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Energy prices and costs report

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Energy prices and costs in Europe

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4. Future high energy prices in the EU: macroeconomic consequences

The aim of the present chapter is to evaluate the macroeconomic and sectoral consequences of an increase in electricity and gas prices in the EU if such increases do not take place in non EU countries.

The approach is to quantify stylized scenarios in which hypothetical causes drive divergence of electricity/gas prices in the EU relatively to the non-EU world. By no means are such hypothetical causes related to concrete policies in the EU. The purpose of the study is purely analytical.

The Reference scenario projection of PRIMEs 2013[1] which mirrors adopted policies in the EU and in the Member-States assumes full achievement of EU objectives (2020 policy package), implementation of current legislation including the Energy Efficiency Directive and full implementation of the ETS Directive. In this policy context the Reference scenario projects increasing electricity prices in the EU until 2020 relative to 2010 levels and full stabilization of prices after 2020. The Reference scenario also projects average prices of gas imported in the EU to increase and remain at high levels, which contrasts with the recent gas price drop in the North American markets. In addition, persisting subsidization in several non-OECD countries and in the emerging economies explain low energy prices experienced in the domestic markets of those countries, as reported by the World Energy Outlook of the IEA (2012). Therefore, the Reference scenario projects price divergence of electricity and gas prices between the EU and the USA and between the EU and the emerging markets for different reasons.

Obviously it is worth to explore the macroeconomic and sectoral consequences on the EU economy of such a persisting price differential. The adopted approach preferred to build the analysis starting from the existing Reference (2013) scenario and assume further increases in the price differential for electricity and gas over a medium-term horizon. To quantify these consequences using a model it is necessary to assume which are the drivers of such an increasing price differential because depending on the driver the macroeconomic effects can be slightly different. For this purpose, different scenario variants have been conceived which lead to similar price differentials but differ in the assumed hypothetical causes.

For the assessment of impacts, we start from a quantification of a reference macroeconomic and sectoral projection of the world economy using the GEM-E3 model, split in many countries/regions including the individual EU28 member states. A short description of GEM-E3 is available in Annex 6. The reference projection includes all assumptions made for constructing the Reference[2] 2013 energy and transport projection and mirrors the specific energy, transport and environmental projections of Reference 2013. The geographic coverage of GEM-E3 is global whereas the scope of the Reference 2013 energy/transport projection is only European. So it was necessary to include assumptions about growth, energy and emissions for the non-EU world regions. For this purpose we have relied upon IEA and Prometheus model projections which has been also used to carry out projections for the world

[1] PRIMES is a European energy system and market model. PROMETHEUS is a world energy market model. See www.e3mlab.eu for further details.

[2] The main assumptions of the reference scenario include) GDP projections based on the report “2012 Ageing report: Economic and budgetary projections for the 27 EU member states (2010-2060)”, by DG-ECFIN and GHG emissions, RES deployment and energy efficiency consistent with the EU Roadmap for moving to a low carbon economy in 2050.

economy and energy for the purpose of projecting fossil fuel prices to the future considered as inputs to the Reference 2013 energy scenario.

To study the impacts of electricity and gas price increases in the EU we quantify alternative scenarios using GEM-E3 which include the price increases and we compare projections against the reference scenario from which we draw conclusions. As GEM-E3 is a fully comprehensive and global equilibrium model, we need to specify the cause or the driver of electricity and gas price increases. For this purpose we have quantified several variants of the price increase scenario in which we vary the assumptions about the driver of price change. We provide more details below.

As a computable general equilibrium model GEM-E3 cannot produce forecasts as it requires exogenously assumed productivity, population and technology progress trends. As usually done for such models, a reference projection is produced by dynamically calibrating model-based projections to a pre-defined (assumed) trajectory of aggregated figures such as GDP, emissions, current account, consumption over investment ratios, etc. The dynamic calibration depends on assumed productivity evolution for which the assumptions usually rely on independent statistical studies on trends[3]. The model serves to produce a projection with details by institutional sector and branch of activity ensuring consistent with the assumed growth of aggregated figures.

As is the case of all such models, GEM-E3 produces powerful results when comparing alternative scenarios to a reference, and so it evaluates the impacts of the changes mirrored in the alternative scenarios.

We distinguish between two scenario cases: firstly we quantify scenarios in which electricity and gas prices increase[4] in the EU and we distinguish between several drivers of such increases. Secondly we quantify a scenario in which electricity and gas prices decrease in all non-EU countries but not in the EU. So in both cases the EU electricity and gas prices increase relative to non-EU countries; this has consequences on EU production and consumption cost structure in all sectors and drives crowding out effects on non-energy activity, weakens foreign competitiveness and reduces the EU GDP.

While the modelling exercise covers the time period until 2050 in 5-year steps[5], the focus of this chapter is on developments up to 2020.

4.1. Scenario Description

Higher electricity and gas prices in the EU

For scenario definition purposes, end-user prices for electricity and gas increase in the EU by a pre-defined percentage per year relative to the reference scenario levels. The changes in energy prices relative to the reference are presented in Figure 1.

[3] Labour productivity follows DG-ECFIN (2012) and autonomous energy efficiency improvements follows PRIMES 2013 Reference scenario.

