# How to reduce Europe's energy import dependency significantly by deep renovation of buildings

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## Abstract

During the negotiations of EU´s 2030 energy and climate package the political turmoil in the Ukraine has triggered a discussion around the European energy security strategy. This process has highlighted the geopolitical risks of imports and the vulnerability of the EU and its economy.

Within this framework the paper analyses the EU's current energy consumption of all sectors in a first step and the shares per energy carrier imported by country of origin. Based on this the second step is a detailed analysis of the EU building sector energy demand with details on heating, hot water, cooling and electricity consumption. In a third step the effects of deep renovation measures (building shell and HVAC systems) in the EU's building sector on the energy import balance are shown with target years 2030 and 2050. This part is based on a comprehensive scenario modelling with the Ecofys Built-Environment-Analysis-Model BEAM². Not only the speed of energy demand reduction, but also costs for deep renovation are addressed in comparison with other options such as shale gas, nuclear energy or coal. Since measures to the building shell and regarding HVAC systems are analysed, a reduction of the useful energy demand is accounted for as well as system and fuel switches due to replacement of systems and/or new installations. Main key message here is about by how much energy imports can be reduced in what timeline and what energy carriers play what roll.

As last step a brief overview about potentials in other sectors is given, addressing especially the effects to energy imports due to increasing energy efficiency in industry and renewable energy production.

## Introduction

Energy security became a first-level political priority in early 2014 as a result of the escalation of tension between Russia and Ukraine, which reached its highest levels during last years' summer. But the problem is not new. Despite the relatively "stable" period that the EU has experienced from the oil crisis in the 70's, in the winters of 2006 and 2009 some EU eastern Member States experienced temporary disruptions of gas supplies. This was "a wake up call", as recognised by the Commission in its Energy Security Strategy (adopted on 28 May 2014). Nevertheless, it was not until last year that the EU decided to take bold action in order to avoid that this "recurrent" problem becomes a serious threat to the continent's prosperity.

The above-mentioned Security Strategy states that today the EU imports 53 % of the energy it consumes, and energy import dependency relates mainly to crude oil (almost 90 %), to natural gas (66 %). In addition to the major political threat that this represents, this dependence is an enormous economic problem (The EU external energy bill represents more than €1 billion per day).

The Commission proposes to tackle this problem by "concrete actions implemented in the short, medium and longer term" which are "based on eight key pillars", one of which is "moderating energy demand". Within this chapter, the EU strategy acknowledges that achieving significant energy savings is only possible if there is a clear identification of priority sectors as well as mobilisation of investment capital that can be easily accessed. The building sector is clearly identified as

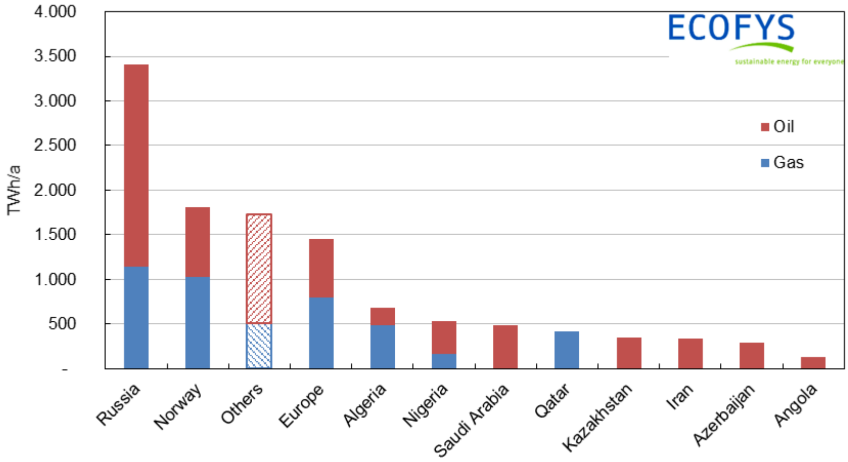


*Figure 1. Europe's total gas and oil imports compared to domestic own production.*

the one with the largest potential for savings, but the strategy does not include any calculation of the impact of buildings on energy imports.

