electricity demand can be reduced by 0.7 EJ by improving electric drive systems and using more efficient drives.

In total, energy efficiency improvements can reduce energy demand in the industry sector by 2.1 EJ, compared to BAU. These energy savings will reduce natural gas demand by 0.7 EJ.[18]

Renewable energy in industry is projected to grow in the BAU scenario, from less than 1 EJ currently to 1.2 EJ in 2030. If renewable energy use continues to grow at the same rates observed between 2000 and 2010, then renewable energy consumption would reach 1.4 EJ by 2030. This would reduce natural gas demand by another 0.1 EJ.

The efforts in energy efficiency and renewable energy described here could reduce natural gas demand by 0.7 EJ in 2030, which is equivalent to more than 20 per cent of current industrial natural gas demand.

[16] The decrease can be attributed to a higher efficiency as well as a shift to products that are less energy intensive

[17] Please see Section 7.2 for the definition of cost-effectiveness used here

[18] We assumed the energy saving potential for heating is distributed equally among fossil fuels: this means that the share of each fuel in the fossil fuel mix remains the same

5 Natural gas demand in energy supply

In 2012, energy supply sector was the second largest consumer natural gas in Europe. Energy supply accounted for 4.8 EJ, or 30 per cent, of total natural gas consumption. Energy efficiency measures in the demand sectors (buildings and industry) can reduce natural gas consumption to 3.3 EJ in the energy supply sector, realistic development of renewable sources can further reduce natural gas demand by an additional 1.5 EJ to 1.8 EJ in 2030.

5.1 Current status and outlook

Electricity and heat generation in 2012 consumed 28.7 EJ of primary energy in order to generate 11.9 EJ (3,300 TWh) of electricity and 2.5 EJ of heat (Eurostat, 2014b). Most electricity is produced from coal and nuclear power; 3.4 EJ (950 TWh) and 3.2 EJ (880 TWh) respectively. Natural gas is the third largest contributor to electricity generation, responsible for 2.1 EJ (580 EJ) of electricity. The total primary natural gas consumption for electricity and central heat generation was 4.8 EJ.

Renewables accounted for about 24 per cent of the electricity generated in 2012. Hydropower, biomass, and wind energy were the largest renewable energy sources.

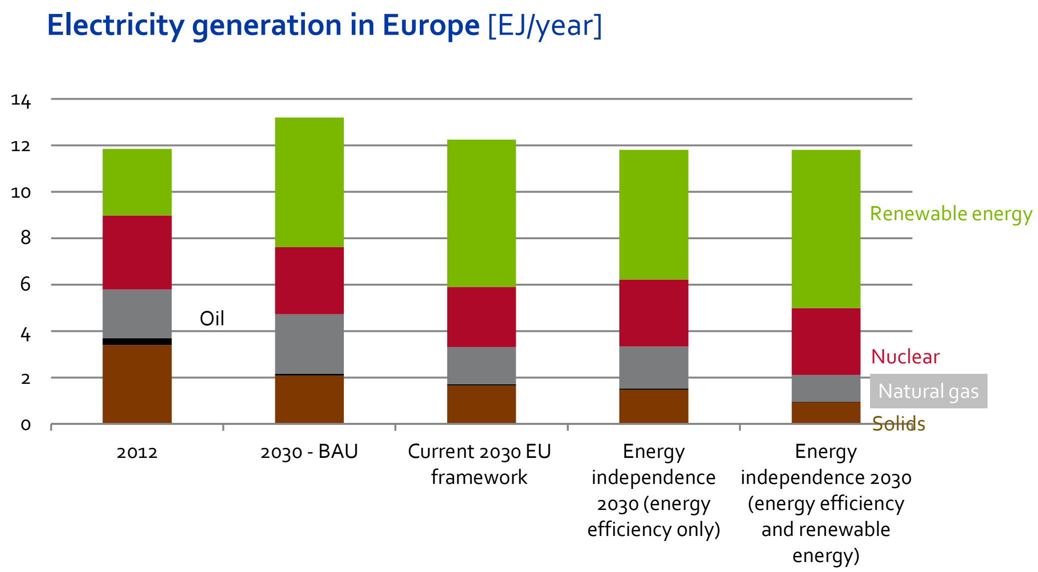

Figure 6 Electricity generation in Europe in 2012 and 2030 under different scenarios.