[4] Energy price increases are projected by a number of studies including the WEO (2013) and EIA (2013). The main drivers of energy prices can be classified in the following categories: i) Activity level/Demand, ii) Reserves, iii) Production costs and iv) market power. Depending on the assumptions on the reserves and GDP growth made by each study the price increases differ. Here all variants that include energy prices higher than the reference are conceived only as stylized cases aiming at exploring the level of resilience of EU economy towards energy price changes and at studying the consequences depending on the cause of energy price rise.

[5] 2015 is the first projection year; the year 2010 is a projection in modelling terms because the database uses 2007 as base statistical year but the 2010 projection does not vary by scenario. The resolution of the model in terms of different sectors and countries is the largest ever produced with GEM-E3.

It is assumed that a temporary distortion in the electricity and gas markets drive prices above the reference level in the short to medium term. This distortion can be attributed to a number of factors i.e. changes in energy taxation, market power or changes in supply structure. Each cause has distinct effects on the economy through different channels.

The price differential relative to reference reaches its maximum value by 2025, and reduces afterwards reverting back to reference price levels in the long term. Such drivers of price differentials can persist in the medium term but it is unlikely to last over long term because they rely on national policies which are obviously incompatible with well-functioning integrated global markets. So it is logical to assume that global market forces will prevail in the long term and the price differential will tend to decrease over time. The annual rates of price increases are assumed to be the same in all EU member states.

Figure 1: Electricity and Gas price EU28

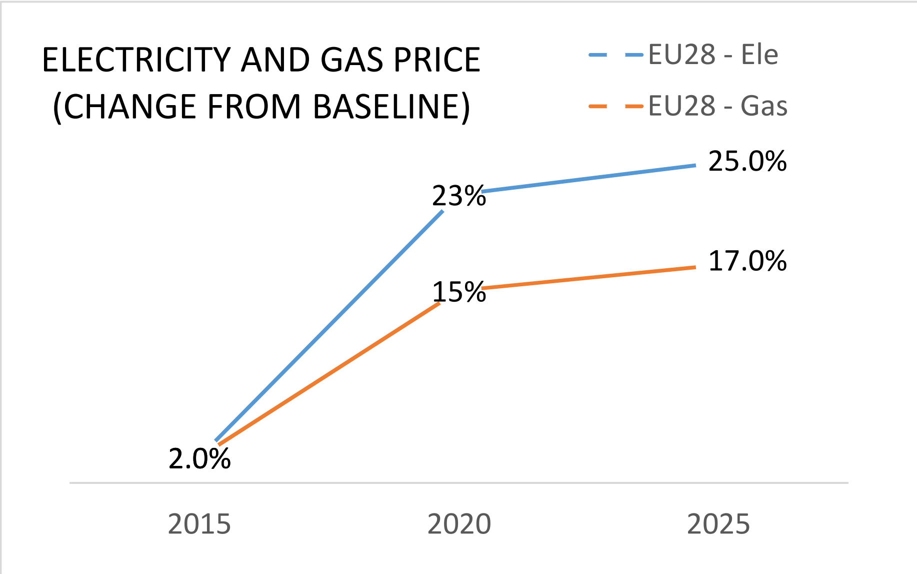
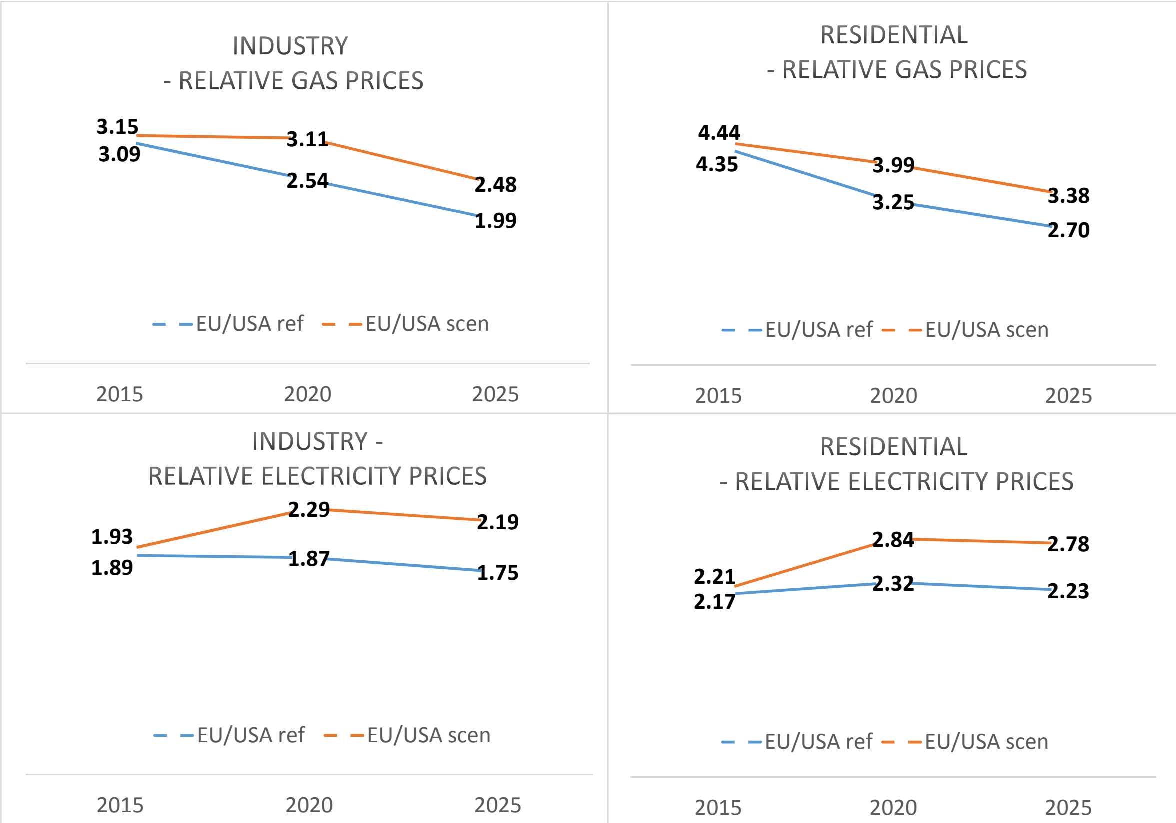