Therefore this paper provides such calculations (based on two Ecofys studies, "Deep Renovation of Buildings – An effective way to decrease Europe's energy import dependency" for Eurima and "Increasing the EU's Energy Independence – A no-regrets strategy for energy security and climate change" for Open Climate Network) and also sheds some light on the most cost-effective way building can contribute to solve the energy dependence problem in a sustainable, stable manner, avoiding – as it was the case in the past – that the energy security problem arises again in a few years from now.

## EU's dependency on energy imports for buildings

### A BRIEF SECTOR OVERVIEW

Currently, the world largest consumer of natural gas is the EU. The yearly demand of natural gas is around 4,700 TWh per year[1] and has a net import share of 65 %. Including oil even 76 % was imported from outside of the EU in 2011. 25 % of the natural gas imports and 32 % of oil imports are supplied by Russia – in total one third of oil and gas imports originate from Russia (see Figure 1[2]).

As pictured in Figure 2[3] the transport sector has a net import share of 79 % and thus is considerably dependent on energy imports. The import share of other sectors are lower due to a high share of electricity (partly from nuclear and renewables). As described above the dependency on gas and oil are significantly higher. Especially the residential sector has the highest share of natural gas consumption.

### BUILDING SECTOR

Given that the allocation of imported energy is the same as for the EU as a total (the net imported share of gas is 65 % and of oil is 85 %), the buildings sectors has a net import share of 37 % (without energy carriers for electricity generation). The amount of imported gas is more than double the amount of oil as shown in Figure 3[4]. The building sector in total has imported more than 1,700 TWh of energy per year.

31 % of the net imported oil and gas is distributed to the building sector (61 % of all imported gas and 14 % of all imported oil), assuming the same averages for the final energy demand per sector and energy carrier as for the entire EU. Around ¼ of imported energy account to Russia and Norway (Figure 4[5]).

## Reduce dependency on imported energy in the building sector

This paper follows the 'deep renovation' track[6] for the building sector, completed with data on cooling, originating from the Heat Pump Implementation Scenarios.[7] Generally the deep renovation track has the potential to quickly decrease the demand for gas and oil – on this way by 2050 the dependency on imports can be reduced to nearly zero. In this study deep renovation in defined as follows: a high level of energy efficiency improvement at a rate of 2.3 % of the building stock, with a high focus on the efficiency of the building envelope and high use of renewable energy. As pictured in Figure 5[8] in the deep renovation scenario the final energy use can be reduced by 66 % (compared to 2010) for space heating, hot water and cooling in buildings. Excluding cooling the track leads to a 75 % reduction of final energy use by 2050.

1. Europe's total gas and oil imports compared to domestic own production based on primary energy demand.

2. Source: Economics of deep renovation, Ecofys for EURIMA , see http://www.eurima.org/uploads/ModuleXtender/Publications/51/Economics_of_Deep_Renovation_Ecofys_IX_Study_Design_FINAL_01_02_2011_Web_VERSION.pdf.

3. Average net imported shares of all energy carriers. Source: IEA (2013a), IEA (2013b) and Eurostat (2014). Because of large difficulties in forecasting until 2050, this paper assumes that power is only produced from domestic sources.

4. Sources: IEA (2013a), IEA (2013b) and Eurostat (2014).

5. See footnote 4.

6. Source: Ecofys study for Eurima "Deep Renovation of Buildings – An effective way to decrease Europe's energy import dependency".

