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Deep renovation of buildings

An effective way to decrease Europe's energy import dependency

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Key messages about deep renovation and imports

It is widely acknowledged that renovating dwellings and commercial buildings in the EU will have a large impact on the use of energy. This paper links buildings renovation to the EU's dependency of imported energy carriers. Based on a literature study, the following three key messages emerge.

Key message 1

Deep renovation of buildings (see text box) helps the EU becoming significantly less dependent on energy imports. While buildings use a significant 61% of all imported gas, the deep renovation scenario shows a reduction of the sectors gas consumption of 95% by 2050 and of oil consumption by 97%. Thereby, the building sector can, quicker than other options, reduce its own imports by 20% by 2020, 60% by 2030 and 100% by 2050. By 2040 roughly, the equivalent of the 2011 EU domestic supply would be sufficient for all heating and cooling demand in the EU buildings.

Key message 2

Comparison with data from literature (Ecofys[1], IPCC[2]) proves that other options to reduce import dependencies that focus on the supply side are not cheaper and create other dependencies or risks. The alternative "shallow renovation"[1] with very high shares of renewable energy is 3.5 % more expensive[3] than deep renovation. Also further options to reduce dependencies do not show better economics[4], and in some cases would require substantially more time in order to be fully operational (with the subsequent uncertainty). At the same time, nuclear power and shale gas raise obstructive issues in health, safety, environment or public acceptance.

Key message 3

Deep renovation is a suitable way forward, not only for reduction of EU's dependency on imports, but also for generating significant GHG emission reductions (90% savings by 2050 compared to 1990) and energy savings, while providing 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[1]) and job creation (1.4 million additional jobs compared to the baseline[1]).

*'**Deep renovation'** means: 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. This track leads to a 75% reduction in final energy use by 2050 (compared to 2010)[1]. Including cooling[5], the present study estimates that the energy demand will be reduced by at least 66%.*

[1] 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.
[2] IPCC Fifth Assessment Report, Working Group III, 2014, chapter 7 and 9, draft final version.
[3] Based on NPV calculation of total yearly costs (investments and energy costs) from 2012-2050 and a discount rate of 4%.
[4] Electricity from nuclear power can be produced at costs of 4€ct – 20€ct per kWh, (equivalent to 6 €c/kWh – 11 €c/kWh for useful energy in the building) putting the costs of energy saved in deep renovation of a building (2-9 €ct per kWh) on the safe side. Costs of shale gas production (both domestic and imports) are not expected to be lower than conventional gas today.
[5] Data on cooling for this study are based on an Ecofys study for European Heat Pump Association.

The challenge for the EU

At present, the EU has set energy and climate targets for 2020 and 2050, while discussing a 2030 framework. Recent developments in the Ukraine have shifted the focus towards the aspect of reducing the EU's dependency on external suppliers of energy carriers. This paper addresses how deep renovation of buildings contributes to reducing energy imports.

The present political turmoil in the Ukraine has again highlighted the geopolitical risks of imports and the vulnerability of the EU economy. Focusing on imports of gas and oil from Russia (through the Ukraine), the European Council has called on the European Commission to rethink its energy strategy and to present by June 2014 a comprehensive plan for the reduction of EU energy dependency[6].

The options are limited:

- Using **idle gas or oil production capacity:** opportunities are scarce, take considerable time to (re)gain capacity and are only a temporary solution.
- Producing **shale gas** in the EU is not easily realised, because of environmental, technical and economic concerns.
- Diversifying sources (e.g. **LNG** by ships, natural gas through new pipelines, or substitution with coal) could reduce the geopolitical risks, but are not immediately available or applicable.
- Developing domestic energy carriers like **nuclear or renewable energy** is on-going, but reaching substantial shares will take decades.
- At many occasions, many institutions like the EU itself, the IEA and the UN, stress the benefits of **energy savings** and their very large cost-efficient potential, e.g. in the buildings sector. Economic and non-economic barriers are hindering a full exploration of this potential.