Figure 2 shows gas and electricity price differentials in the EU relative to USA prices in the scenario variants that project increasing prices in the EU. In these scenarios the price differentials are assumed to increase in the medium term and to decrease in the long term for the reasons explained above.

Figure 2: Relative energy prices expressed as ratios of EU over USA prices



The different drivers considered[6] as causes of electricity and gas price rise are the following:

- Rise of taxation applied on gas and electricity assuming application of excise taxes above reference levels; two distinct variants are considered regarding the way additional state revenues due to the energy tax are recycled back to the economy.
- Increase of profit margins in gas and electricity supply resulting from excessive market power
- Increased penetration of renewable energy sources at higher generation cost than in the reference.

These causes drive price increases only in the EU and not in non-EU countries though different channels.

Scenario B21: Taxation driving higher electricity and gas prices

In this scenario an indirect tax is imposed on end-user electricity and gas prices at levels calculated so as to obtain exactly the assumed price increases as presented in Figure 1. The additional taxation implies additional revenues for the state. To maintain public budget unchanged from reference, it is assumed that the rate of social security contributions of

[6] Depending on the choice of the driver the impact on the economy of the same price increase is different. Here a variety of drivers is selected in order to get a comprehensive picture of the different possible outcomes.

employers decrease; it is obviously assumed that the state recycles tax revenues back to the economy in an aim at reducing labour costs. This case is denoted as **B21a.**

An alternative assumption about recycling, which has been quantified for sensitivity analysis purposes, is to transfer additional state revenues of the energy taxation to households as a lump-sum transfer, which implies an increase in households' income. This case is denoted as **B21b**.

Scenario B22: Higher price mark-ups driving higher electricity and gas prices

In this scenario it assumed that the gas and electricity supply sectors experience excessive market power allowing higher profit margins than in reference. In the model this is achieved by increasing the cost mark-up so as to obtain the predefined electricity and gas price increases. The cost mark-up generates higher gross operating surplus which is a capital income. These revenues are distributed to the economic sectors according to their share of ownership. Roughly 80% of the revenues are allocated to households as additional income and 20% are allocated back to firms and are re-invested.

Scenario B24: Higher price only for electricity driven by generation mix

In this variant only electricity prices increase relative to the reference assuming that generation costs increase as a consequence of high penetration of renewable energy sources (RES) in the electricity generation mix.

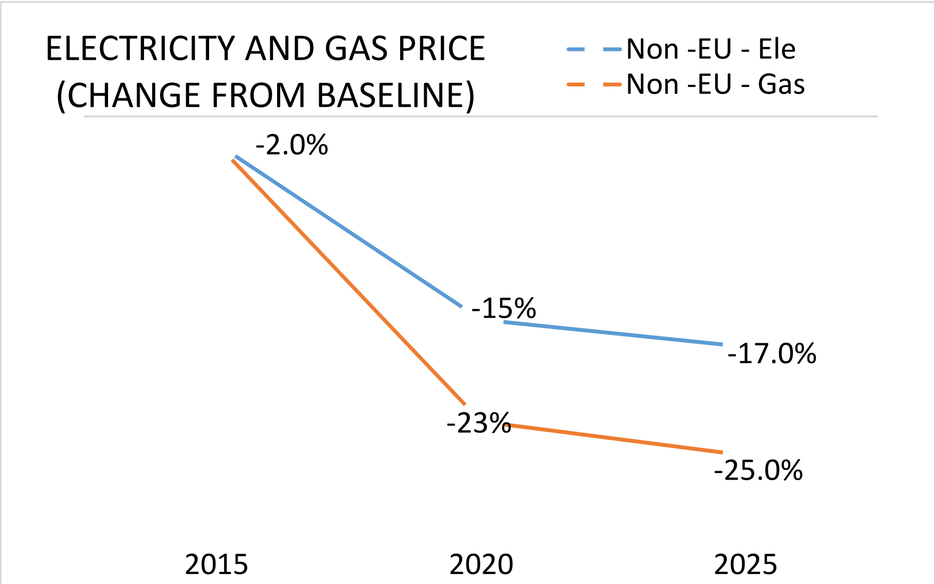
Scenario B23: Low electricity and gas prices in the non – EU countries

Price differential can also be due to causes occurring outside the EU. Cheaper and more abundant resources, or even subsidization, can drive reduction in electricity and gas prices in non-EU countries. For the purposes of the analysis it is assumed that the price reduction does not propagate in the EU. Certain geographical or market conditions can make this happen in reality. Therefore a scenario is defined which does not assume indigenous to the EU causes of price differentials bit instead assumes lower electricity and gas prices in the non-EU world driven by cheaper resources and further assumes that electricity and gas prices in the EU remain at reference scenario levels.