7. As the effect of Croatia is assumed to be minor, data for this 28th member state of the EU are not included.

8. Source: Ecofys (2012).

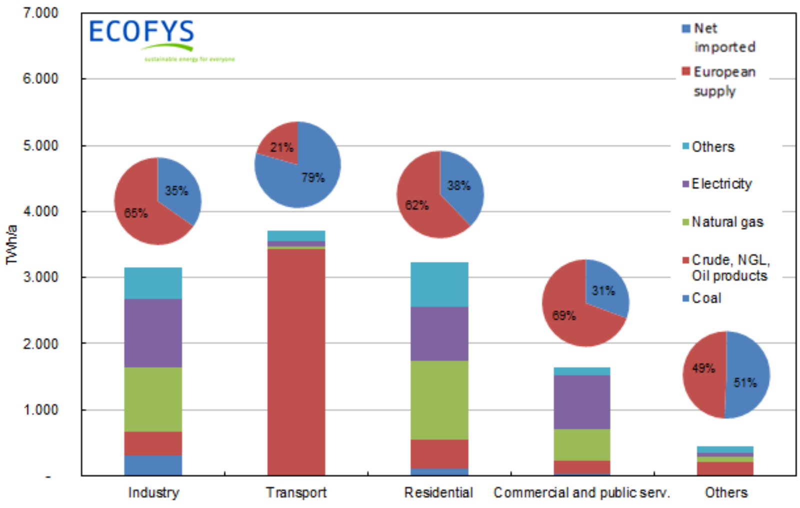


*Figure 2. Final energy consumption per sector and energy carrier with energy import dependency.*

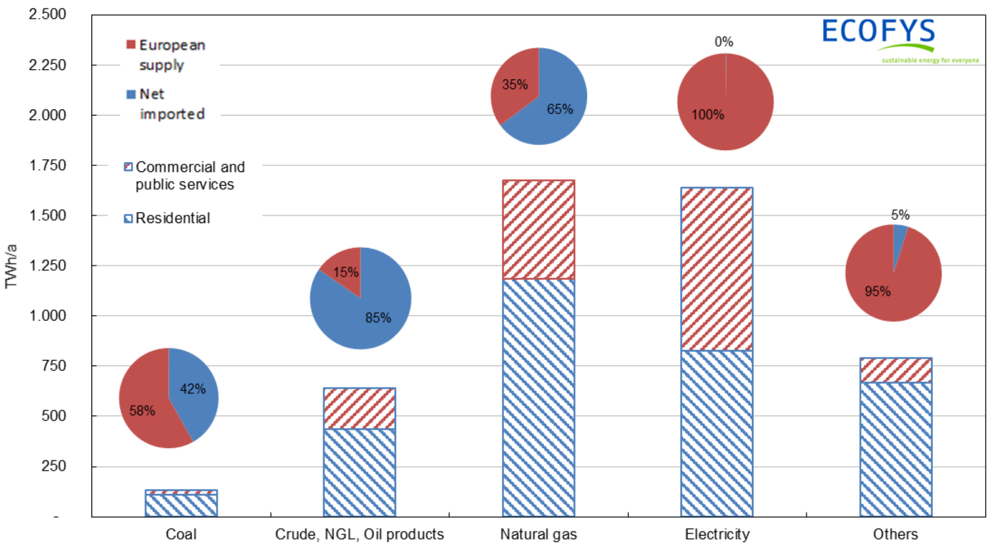


*Figure 3. Final energy consumption by energy carrier in the EU's building sector and shares of net imports.*