***Source*: Eurostat 2014b, European Commission 2013, European Commission 2014b, Ecofys analysis**

In the BAU scenario, total electricity generation is expected to grow, as is the share of renewable energy (to 42 per cent in 2030). The growth in renewable energy, combined with an increase in efficiency of thermal power generation, results in a decrease of 2.6 EJ in the primary energy input to electricity plants, despite the increase in electricity generation (European Commission, 2013).[19]

5.2 The impact of energy efficiency and renewable energy

If the industry and buildings sectors were to implement energy efficiency measures that save electricity,[20] as described in the previous chapters, electricity generation could be decreased by 1.4 EJ in 2030 compared to the PRIMES scenario. This would reduce natural gas demand by 1.9 EJ below the PRIMES scenario or 1.5 EJ below 2012.[21]

If renewable energy growth maintains the trend of 2000-2010,[22] electricity generated by renewables would grow from 5.6 EJ (1550 TWh) to 6.8 EJ (1890 TWh). This increase in renewable electricity would reduce natural gas demand by another 1.5 EJ.

[19] In energy statistics, non-thermal renewable energy generation (for example wind energy, solar PV and hydropower) have a 100 per cent efficiency.

[20] Fuel savings are accounted for in the respective sectors, in this sector we account only for electricity and heat savings

[21] We assume that electricity savings and a growth in renewable energy are at the expense of fossil fuels and not at the expense of nuclear power and renewable energy generation. Furthermore, we assume that the fossil fuel mix remains the same

[22] For a discussion on the assumptions used here for the growth and share of renewable energy please see Section 7.3

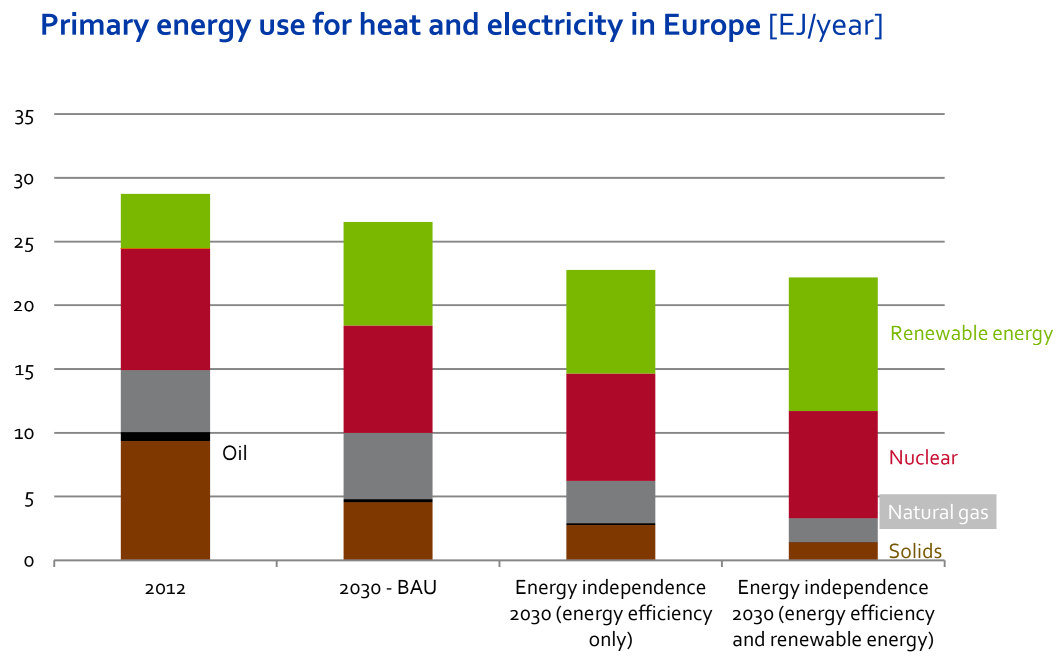

Figure 7 Primary energy input for electricity and central heat generation in Europe in 2012 and 2030 under different scenarios.

***Source*: Eurostat 2014b, European Commission 2013, Ecofys analysis**

6 Implications for the EU

This section draws together the sector specific analyses and discusses the implications at the EU level. We show that the primary energy supply can be made significantly less dependent on natural gas if the kind of energy efficiency and renewable energy measures discussed in this paper are implemented. Furthermore, European greenhouse gas emissions can be reduced well below the currently proposed 40 per cent target by 2030 and could reach levels that (without the need for international carbon offsets), are in line with what might be considered a "fair" target for the EU. This has important implications for EU policy-making, allowing the EU to set a high bar for emissions reductions in the international climate negotiations.