Electricity and gas prices in the non-EU countries as assumed in this scenario are shown in Figure 3. Gas prices in the non-EU countries are assumed[7] to decrease more than electricity prices relative to the reference scenario. The decrease in prices takes place mainly until 2025 where after prices revert back to reference scenario levels.

[7] This could be due to the discovery of new reserves.

Figure 3: Electricity and Gas price for non-EU countries



Modelling assumptions

The GEM-E3 model covers the global economy by distinguishing 46 countries/regions linked through endogenous bilateral trade flows. The model has been extended so as to include all the non-EU G20 countries in addition to representing the individual EU28 member states. Activity by sector is split in 22 sectors/products and electricity generation is split in 10 technology types. The industrial sector resolution covers 9 industrial sectors and has included maximum focus allowed by data availability on energy-intensive industries[8].

GEM-E3 is an open economy model for the EU and its current account can change by scenario. In all counterfactual scenarios quantified with the model it was assumed that the current account of the EU28 as a percentage of GDP will remain unchanged as compared to the reference scenario. This assumption is necessary to render the different scenarios comparable to each other. In fact, as the model does not include a mechanism to readjust exchange rates of countries through financial/monetary mechanisms, it would not capture adequately the effects of an eventual persisting current account deficit in a particular region. It would be unrealistic to assume that in a scenario such a persisting deficit would perpetuate without consequences on relative exchange rates. Instead of a monetary mechanism the GEM-E3 model uses relative interest rates as an equivalent balancing instrument. The EU wide interest rate re-adjusts endogenously in the model so as to keep the current account as a percentage of GDP unchanged. This is a good proxy of a current account re-balancing through exchange rate re-adjustment. For example interest rates may increase when changes of prices in the EU imply pressures towards current account deficit. From a modelling perspective the EU-wide interest rate is a closure instrument; alternatively the exchange rate could be an equivalent closure instrument but since the GTAP[9] original data are all expressed in dollars, GEM-E3 design has opted for using interest rates instead of exchange rates for closure purposes.

[8] The regional and sectoral aggregations of the model are summarized in the Appendix.

[9] The Global Trade Analysis Project (GTAP) is a global network of researchers and policy makers conducting quantitative analysis of international policy issues. GTAP is coordinated by the Centre for Global Trade Analysis in Purdue University's Department of Agricultural Economics.

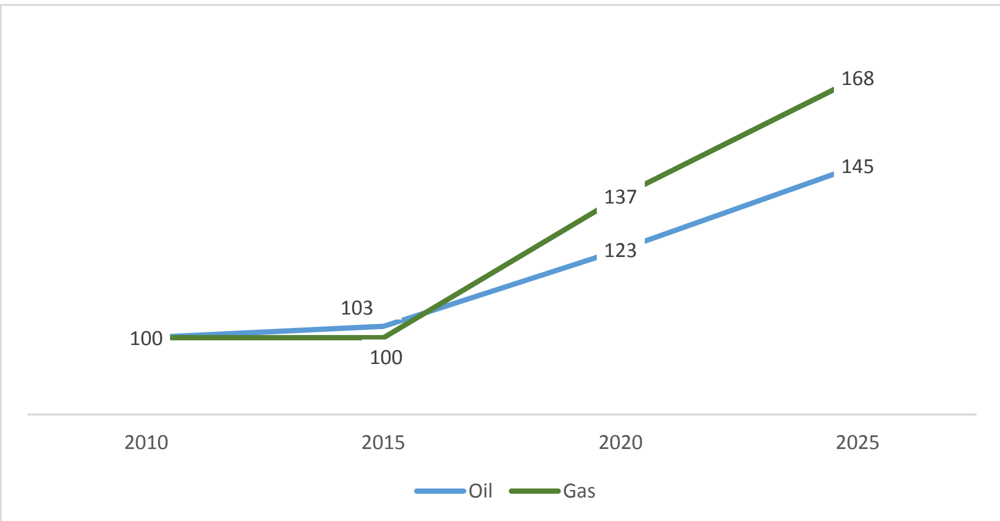
For the specification of the alternative scenarios we have made explicit assumptions on the causes of higher gas and electricity prices in the EU countries as mentioned in the previous section.

Reference scenario

Basic Assumptions

The GEM-E3 reference scenario is consistent with the PRIMES 2013 reference scenario for the EU. The growth and activity projections by sector and by EU Member-State are identical to the growth assumptions driving energy projections in the PRIMES 2013 reference scenario and the energy-related (consumption, electricity generation mix, prices) projections using the GEM-E3 model have been calibrated so as to be very close to energy projections of PRIMES 2013 reference scenario. As GEM-E3 is a global model, energy projections by PROMETHEUS model have to be used to calibrate GEM-E3 energy-related projections for the non-EU countries. For this purpose the PROMETHEUS 2013 reference scenario has been retained which is roughly consistent with the IEA World Energy Outlook New Policies scenario of 2012 and has also served to project world fossil fuel prices for the inputs of PRIMES 2013 reference scenario. Thus, the degree of consistency achieved between macroeconomic and fossil fuel price projections as assumed for the reference 2013 scenario is also fully ensured in the current GEM-E3 reference scenario. As PROMETHEUS has limited geographic resolution, the disaggregation of projections by country had to be complemented by using additional sources. For this purpose a 2012 MIT outlook[10] has been chosen because of the sufficient level of detail and also because the projections are roughly similar to IEA projections. Labour force and unemployment rate projections have been based on the Ageing report 2012 of DG-ECFIN for the EU member states and on the ILO for non EU countries. International fossil fuel prices are based on the PROMETHEUS 2013 reference projection. Figure 4 presents the trajectory for average fossil fuel prices in EU imports.