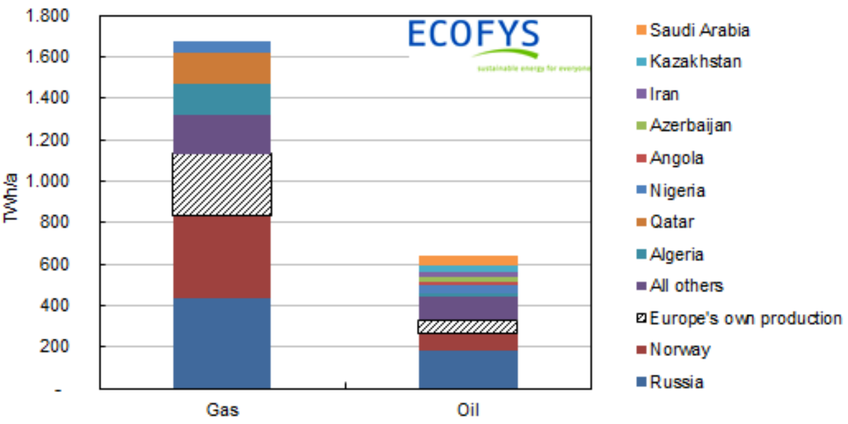


*Figure 4. Gas and oil imports in the building sector and countries of origin.*

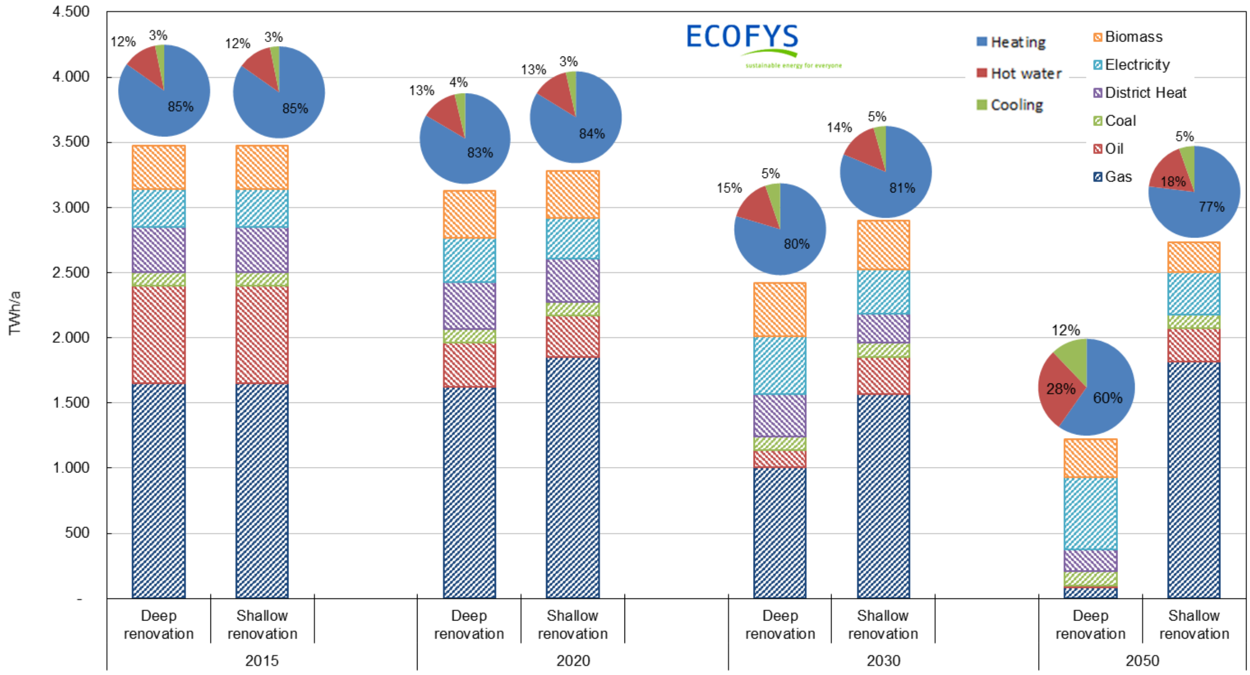


*Figure 5. Final energy demand in the building sector for deep and shallow renovation scenarios.*

The gas consumption can be decreased from 1,653 TWh in 2015 to 82 TWh (by 95 %) in 2050 whereas the demand for oil can be reduced by 97 % (from 745 TWh to 19 TWh). Regarding the shallow renovation the consumption for space heating, hot water and cooling in buildings can be reduced by around 24 % by 2050. Hence, energy import independency cannot be reached.

### BECOMING INDEPENDENT OF GAS IMPORTS

The following figure shows the effects of deep renovation and how this scenario for the buildings sector can gradually reduce the EU's dependency on natural gas imports. The left bar illustrates as a reference the 2015 imports and domestic production of natural gas, so any future reduction of the gas demand could be related to imports from specific regions. According to the calculated scenario, by 2035 the EU's buildings sector could save the equivalent to the imports from – for instance – Norway and Russia. After 2040, the equivalent of the 2011 EU domestic supply would be sufficient for all heating and cooling demand in the EU buildings. Additionally, beyond 2040 the domestic supplies can help to become independent from gas imports in other sectors as well.