'Rethinking the strategy' also has to account for the other priorities in energy and climate policies, like greenhouse gas emission reductions and competitiveness of the EU economy. In this context, energy efficiency measures and renewables are the preferred options that reduce energy import dependency while meeting other mid- and long- term energy and climate targets and not raising other issues in health, safety, environment and public acceptance. Also the timing matters. Reducing vulnerability on a short term may ask for other options than structural medium or long term strategies.

Building on the earlier Ecofys study for Eurima, this paper focuses on the effects on import dependency by applying deep renovation as a measure, and how this will affect the use of natural gas and of electricity.

[6] For reference: Gas and oil imports from Russia currently account for 20% of total EU energy imports and about 26% of EU's gas and oil imports.

EU's energy imports for buildings

At present, the EU demand for natural gas is the largest in the world, with a consumption[7] of around 4,700 TWh per year and a net import share of around 65%. With oil, import dependency is even higher. The dependency of imports differs from sector to sector.

Overall imports

Domestic production of oil and natural gas modestly contributes to the EU oil and gas consumption. In 2011, 76% of all gas and oil (65% of gas, 85%% of oil) was imported from outside of the EU. About one-third of these imports originates from Russia (25% of all imported natural gas, 32% of all imported oil), see Figure 6 in the annex.

Especially the transport sector, with a net import share of 79%, is highly dependent on energy imports (Figure 1). The industry, commercial and residential sectors are less dependent, with approx. 1/3 net imports, due to a high share of electricity (partly from nuclear and renewables). In gas and oil, import shares are significantly higher. Here, the residential sector has the highest shares of natural gas consumption.

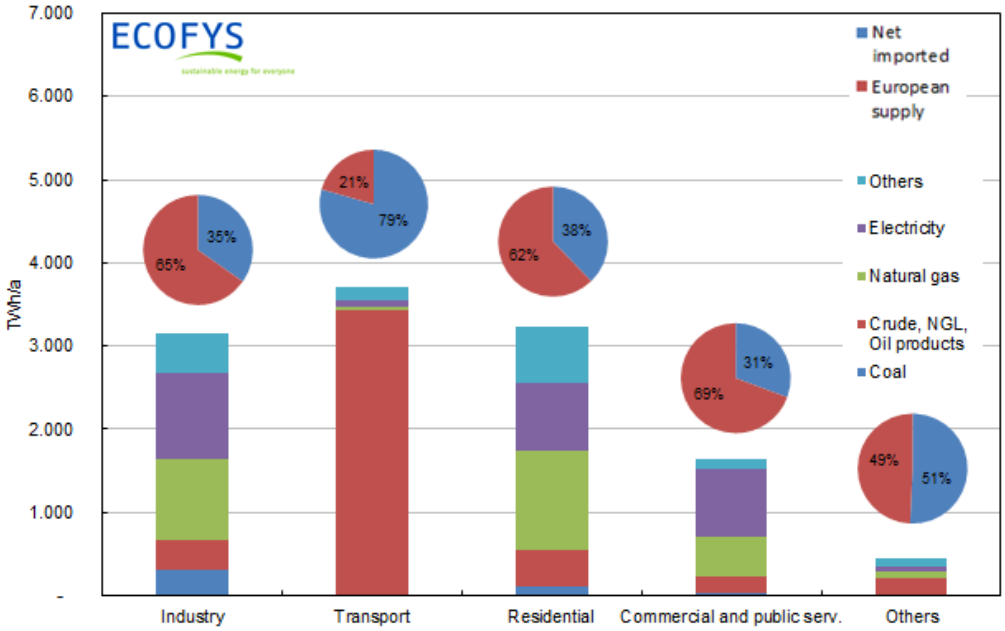

Figure 1: Final energy consumption per sector and energy carrier with energy import dependency[8]

[7] Based on primary energy.
[8] 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.

Building sector imports

Regarding the building sector, in total more than 1,700 TWh of energy is imported to Europe. Assuming the same domestic/import distribution as for the EU as a total (whereas the net imported share of gas is 65% and of oil is 85%), the buildings sector relies about 37% on imported energy, whereas the amount of imported gas is more than double the amount of oil (Figure 2).