Figure 4: International fossil fuel prices in the Reference GEM-E3 scenario (2010 index)



Note: Fossil fuel prices are average import prices to the EU, not world average.

The international fossil fuels prices have been projected based on the PROMETHEUS (stochastic world energy model) model reference scenario for 2013.

[10] Available at: http://globalchange.mit.edu/Outlook2012

Oil prices increase continuously but the pace of price rise is slow due to high resource base, apart from uncertain (and temporary) effects of production capacity pressures in relation to demand evolution.

In the short term, high oil prices reflect the failure of productive capacity to grow in line with demand (fuelled by economic recovery and persistent growth in emerging regions).

The situation eases somewhat around 2020 before seeing declining global Reserves to Production ratios from 2030 onwards and result in a resumption of upward trends. For 2035 oil prices projected by PROMETHEUS are broadly in agreement with IEA-WEO 2011 New Policies.

Short term projections of natural gas prices (average prices of EU imports) show high increases owing to increasing demand from Asia (particularly Japan after Fukushima and China because of demand growth) which more than counterbalance reduced import demand in North America following shale gas exploitation. Asian gas import prices are mainly driving European LNG gas import prices in the short term while Russian gas prices for exports to the EU are mainly indexed to oil prices.

In the longer term the gas price pace diverts from the upward trend of the oil price, a major break with past price behaviour, due to the very large additional and currently unexploited resources including unconventional gas that is assumed to enter the global market in the decade 2020-2030 also in new regions, such as China, in addition to further growth in North America. As a consequence, natural gas prices tend to stabilize at a level that nonetheless is still high enough to ensure economic viability of unconventional gas projects.

China enters the global market for coal in 2008 and is assumed to remain a global player therefore causing coal prices to remain at high levels throughout the projection period. Coal prices increase at a rather slow pace in the 2025-2040 period due mostly to competition with gas in the electricity generation sector. In the longer term coal prices stand at levels that are above recent peaks (e.g. 2008).This is due to consistent demand growth in regions that undertake only limited GHG abatement policies after 2020 under reference case assumptions.

Overview of the GEM-E3 Reference scenario

Over the 2015-2050 time period the EU28 GDP is projected to grow annually by 1.5% on average. This rate is lower than the average world GDP growth rate which is 2.6% for the same time period. Table 1 presents the projection of GDP for the EU and a decomposition of GDP in large aggregated components. The projection is consistent with Ageing Report 2012 projection in the long term and with DG ECFIN short term projections 9as available in early 2013).

In 2010 the openness index[11] (trade to GDP ratio) of the EU economy is close to 30% which is assumed to be maintained until 2050, a trend which implies that exposure of the EU economy to foreign competition will increase in the long term. The reference projection assumes that the EU maintains a trade surplus over the projection period which is slightly below 1% of GDP.

The main trading partners of EU are the USA and China for exports[12] and the USA, China and Russia for imports[13]. The EU has currently a trade surplus in services, intermediate goods

[11] (Exports + Imports) / GDP. In this calculation exports and imports do not include intra-EU trade.
[12] These two countries represent nearly 30% of total EU exports
[13] These countries represent 33% of total EU imports

and equipment goods but a trade deficit in energy goods, metals and consumer goods. The reference scenario projects trade surplus to be maintained and even reinforced in services, to be maintained by weaken over time in intermediate goods but to gradually revert to a deficit in equipment goods. The projection involves continuation of trade deficits in energy and consumer goods. These trends reflect growth driven by a higher share of services sector and general reliance on growing contribution of knowledge capital in all sectors allowing activity to produce more high value-added commodities and less material-intensive ones. Foreign competition pressure are shown to increasingly intensify in the equipment and intermediate goods industries as a result of spill over of technology progress in these sectors towards emerging economies. Trade deficit of the EU is projected to persist in sectors depending on labour costs, such as consumer goods industry, and in sectors depending on resources costs, including intermediate commodities notably ferrous and non-ferrous metals.

Table 1: EU28 GDP growth and components in the Reference scenario

EU28	b$2010			Annual % changes		
	2010	2020	2025	2020	2025	2010-2025
Gross Domestic Product	16259	19169	20758	1.7	1.6	1.6
Investment	3178	3791	4111	1.8	1.6	1.7
Public Consumption	3421	3906	4235	1.3	1.6	1.4
Private Consumption	9463	11191	12114	1.7	1.6	1.7
Trade Balance (% of GDP)	1.2%	1.5%	1.4%			

Source: GEM-E3

Table 2: Rest of the World GDP growth in the Reference scenario

Gross Domestic Product	2010	2020	2025	2020	2025	2010-2025
Brazil	1266	1779	2067	3.5	3.0	3.3
Canada	1432	1784	2017	2.2	2.5	2.3
China	4492	9175	12463	7.4	6.3	7.0
India	1445	2686	3573	6.4	5.9	6.2
Japan	5366	6014	6439	1.1	1.4	1.2
USA	15696	20564	23134	2.7	2.4	2.6
Russia	1050	1494	1683	3.6	2.4	3.2
Rest of G20	4915	7137	8449	3.8	3.4	3.7
Rest of the World	6005	8835	10636	3.9	3.8	3.9

Source: GEM-E3

Table 3: EU28 Openness indicator

EU28	2010	2020	2025
Openess	26%	27%	28%

Source: GEM-E3

As mentioned the reference scenario projects a restructuring of the EU economy towards higher shares of services in the future and a shift towards higher value added and less resource intensive production. Energy intensive industries, which are mostly depending on energy costs, represent a small share in total value added (4% in 2010) which is projected to further decrease over time.