6.1 Energy demand and supply

In 2012, primary energy demand in Europe was met principally by fossil fuel sources (65 per cent); natural gas was the second largest fossil energy carrier after oil, with a share of 23 per cent of total energy supply. Renewable energy sources played a significant but more modest role, providing 11 per cent of the primary energy demand. The share of renewables seems likely to continue its growth into the future, driven by the EU Renewable Energy Supply directive of 2009 (European Commission 2009), which sets a 20 per cent renewable energy target in 2020 and requires member states to implement measures accordingly. In addition, energy efficiency also seems likely to play a role; energy intensity will decrease by 30 per cent by 2030 (relative to 2012) according to the PRIMES scenario (European Commission 2013).

Based on our calculations for energy efficiency and renewable energy in the industry and buildings sectors, we estimate that cost-effective energy efficiency measures in these two sectors could reduce final energy demand by an additional 7 EJ compared to the PRIMES scenario, which is at 31 EJ in 2030 (Figure 8). Assuming that renewable energy will continue its historic growth rates and that energy demand reductions in the two sectors are shared over the fossil fuel carriers as described in Sections 3.2 and 4.2, then dependence on natural gas would be reduced. We estimate that the share of natural gas in final energy demand will be reduced from 31 per cent under the PRIMES scenario to 24 per cent, a full 7 percentage points lower. This extra reduction will be achieved only if both energy efficiency measures and renewable energy gains are implemented. In absolute numbers this means that the use of natural gas can be reduced by 4 EJ.

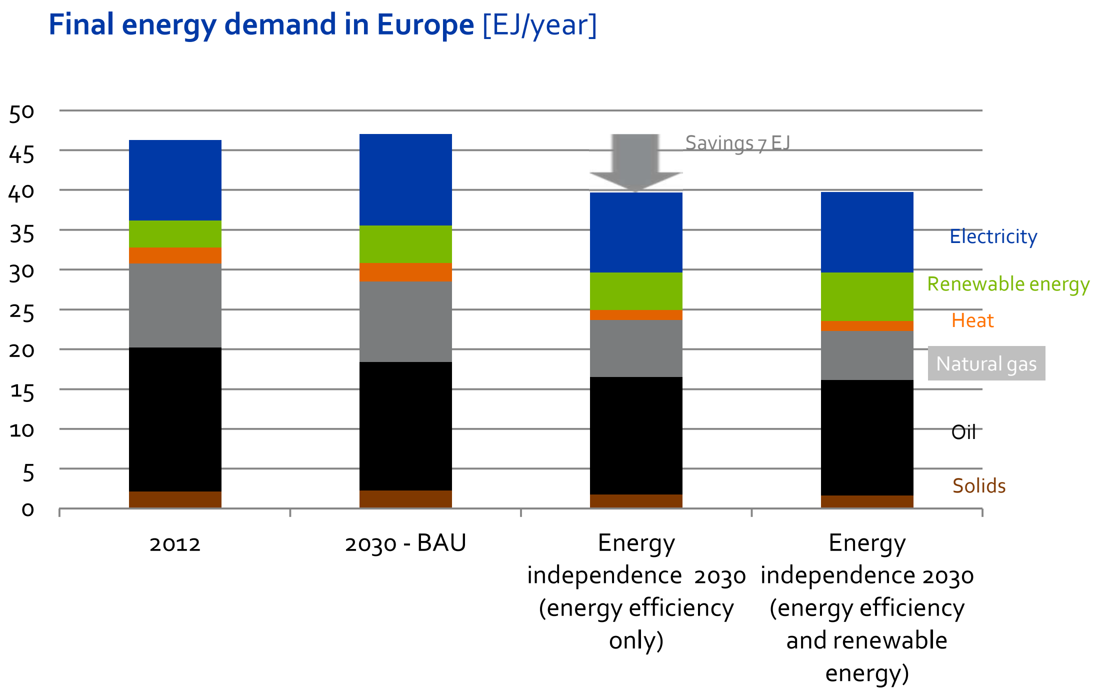

Figure 8 Final energy demand by energy carrier in Europe in 2012 and 2030 under different scenarios. ***Source*****: Eurostat 2014, European Commission 2013, Ecofys analysis**

Increased use of renewable sources in the energy supply sector can further reduce dependence on fossil fuels. The primary input to central electricity and heat generation can be reduced, according to our calculations, by 4.2 EJ down from 26.5 EJ under the BAU. Together with the increased use of renewable energy sources this can reduce the use of natural gas by 3.4 EJ down from 5.2 EJ under the BAU.