## Comparison of costs: alternatives to deep renovation?

To analyse the costs of selected alternatives to the deep renovation scenario a literature review was conducted. Alternatives considered in this paper to reduce fossil fuel imports are (i) "shallow renovation" with a high share of renewables or alternative (domestic) supply options, (ii) increase share of other domestic energy sources – such as nuclear energy or fossil fuelled power with carbon capture and storage – and (iii) extraction of shale gas.

(i) Literature shows that "shallow renovation" with a very high share of renewable energy supply is not cheaper and are not cost effective as evaluated in a study of Ecofys for Eurima[9]. On the contrary, this alternative is 3.5 %[10] more expensive than the deep renovation scenario.

The Fifth Assessment Report of Intergovernmental Panel on Climate Change (IPCC)[11] indicates that costs of different kind of renewable electricity production ranges from 2 to 45 €c/kWh (equivalent to 5 €c/kWh – 18 €c/kWh for useful energy in the buildings[12]) whereas the costs of saved energy in the deep renovation scenario show spans from 2 to 9 €c/kWh[13]. Hence, the results show that the costs of deep renovation are less expensive.

(ii) For nuclear energy the IPCC reports the cost of nuclear energy from 4 €c/kWh to 20 €c/kWh (equivalent to 6 €c/kWh–11 €c/kWh for useful energy in the building). The fossil fuelled power with carbon capture and storage (CCS) are indicated between 4 €c/kWh and 23 €c/kWh (equivalent to 6 €c/kWh–12 €c/kWh for useful energy). The analysis identifies the deep renovation scenario as the more cost effective option than nuclear energy and fossil fuelled power with CCS. Additionally these sources would require in some cases substantially more time in order to be fully operational (with the subsequent un-

9. In a previous publication commissioned by Eurima, Ecofys provided a 'deep renovation' track, based on data and scenarios for heating and hot water in the EU27. www.eurima.org/uploads/ModuleXtender/Publications/90/Ecofys_X_leaflet_05_10_2012_web_Final.pdf.

10. Based on NPV calculation of total yearly costs (investments and energy costs) from 2012–2050 and a discount rate of 4 %.

11. IPCC Fifth Assessment Report, Working Group III, 2014, chapter 7 and 9, draft final version.

12. Based on the assumption of electricity driven heat pumps to cover the energy needs and taking into account average investment costs. The useful energy is directly comparable with the costs of energy saved from energy efficiency measures.

13. Source: Economics of deep renovation, Ecofys for EURIMA , see http://www.eurima.org/uploads/ModuleXtender/Publications/51/Economics_of_Deep_Renovation_Ecofys_IX_Study_Design_FINAL_01_02_2011_Web_VERSION.pdf.

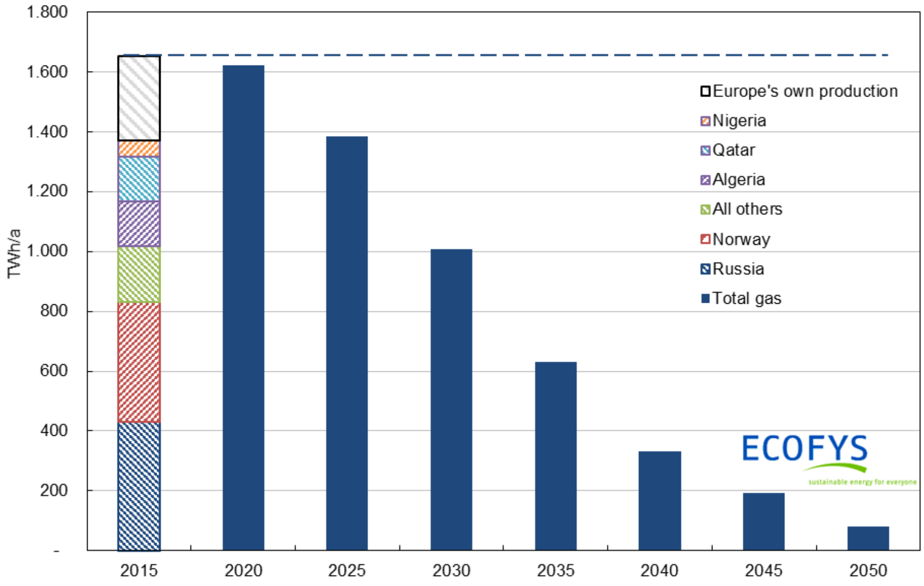


*Figure 6. Effects of deep renovation in the building sector towards independency of EU's gas imports.*

certainty) and raise some other obstructive issues in health, safety, environment or public acceptance.