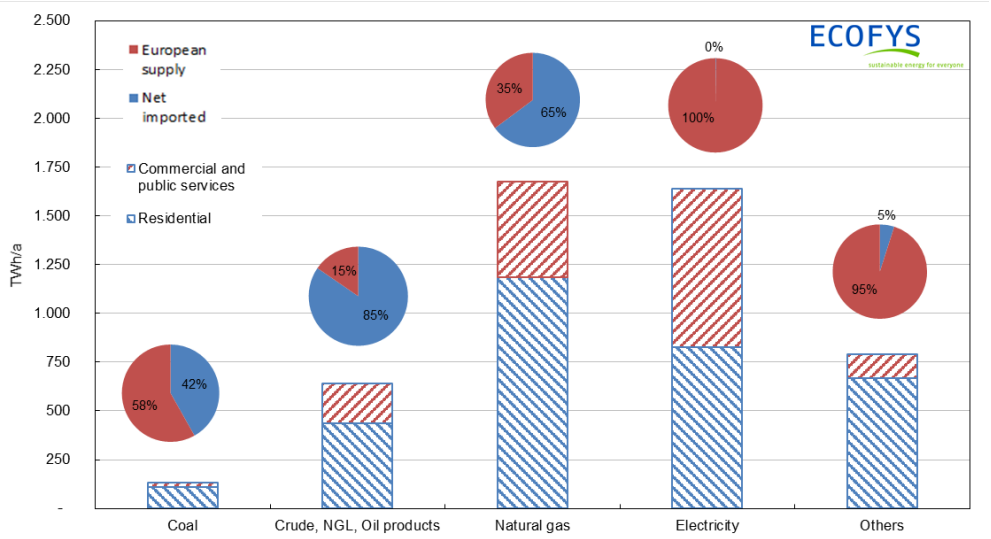

Figure 2: Final energy consumption by energy carrier in the EU's building sector and shares of net imports[9]

Again assuming the same averages as for the whole of the EU, the buildings sector final energy demand also depends heavily on energy imports. 31% of all net imported oil and gas is consumed in the building sector (61% of all imported gas and 14% of all imported oil). Russia and Norway account for about 1/4 of the imports each (Figure 3).

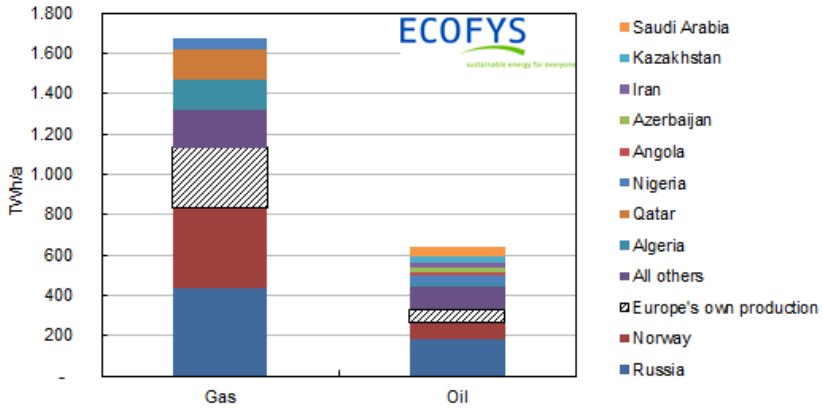

Figure 3: Gas and oil imports in the building sector and countries of origin[10]

[9] Sources: IEA (2013a), IEA (2013b) and Eurostat (2014).
[10] Source: IEA (2013a), IEA (2013b) and Eurostat (2014).

Energy efficiency in the building sector

A 'deep renovation' track in the buildings sector can quickly reduce the need for gas and oil, bringing back the dependency of imports to zero by 2050.

This paper follows the 'deep renovation' track, completed with data on cooling, originating from the Heat Pump Implementation Scenarios.[11] In total final energy use for space heating, hot water and cooling in buildings is reduced by 66% in the 'deep renovation' scenario by 2050 (Figure 4).