Assuming the potential for the sectors described above is realized in full, the total primary energy demand (**Error! Reference source not found.**) can be decreased by 13 per cent under the 'Energy independence 2030 (energy efficiency only)' scenario and 14 per cent under the 'Energy independence 2030 (energy efficiency and renewable energy)' scenario compare to the PRIMES scenario. With respect to natural gas both, energy efficiency and renewable energy measures, lead to a reduction in the share of natural gas in primary energy demand from 25 per cent under the BAU to 20 per cent under 'energy efficiency only' to 16 per cent under 'energy efficiency and renewables.' In total, energy efficiency and renewable energy measures as described above are able to reduce the share of natural gas by 9 percentage points, or 7.4 EJ, compared to the BAU forecast, down to 16 per cent (9.4 EJ) of total primary energy supply in 2030 (Figure 10).

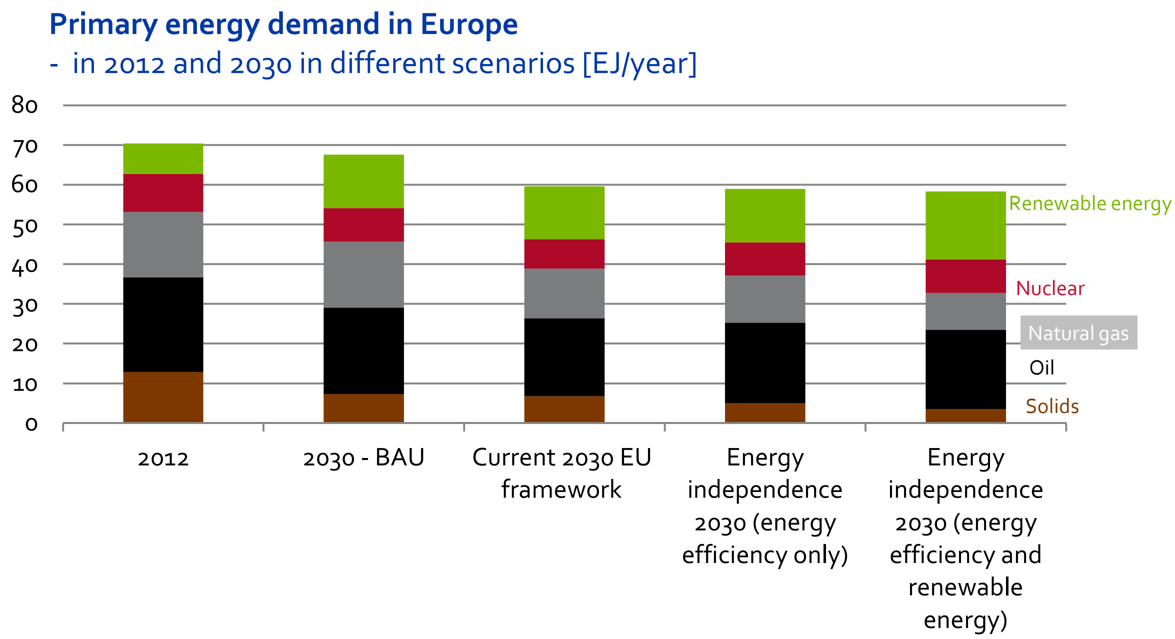

Figure 9 Primary energy demand by energy carrier in Europe in 2012 and 2030 under different scenarios.

***Source*: Eurostat 2014, European Commission 2013, European Commission 2014b, Ecofys analysis**

The 2030 framework for climate and energy policy (European Commission 2014a), according to the impact assessment (European Commission 2014b), will be able to decrease primary energy demand by 12 per cent below BAU. Simultaneously the share of natural gas in total primary energy demand will be reduced by only four percentage points compared to the BAU points to 21 per cent. As we have tried to show, concerted efforts in energy efficiency and renewables will have a real effect on natural gas dependency; such efforts can reduce natural gas consumption by nine percentage points, a reduction that is more than double the potential impact of the 2030 framework for climate and energy policy suggests (four percentage points).