Table 4: EU28 trade balance (exports - imports) in commodities and services

Trade Balance (in b$ 2010)	2010	2015	2020	2025
Agriculture	-41	-51	-61	-64
Energy	-250	-262	-277	-299
Intermediate goods	37	133	170	176
Equipment goods	115	65	-12	-87
Consumer goods	-61	-118	-164	-206
Services	396	510	629	786
Total	198	277	286	307
Details about intermediate goods				
Metals	-48	-8	-9	-19
Chemicals	73	139	172	186
Non Metallic Minerals	-6	-7	-6	-8
Paper and Pulp	18	10	12	17
Details about equipment goods				
Electric goods	-154	-162	-169	-176
Transport equipment	102	108	96	99
Other equipment goods	167	118	62	-9

Source: GEM-E3

Table 4 shows a strong increase in the terms of trade for the services sectors. This result is linked to the on-going tertiarisation of the EU economy but may also be related to the assumption of a fixed current account.

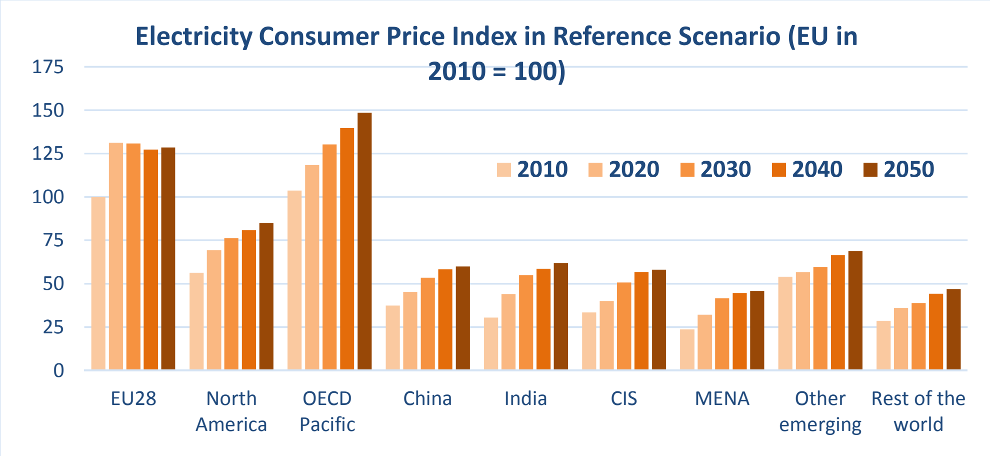
Table 5: Average EU electricity price in the Reference scenario

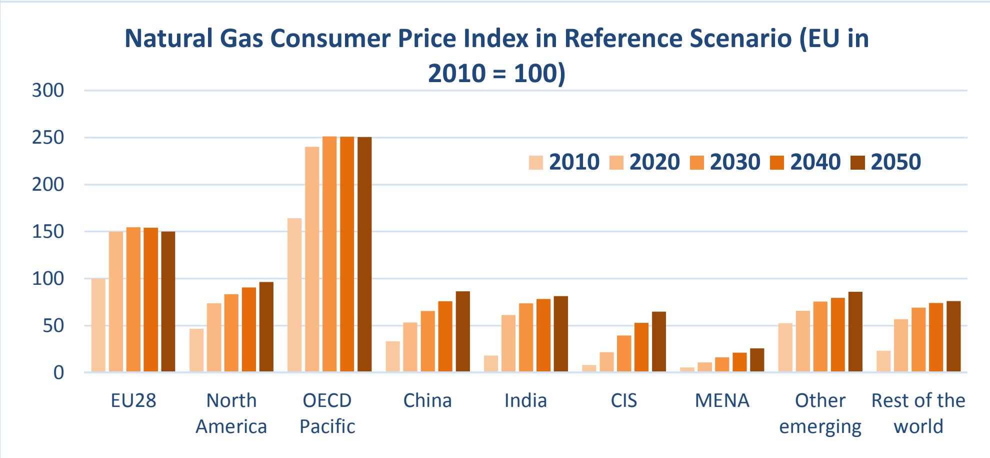
Annual growth rates	2011-2020	2021-2030	2031-2050
Average end-consumer prices	2.76%	-0.04%	-0.09%
Electricity generation costs	2.40%	-0.17%	-0.19%
of which fuel costs	1.36%	-0.78%	-0.49%
Grid and supply costs	2.35%	1.01%	0.57%
Taxation and ETS costs	22.02%	7.86%	0.93%
Recovery of RES support	22.57%	-4.70%	-23.45%

Source: GEM-E3 and PRIMES

The price of electricity is calculated on the basis of generation costs, the recovery of investment expenditures in grid infrastructure, the costs of renewable support schemes, the ETS auction payments and the applicable taxes. In the reference scenario electricity prices are shown to increase mainly until 2020 as a consequence of rising gas prices, assumed in the reference scenario context and the increased costs for renewables.