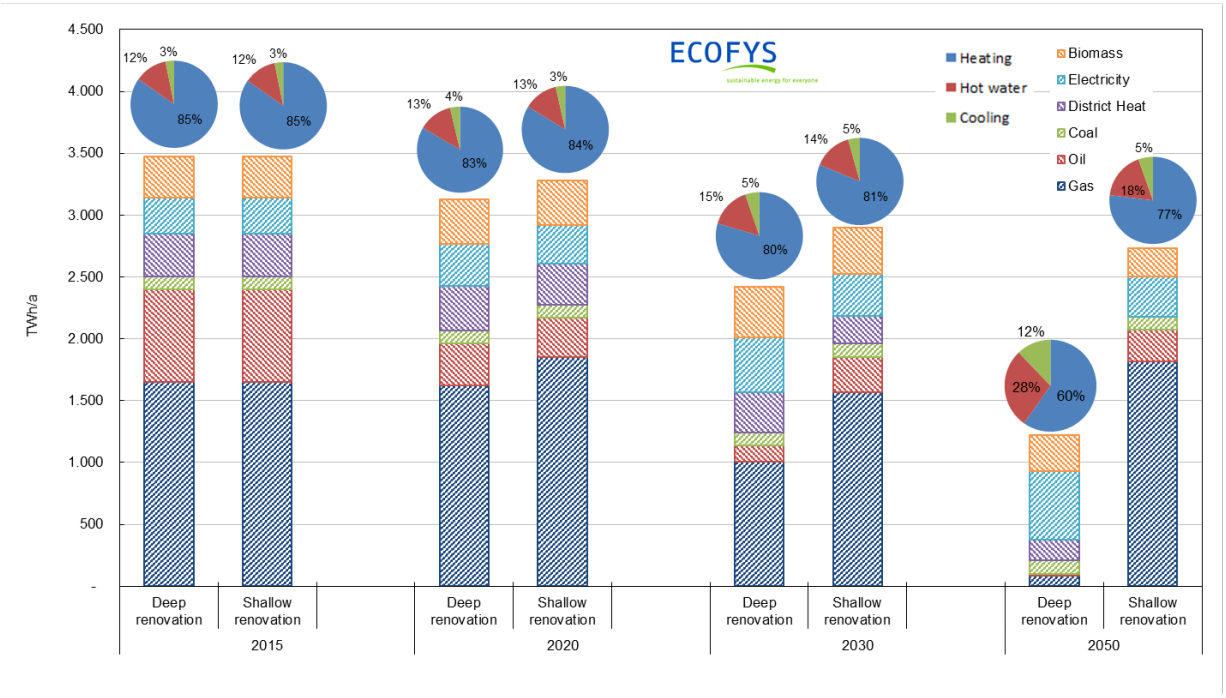

Figure 4: Final energy demand in the building sector for deep and shallow renovation scenarios[12]

By 2050, the deep renovation scenario shows a reduction of gas consumption by 95% (from 1,653 TWh/a in 2015 to 82 TWh) and of oil consumption by 97% (from 745 TWh to 19 TWh).

However, the shallow renovation scenario practically does not reduce the demand for gas. Hence, energy import independency cannot be reached.

[11] As the effect of Croatia is assumed to be minor, data for this 28th member state of the EU are not included.
[12] Source: Ecofys (2012)

Becoming independent of gas imports

Figure 5 illustrates how deep renovation on the gas demand in the EU building sector can gradually reduce the EU's dependency on natural gas imports. As a reference, the diagram shows 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. Just after 2040, the equivalent of the 2011 EU domestic supply would be sufficient for all heating and cooling demand in the EU buildings. And beyond 2040, these domestic supplies could be used to help reducing the import dependency of other sectors as well.