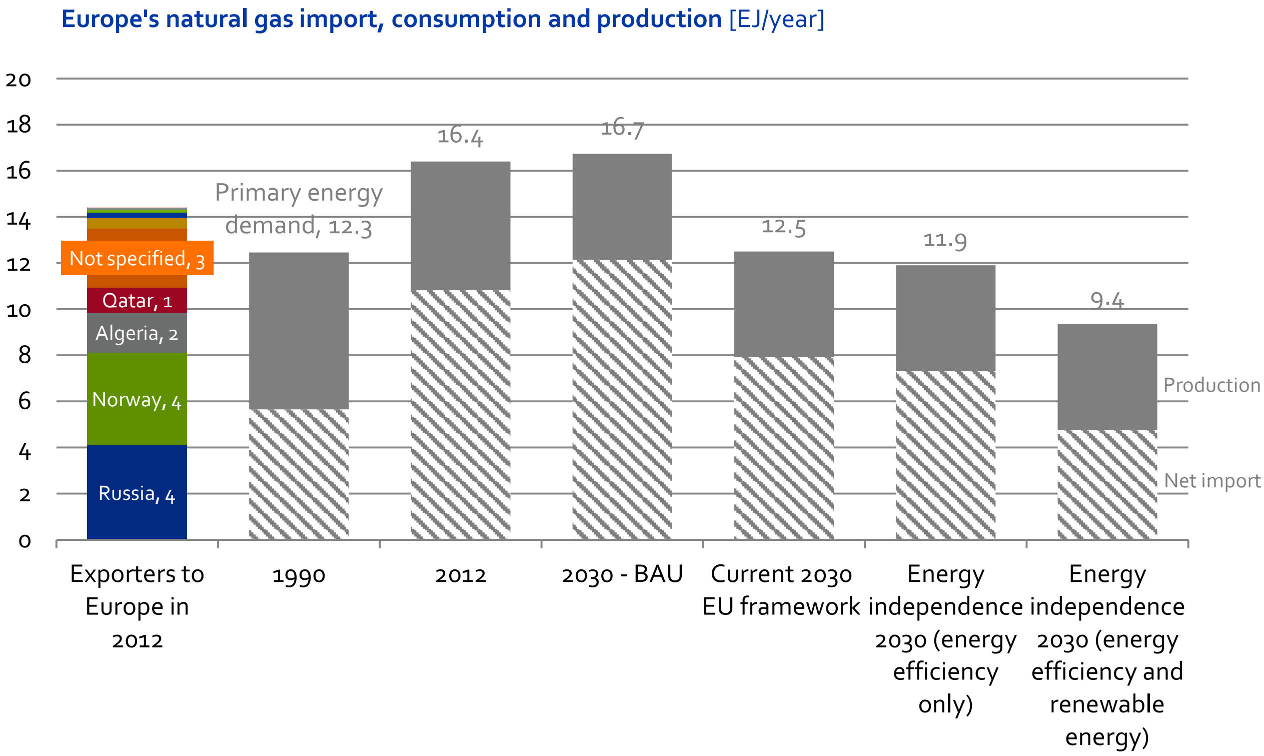

Figure 10 Leading exporters of natural gas to Europe, historic and possible future production and net-imports in 1990, 2013, and under different scenarios for 2030.

***Source*: Eurostat 2014, European Commission 2013, European Commission 2014b, Ecofys analysis[23]**

6.2 GHG emissions

Energy-related GHG emissions can be cut by 53 per cent compared to 1990,[24] nine percentage points below the target of the 2030 framework for climate and energy policy (European Commission 2014a), if the energy efficiency and renewable energy measures outlined here are implemented. In 2013, energy-related GHG emissions were already 14 per cent lower than in 1990; they will be reduced to 31 per cent lower than 1990 levels under the PRIMES scenario and could be reduced further to 42 per cent below 1990 levels if the proposed 2030 Framework for Climate and Energy Policies is implemented. Our calculations show that energy efficiency measures alone could reduce emissions by 46 per cent compared to 1990 levels. Potential energy efficiency measures in the transport sector have not been included in our calculations.