(iii) For shale gas several authoritative studies (Joint Research Centre, Global Energy Assessment) estimate the production costs of EU shale gas of most likely higher that conventional gas and also higher than US imported shale gas. In the last case the costs of US gas prices are expected to increase in the next years and decades as the demand and also production cost will rise.

## Potentials in other sectors

Beside the building sector the study "Increasing the EU's Energy Independence"[14] focuses on two other key sectors for reducing natural gas dependencies: (i) industry and (ii) energy supply.

(i) The industrial natural gas demand of the EU can be reduced by 20 % by increasing energy efficiency and the share of renewable energy. Energy efficiency measures such improving processes (i.e. by reusing heat) and heating systems[15] can reduce natural gas demand by 0.7 EJ. Actions for energy-intensive process are not considered in the above mentioned study. Thus, the potential for reducing the dependency on natural gas presented here are a conservative estimate.

By increasing the share of renewable energy in industry the natural gas demand would reduce another 0.1 EJ given that the grow rate is the same as observed between 2000 and 2010.

(ii) The energy supply sector can reduce the natural gas demand by 19 % of the current amount. Mainly this can be achieved by increasing renewable energy and energy efficiency measures for heat and power plants. Both measures can decrease natural gas demand by 2.9 EJ–1.9 EJ below the PRIMES[16] scenario for energy efficiency and 1.5 EJ by increased renewable energy.

## Conclusion

The results of the analysis indicate that the EU's buildings sector use 61 % of all imported gas. Thus, deep renovation in the buildings sector can significantly contribute to become less independent from energy imports. The gas consumption in this sector can be reduced by 95 % and the oil consumption by 97 % by 2050. As result the buildings sector can reduce its own imports by 20 % by 2020, 60 % by 2030 and 100 % by 2050. From 2035 onwards the EU's buildings sector could be independent from imports from Russia and Norway and after 2040 the equivalent to the 2011 domestic energy production would be sufficient for all heating and cooling demand in the EU building stock.

The literature review proves that deep renovation for the buildings sector is less expensive and thereby more cost effective than other alternatives. The renovation track with less energy efficiency and more renewable energy supply ("shallow renovation") is 3.5 % more expensive than deep renovation. Other options like nuclear energy, fossil fuels combined with CCS or shale gas (domestic or imported) do not show better economics. Additionally, a few options to reduce energy import dependencies create other dependencies or different risks regarding health, safety, environment or public acceptance.

The GHG emissions reductions provided by deep renovation could be 90 % by 2050 compared to 1990. Additionally GHG emissions reduction and energy savings have a strong impetus for economic recovery (more than 30 % increase of investments in deep renovation components and technologies instead of energy costs compared to baseline[17]). Last, but not least, deep renovation also contributes to create a large amount of local, stable jobs (1.4 million additional jobs compared to

14. Source: Ecofys (2014b).

15. Source: Boßmann et al. (2012).

16. The, forecast developments based on current economic and demographic trends and existing policies.

17. In a previous publication commissioned by Eurima, Ecofys provided a 'deep renovation' track, based on data and scenarios for heating and hot water in the EU27. www.eurima.org/uploads/ModuleXtender/Publications/90/Ecofys_X_leaflet_05_10_2012_web_Final.pdf.

the baseline[18], especially on SMEs in the construction sector) therefore ambitious action on this field should become a priority in EU policies.

In addition to this energy efficiency measures in the industrial sector and measures in the energy supply sector can be used to significantly reduce mainly the gas imports to the EU.

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18. See footnote 17.