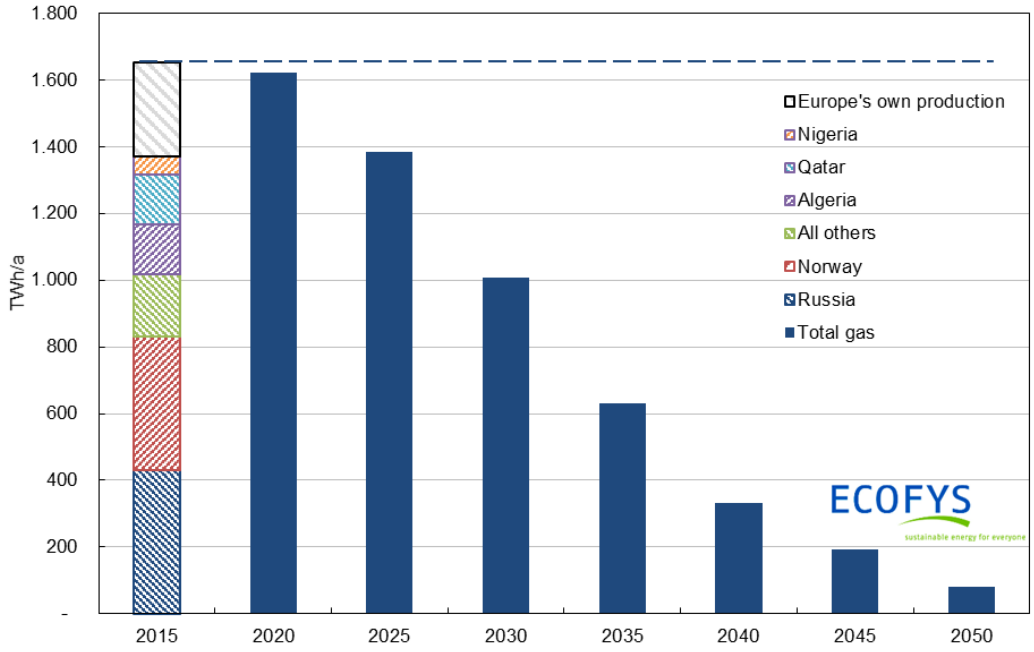

Figure 5: Effects of deep renovation in the building sector towards independency of EU's gas imports

Costs: deep renovation versus other options

Literature shows that alternatives to deep renovation for reducing the fossil fuel import dependency, e.g. shallow renovation with a very high share of renewables or alternative (domestic) supply options, are not cheaper and create other dependencies or risks.

An alternative to deep renovation as a strategy to reduce fossil fuel import dependency could in principle be a renovation track that focuses less on energy efficiency and even more on renewable energy supply. However such "shallow renovation" with very high shares of renewable energy does not turn out to be more cost effective but was assessed in an earlier study of Ecofys for Eurima[13] to be 3.5 % more expensive[14].

As another source of information on renewable energy costs, the recent Fifth Assessment Report of the Intergovernmental Panel on Climate Change (IPCC)[15] reports costs for renewable electricity production of different kinds to range from 2 €c/kWh to 45 €c/kWh (equivalent to 5 €c/kWh – 18 €c/kWh for useful energy in the buildings[16]) . Compared to these production costs, the costs of saved energy in deep renovation (if cost effectively combined with anyway due maintenance measures) show spans from 2 to 9 €c/kWh[17], putting the costs of deep renovation on the safe side.

Also further options to reduce fossil fuel dependencies do not show better economics than a deep renovation strategy. The IPCC report ranges the costs of *nuclear energy* between 4 €c/kWh and 20 €c/kWh (equivalent to 6 €c/kWh – 11 €c/kWh for useful energy in the building) and fossil fuelled power with carbon capture and storage (CCS) between 4 €c/kWh and 23 €c/kWh (equivalent to 6 €c/kWh – 12 €c/kWh for useful energy). Meanwhile, these sources would require in some cases substantially more time in order to be fully operational (with the subsequent uncertainty) and raise some other obstructive issues in health, safety, environment or public acceptance.