[23] Note the bar "Exporters to Europe in 2012" shows the absolute import to Europe, the bars labelled as net import show the absolute import-exports

[24] Energy related emission were calculated based on the primary energy demand calculations as presented in **Error! Reference source not found.** and using emission factors from the IPCC

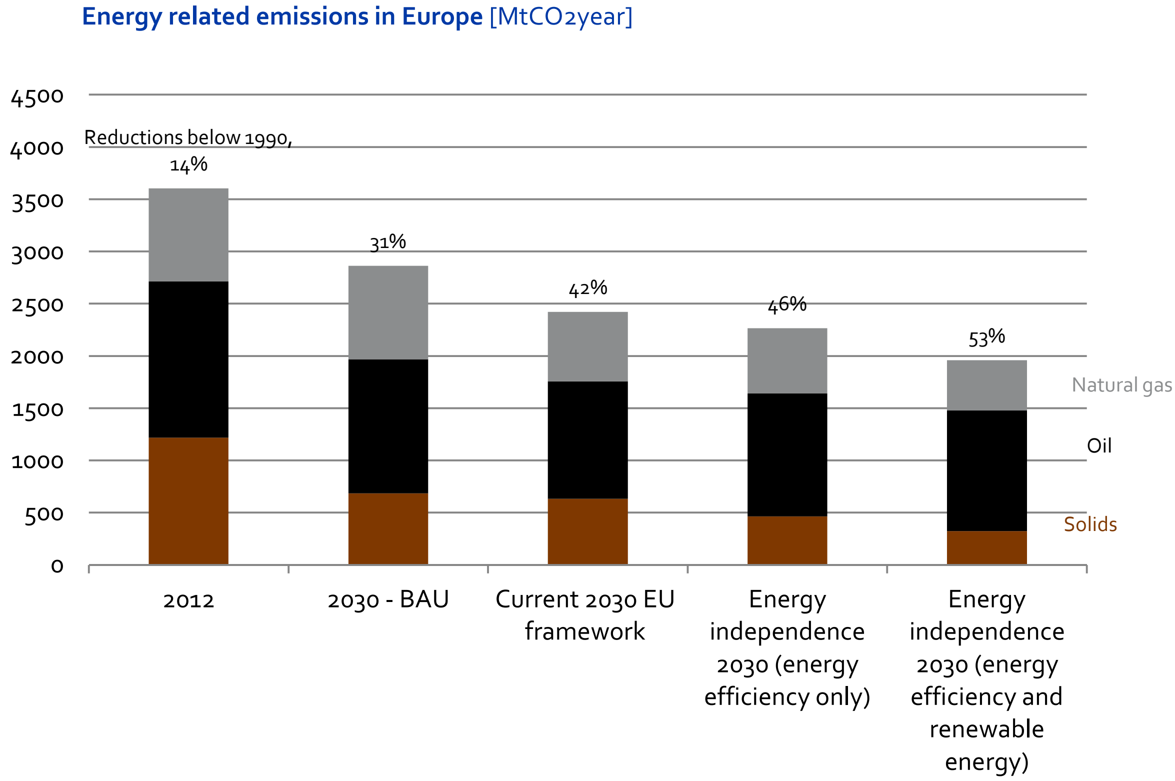

Figure 11 Energy related emissions by energy carrier in Europe in 2012 and 2030 under different scenarios.

***Source*: Eurostat 2014a, European Commission 2014b, Ecofys analysis**

Total GHG emissions, including land use, land-use change and forestry (LULUCF), could be reduced to 49 per cent below 1990 levels according to our calculations. The current 2030 Framework for Climate and Energy Policies assumes that little or no effort will be undertaken to reduce emissions from non-energy sources.[25] While non-energy emissions have more limited potential than energy-related emissions, emissions from agriculture, as well as LULUCF emissions, have stabilised or even decreased slightly in past years (EEA 2014). Furthermore, as already mentioned, our calculations do not take account of possible emission reductions in the transport sector. Hence, the potential exists to reduce emissions beyond 49 per cent below 1990 levels.

A 49 per cent reduction below 1990 emission levels is arguably in line with what might be considered a "fair" contribution by the EU towards the global effort to limit global warming to 2°C above preindustrial levels. In an earlier study (Ecofys 2013b), we showed that the range of effort sharing approaches results in an average emission reduction target of 49 per cent below 1990. Given that the

[25] According to our own calculations, the 40% is based on a calculation that assumes that non-energy emissions will increase under the energy and climate package.

study presented here uses only cost-effective energy efficiency improvement and realistic renewable energy growth, it would be in the EU's interest to take full advantage of this situation and reiterate its position as role model in the international climate negotiations by putting forward a more ambitious domestic emission reduction target than that proposed. Our analysis shows that the EU could take the lead in putting forward an "intended nationally determined contribution 'INDC'" that represents a fair contribution to a new international climate agreement.