Figure 5: Electricity and gas consumer price index projections in the Reference scenario (based on PRIMES and PROMETHEUS models)





The rise of electricity prices is shown to stop after 2020. This is driven mainly by the projected decoupling of gas to oil prices and the modest increase of gas and coal prices after 2020. Productivity in electricity generation and supply also increases after 2020 as new power plants are massively committed in the system which embody technologies with higher efficiency.

Although the system has increasing needs to recover capital costs as replacement of old generation capacities increases after 2020, given the ageing of power plants in the EU, technology progress allows compensation of higher capital costs by efficiency and unit cost reduction gains. ETS carbon prices are projected to increase after 2025 and reach significant levels driven by ETS Directive implementation which provide for a linear annual decrease of allowances (EUA) at an amount calculated by applying 1.74% on base year emissions. ETS auction payments by electricity generators are assumed to be reflected onto retail prices.

Costs of renewable support schemes are projected to significantly decrease after 2020 as a result of gradually decreasing feed-in tariff schemes, as renewable development after 2020 is mainly driven by ETS carbon prices and is facilitated by investment cost decreases due to learning trends. The drop of renewables cost compensates the projected increase in costs driven by ETS.

The gap of energy prices between EU and other countries (mainly with USA, Japan and China) is assumed to remain throughout the simulation period and to reduce along a relatively low pace of convergence over time (see Figure 5). The low price countries see increasing prices in the future but price levels in the long term remain well below the EU levels. Increasing and diverse energy prices are also projected by a number of studies including

IEA's WEO (2013). The reason of persisting price divergence is subsidization in the non-OECD countries. For North America it is due to emergence of non-conventional hydrocarbons which has allowed for price drops already before 2010.

4.2. Modelling results

Macroeconomic impacts of price increase in the EU

Overview of results

An increase in the prices of gas and electricity, unilaterally in the EU and non in the non-EU world, affects economic activity through multiple channels setting in motion substitutions between production factors, changes in foreign trade, restructuring of production and demand towards less energy intensive goods and services, etc.

Because electricity and gas cannot be perfectly substituted by other commodities or services, the increase of their prices implies higher costs to be borne by end-consumers of energy (firms and households) and as the resources of the economy are limited, the price rise implies a crowding out effect affecting expenditures in other goods and services. For households, the share of energy expenditures to total expenditures has to increase, given that gas and electricity products are considered as essential inputs and cannot be perfectly substituted. Thus purchasing power of income weakens which implies lower demand for non-energy related goods and services.

Also because of lack of substitution, production costs of energy consuming producers of goods and services will see increased costs (1.2% on average in 2025 above reference). Consequently prices of domestically produced goods and services have to increase which drives lower domestic demand both by households and by other production sectors using domestically produced goods and services as input production factors (demand for energy intensive products decreases by 1.0% in 2025).

Although substitutions away from electricity and gas are difficult, the consumption and production structures adapt as much as possible to alleviate the cost impacts of price rise and the economy finds a new equilibrium in capital and labour markets at lower price clearing levels (return on capital and wage rates) in order to mitigate downwards pressures stemming from lower domestic demand. So the substitutions and the market re-adjustments reduce the cost impact of price rises at levels below cost impacts that would be suggested by the initial share of electricity and gas in total costs by sector.

The model results show that at the new equilibrium, with electricity price increases of 25% and gas price increases of 17% unit cost of total households' consumption increases moderately by 0.4% on average in 2025 (driven by 6% increase of unit costs of all energy forms consumed by households) and average production cost of firms increases by 0.35% in 2025 while costs increase by 1.5% in energy intensive industries, compared to reference. Consumer price index increase by 0.59% and GDP deflator by 0.20% compared to reference in 2025. The cost and price impacts reduce beyond 2025 while electricity and gas price increases diminish by assumption.

Driven by the price rise and the lower income due to lower demand for labour, the rise of electricity and gas prices cause private consumption to drop (Table 6). Expenditure for purchasing non-energy commodities and services also decrease, including for the purchasing of equipment goods which use electricity or gas. Nevertheless, energy intensity of households' consumption reduces compared to reference, by 1.5% approximately in 2025, but this gain is not sufficient to overcome the effect of price rise on final consumption.

Table 6: Impacts on Private Consumption (EU28)

(% change from the reference case)	2020	2025	Cumulative (2015-2050)
B21a - Taxation case	-0.21	-0.28	-0.24
B21b - Taxation case	-0.35	-0.49	-0.45
B22 - Price mark-ups	-0.51	-0.59	-0.35
B24 - Generation Mix	-0.79	-0.71	-0.51

Source: GEM-E3

Production of goods and services becomes more energy efficient in all sectors, as a result of electricity and gas price rise: energy intensity decreases by 2.4% (3.5% in energy intensive production) in 2025 compared to reference but this improvement is not sufficient to offset overall cost increases. The effects of price rise on domestic activity and demand exert downward pressures on capital and labour markets leading to lower capital return rates and lower real wages (-0.1% for capital costs and -0.87% for labour costs in real terms in 2025, compared to reference). However, despite cost reductions in using primary production factors, domestic production sees price increases, except in few high labour intensive sectors (services). Therefore the increased prices of domestically produced goods and services moderately impacts foreign competitiveness in these sectors. Imports tend to increase and exports tend to decrease (Table 7 and Table 8). The readjustment of interest rates driven by the capital market re-balances the current account as percentage of GDP but despite this the trade balance deteriorates as a consequence of electricity and gas price increases. The structure of exports also changes, shifting in favour of highly priced exported goods and away from low priced goods (e.g. materials) which is shown as a slight increase of terms of trade (average price of exports over average price of imports) compared to the reference.