The same barriers occur in *shale gas* domestic production or imports. Moreover, costs are not expected to be lower than those for conventional gas. Several authoritative studies (Joint Research Centre, Global Energy Assessment) refer to the fact that EU shale gas will most likely have higher production costs than conventional gas and also higher costs than US imported shale gas. Also, US gas prices are expected to rise in the coming years and decades, because of increasing production costs and increasing demand (also from Asia).

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[13] 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.

[14] Based on NPV calculation of total yearly costs (investments and energy costs) from 2012-2050 and a discount rate of 4%.

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

[16] 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.

[17] 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

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Annex

EU`s energy imports

Domestic production of oil and natural gas only modestly contributes to the EU oil and gas consumption. In 2011, 76% of all gas and oil (65% of gas, 85%% of oil) was imported from outside of the EU Figure 6. . About one-third of these imports originates from Russia (25% of all imported natural gas, 32% of all imported oil), see Figure 6 in the annex.

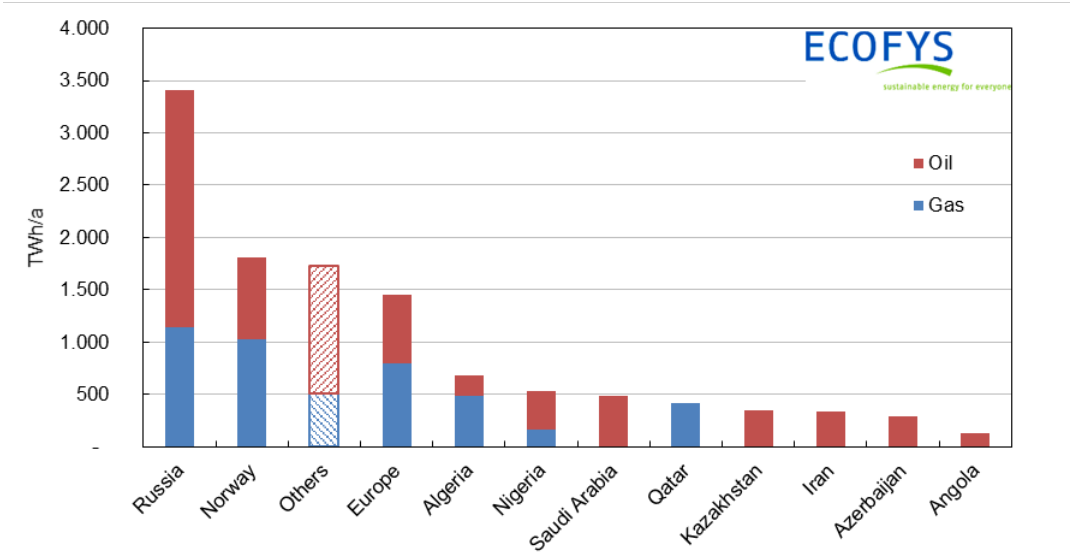

Figure 6: Europe's gas and oil imports compared to domestic own production[18]

[18] See previous footnote

Final energy consumption per sector and energy carrier with energy import dependency disaggregated by five climate zones (relating to figure 1)

Table 1: Western zone: Final energy consumption per sector and energy carrier with energy import dependency[19]

TWh/a	Industry	Transport	Residential	Commercial and public services	Other
Other	205	90	239	56	65
Coal	148	0	29	6	0
Electricity	567	40	475	438	31
Natural gas	586	10	766	307	58
Crude, NGL, Oil products	183	1,870	300	151	75
Net import	32%	75%	37%	30%	41%
European supply	68%	25%	63%	70%	59%

Table 2: Northern zone: Final energy consumption per sector and energy carrier with energy import dependency[20]

TWh/a	Industry	Transport	Residential	Commercial and public services	Other
Other	104	9	103	25	17
Coal	16	-	0	0	0
Electricity	102	4	69	58	4
Natural gas	20	1	8	4	1
Crude, NGL, Oil products	33	182	10	10	16
Net import	18%	58%	8%	10%	31%
European supply	82%	42%	92%	90%	69%

[19] Average net imported shares of all energy carriers, source: IEA (2013a), IEA (2013b), Eurostat (2014)