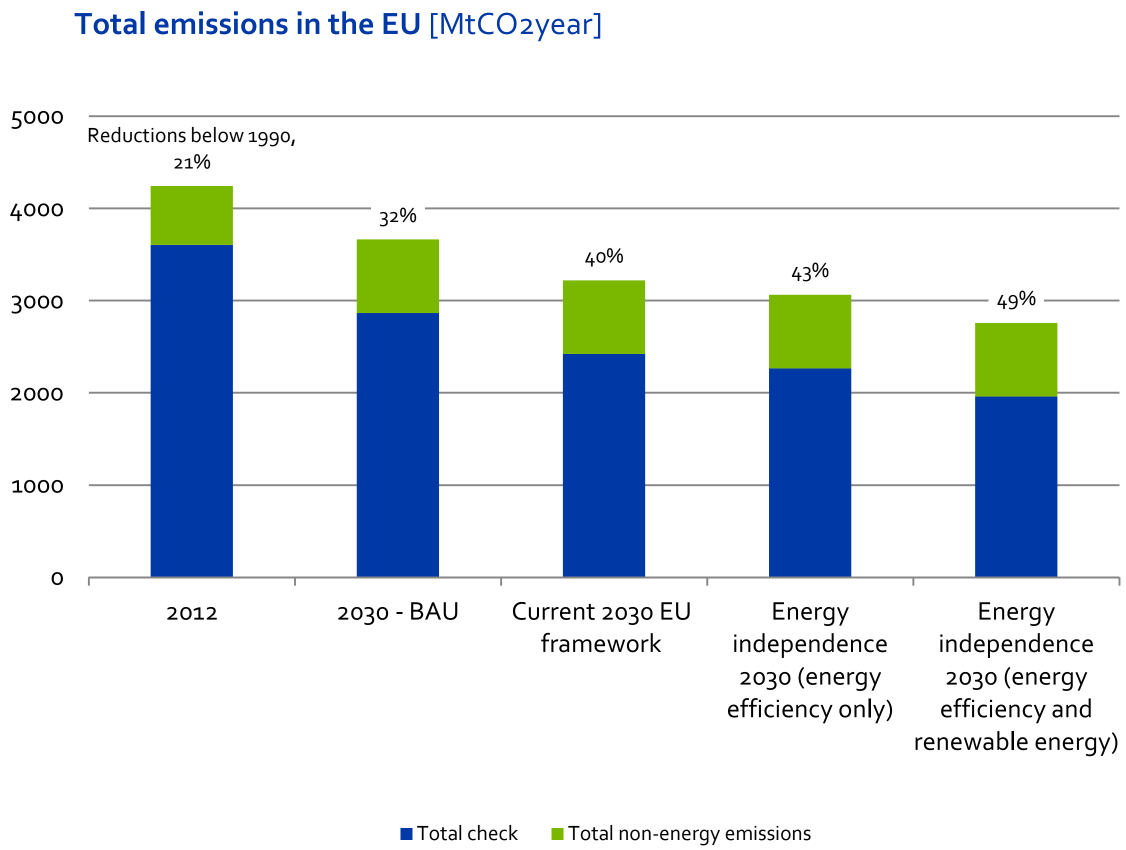

Figure 12 Total emissions (including land use, land-use change and forestry) in Europe in 2012 and 2030 under different scenarios.

***Source*: Eurostat 2014a, EEA 2014, European Commission 2014b, Ecofys analysis**

7 Notes on methodology

7.1 Overview of scenarios

Table 1: Overview of scenarios used in this report

Scenario	Time horizon	Name as used in text	Name as used in graphs	Description
2013 PRIMES baseline scenario (European Commission, 2013)	2030	PRIMES scenario	2030-BAU	The, forecast developments based on current economic and demographic trends and existing policies.
2030 framework for climate and energy policies (European Commission 2014a and 2014b)	2030	2030 framework for climate and energy policies	Current 2030 EU Framework	This year, the European Commission proposed an energy and climate package that comprised an energy efficiency target of 30 per cent and a renewable energy target of 27 per cent. The first target means a 30 per cent savings with respect to the 2007 PRIMES baseline scenario (European Commission 2007), the second target refers to a share of 27 per cent in Europe's gross final energy consumption.
Energy efficiency scenario (own calculations)	2030	Energy independence 2030 (energy efficiency only)	Energy independence 2030 (energy efficiency only)	This includes the effects of cost-effective energy savings that go beyond the BAU scenario. It is based on potential studies of Fraunhofer ISI (Boßmann et al., 2012) and Ecofys (Ecofys, 2014).
Energy efficiency and renewable energy scenario (own calculations)	2030	Energy independence 2030 (energy efficiency and renewable energy)	Energy independence 2030 (energy efficiency and renewable energy)	This includes the effect of the EE study as well as an increased implementation rate of renewable energy. The assumed rates of increase are equal to the growth rates in renewable heat and renewable electricity achieved in the period 2000-2010 (See also Section 7.3).