[20] See previous footnote

Table 3: North-eastern zone: Final energy consumption per sector and energy carrier with energy import dependency[21]

TWh/a	Industry	Transport	Residential	Commercial and public services	Other
Other	63	17	143	26	8
Coal	85	-	74	14	12
Electricity	85	6	53	74	6
Natural gas	79	9	78	43	3
Crude, NGL, Oil products	20	305	9	9	29
Net import	22%	90%	18%	21%	51%
European supply	78%	10%	82%	79%	49%

Table 4: Southern zone: Final energy consumption per sector and energy carrier with energy import dependency[22]

TWh/a	Industry	Transport	Residential	Commercial and public services	Other
Other	73	41	95	4	2
Coal	40	-	1	0	1
Electricity	232	15	182	204	18
Natural gas	217	11	265	101	15
Crude, NGL, Oil products	114	904	107	29	55
Net import	55%	91%	59%	43%	76%
European supply	45%	9%	41%	57%	24%

[21] See previous footnote

[22] See previous footnote

Table 5: South-eastern zone: Final energy consumption per sector and energy carrier with energy import dependency[23]

TWh/a	Industry	Transport	Residential	Commercial and public services	Other
Other	22	5	90	11	2
Coal	15	-	5	0	0
Electricity	49	3	46	39	2
Natural gas	66	3	70	32	3
Crude, NGL, Oil products	20	179	11	5	15
Net import	30%	74%	20%	23%	60%
European supply	70%	26%	80%	77%	40%

[23] See previous footnote

Final energy consumption by energy carrier in the EU's building sector and shares of net imports (relating to figure 2)

Table 6: Final energy consumption per sector (TWh) and energy carrier with energy import dependency (%)[24]

TWh/a		Coal	Crude, NGL, Oil products	Natural gas	Electricity	Others
Western	Residential	29	300	766	475	239
	Commercial and public services	6	151	307	438	56
	Net imported	57%	80%	53%	-1%	5%
	European supply	43%	20%	47%	101%	95%
Northern	Residential	0	10	8	69	103
	Commercial and public services	0	10	4	58	25
	Net imported	100%	62%	23%	2%	6%
	European supply	0%	38%	77%	98%	94%
Southern	Residential	74	9	78	53	143
	Commercial and public services	14	9	43	74	26
	Net imported	0%	97%	86%	-13%	-3%
	European supply	100%	3%	14%	113%	103%
North-eastern	Residential	1	107	265	182	95
	Commercial and public services	0	29	101	204	4
	Net imported	73%	96%	93%	11%	11%
	European supply	27%	4%	7%	89%	89%
South-eastern	Residential	5	11	70	46	90
	Commercial and public services	0	5	32	39	11
	Net imported	26%	78%	50%	0%	-1%
	European supply	74%	22%	50%	100%	101%

[24] See previous footnote

Gas and oil imports in the building sector and countries of origin (relating to figure 3)

Table 7: Origin of oil imports in Europe disaggregated by zone (TWh)[25]

TWh/a	Western	Northern	North-eastern	South-eastern	Southern
Algeria	18	0	0	-	2
Angola	8	-	-	-	4
Azerbaijan	12	-	1	0	11
Iran	9	-	0	-	17
Kazakhstan	28	0	0	3	4
Nigeria	29	-	-	-	8
Norway	77	5	1	-	1
Russia	117	12	16	11	26
Saudi Arabia	28	-	-	-	17
All others	69	1	0	0	40
Europe's own production	56	3	1	1	5

Table 8: Origin of gas imports in Europe disaggregated by zone (TWh)[26]

TWh/a	Western	Northern	North-eastern	South-eastern	Southern
Algeria	25	-	-	1	124
Nigeria	20	-	-	-	33
Norway	377	-	1	-	21
Qatar	115	-	-	-	35
Russia	205	9	76	72	70
All others	82	-	37	18	49
Europe's own production	248	4	6	11	34

[25] IEA (2013a), IEA (2013b), Eurostat (2014)
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