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7.2 What is cost-effective?

In this study we consider cost-effective potential as defined by Fraunhofer ISI (Boßmann et al., 2012). In the study by Boßmann et al. (2012), about 50 per cent of the potential in the building sector and two thirds of the potential in the industry sector are considered cost-effective at high discount rates (8 per cent for buildings, 30 per cent for industry), while the rest of the investments are cost-effective over the lifetime of measures and at higher fuel prices than used in the PRIMES scenario (Boßmann et al., 2012). If we aggregate all measures (as done for this study), the potential is financially beneficial, but policy effort is needed to stimulate some of the individual measures and overcome barriers.

Furthermore Boßmannn et al. (2012) list further technical energy efficiency potential that goes beyond what is considered here. These additional measures are not cost-effective, even at higher fuel prices. However, the monetary savings from the cost-effective measures could more than cover the additional costs from the more expensive measures.

7.3 Renewable energy growth rates

In this study we look at growth rates that were achieved in Europe in the period 2000-2010 (without heat-pumps) and apply these growth rates between 2012 and 2030. These growth rates were:

- 3.5 per cent per year for heating (in buildings and industry)
- 4.9 per cent per year for electricity (output)

For renewables in electricity generation the above mentioned growth rates result in a 58 per cent share of renewables by 2030, which is nearly nine percentage points higher than projections under the 2030 framework for climate and energy policies (European Commission 2014a and 2014b). As Table 2 shows, these growth rates are in line with growth rates outlined in the IEA World Energy Outlook 2012 in the 450 ppm scenario (IEA 2012) as well as the Ecofys Energy report scenario for Europe (a determination of EU27 data from The Energy Report (TER) - Ecofys 2013a), but lower than growth rates in, for example, the Greenpeace Energy [r]evolution scenario (Greenpeace 2012). These scenarios aim for high shares of renewables in total primary energy by 2050 (~100 per cent according to the TER EU27 result, and 50-80 per cent according to the Energy [R]evolution scenario), and assume no use of carbon capture and storage (CCS). A major difference between these scenarios is that the Energy [R]evolution scenario assumes a complete phase-out of nuclear energy by 2040.

Table 2: Share of renewable energy in central electricity generation according to different scenarios

Scenario	RE share in electricity in 2030 (%)
IEA World Energy Outlook 2012, 450 ppm scenario (IEA 2012)	57 (2035)
Ecofys Energy report scenario for Europe (Ecofys 2013)	65
Greenpeace Energy [r]evolution scenario (Greenpeace 2012)	71
2030 framework for climate and energy policies (European Commission 2014a and 2014b)	49.3
Energy efficiency and renewable energy scenario (own calculations)	**58**

7.4 Natural gas development in the energy supply sector

This study assumes that, as the share of renewables in electricity generation increases, the decrease in demand for natural gas is proportional to decreases in demand for other fossil fuels. The resulting share of natural gas in electricity generation by 2030, according to this report, is 9 per cent, which is in line with calculations of the World Energy Outlook (WEO) 450ppm scenario, as shown in Table 3. The Energy [R]evolution scenario calculates a much higher share for natural gas in 2030, since the share of nuclear energy in this scenario is reduced nearly to zero by 2030, whilst in the WEO scenario the share of nuclear energy continues to increase slightly.

Table 3: Share of natural gas in electricity generation according to different scenarios

Scenario	Natural gas share in electricity in 2030 (%)
IEA World Energy Outlook 2012 450 ppm scenario (IEA 2013)	8 (2035)
Greenpeace Energy [r]evolution scenario (Greenpeace 2012)	27
This report	**9**

Recent historical data available from Germany support the assumptions made about the potential for natural gas demand reductions alongside increasing shares of renewables. Whilst the share of renewables increased in Germany between 2010 and 2013 from 16 per cent to 24 per cent, the share of natural gas decreased from 14 per cent to 11 per cent, and the share of coal increased from 42 per cent to 45 per cent (Ecofys 2014c).

7.5 Scope

Regional scope: When referring to Europe, we refer to the EU28 countries.
Primary energy demand: primary energy demand (or gross inland consumption) includes non-energy use. However, **final energy demand** does not include non-energy consumption.

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