Table 7: Impacts on Imports (EU28)

(% change from the reference case)	2020	2025	Cumulative (2015-2050)
B21a - Taxation case	0.00	0.02	0.01
B21b - Taxation case	-0.06	-0.06	-0.07
B22 - Price mark-ups	-0.04	0.01	0.03
B24 - Generation Mix	-0.21	-0.14	-0.11

Source: GEM-E3

Table 8: Impacts on Exports (EU28)

(% change from the reference case)	2020	2025	Cumulative (2015-2050)
B21a - Taxation case	-0.22	-0.25	-0.20
B21b - Taxation case	-0.32	-0.38	-0.33
B22 - Price mark-ups	-0.30	-0.30	-0.17
B24 - Generation Mix	-0.41	-0.39	-0.27

Source: GEM-E3

Private consumption decreases and because of rising EU production costs consumption shifts towards non-European goods, exports decrease and hence overall domestic production decreases. The decline in the activity of sectors exerts a downward pressure in the demand for labour and capital which is partly offset by the substitution effects among production factors, induced by higher electricity and gas prices. Production shifts towards more capital and/or labour intensive methods of production because of substitution. Nevertheless the net effect for both the capital and the labour market is negative as the potentials for substituting energy with capital and/or labour are very limited. So the demand reduction effect dominates leading to lower demand for labour and capital. The downward pressure on capital and labour markets imply lower equilibrium prices which mitigate but do not cancel the volume effects.

Table 9: Unemployment Rate (EU28)

(p.p. difference from reference)	2020	2025
B21a - Taxation case	0.23	0.30
B21b - Taxation case	0.52	0.60
B22 - Price mark-ups	0.51	0.55
B24 - Generation Mix	0.33	0.36

Source: GEM-E3

Table 10: Real Average labour cost (EU28)

(% change from the reference case)	2020	2025
B21a - Taxation case	-0.71	-0.87
B21b - Taxation case	-0.47	-0.66
B22 - Price mark-ups	-0.47	-0.64
B24 - Generation Mix	-0.25	-0.31

Source: GEM-E3

Higher unemployment rates (Table 9) along with lower wages and capital return rates are indicated (Table 10), although the labour and the capital markets do dispose some degree of flexibility. If gas and electricity price rise as a result of additional taxation, and assuming that the additional state revenues are used to reduce labour costs, by decreasing the employer's contributions to the social security system, the reduction of the effective cost of labour has positive influence in the labour market, increasing employment as compared to other scenarios with higher energy prices (Mark-up, High RES and Energy tax with lump-sum transfers to households).

In the labour intensive sectors, where human capital is the most important factor of production, unlike the energy intensive ones, experience some slight gain in competitiveness and an increase in their demand from trade due to the lower labour costs. In these sectors, notably some services sectors, exports increase on average by 0.4% over the period 2015-2050 compared to the reference.

The depression of demand and the reduction of rates of return on capital go together with slowing down of investments which is dynamically captured in the model. Investment expenditures reduce (Table 11), as demand growth expectations reduce. Lower investment implies lower demand for equipment goods, services and construction which are used to build investment; this adds to the depression of total domestic demand. In addition, the reduction of the rate of return on capital, makes investment in the EU less attractive and induces re-orientation of global capital flows which exerts pressures on the current account towards a deficit. Thus lending becomes more expensive and also savings increase which further implies lower consumption. If mark-ups in electricity and gas supply are the causes of electricity and gas price increases capital income increases and these extra revenues are recycled back in the economy acting in favour of investment; thus the increased availability of funding favours overall investment in the economy and despite the depression of demand investment slightly increases dynamically over time (0.001% over the period 2015-2050 compared to the reference) helping to attenuate quickly the adverse effects of the price rise on domestic activity.

Table 11: Impacts on Investment (EU28)

(% change from the reference case)	2020	2025	Cumulative (2015-2050)
B21a - Taxation case	-0.18	-0.26	-0.18
B21b - Taxation case	-0.51	-0.64	-0.53
B22 - Price mark-ups	-0.04	-0.04	0.00
B24 - Generation Mix	0.15	-0.26	-0.16

Source: GEM-E3

The model results confirm that all high energy prices scenarios imply lower EU GDP relative to the reference case (Table 12). Depending on the causes that drive the increase in energy prices the negative impact on GDP is different in magnitude and on each GDP component.

Table 12: Impacts on GDP (EU28)

(% change from the reference case)	2020	2025	Cumulative (2015-2050)
B21a - Taxation case	-0.19	-0.25	-0.22
B21b - Taxation case	-0.34	-0.46	-0.41
B22 - Price mark-ups	-0.35	-0.40	-0.23
B24 - Generation Mix	-0.46	-0.50	-0.36

Source: GEM-E3

The impact of loss of competitiveness on trade is significant for energy intensive products. The adverse effects are far more pronounced on energy intensive products which are more exposed to foreign trade, primarily on ferrous and non-ferrous metals, but also on chemicals. Impacts are lower on non-metallic minerals and on paper which are less exposed to trade and are more related to domestic demand as trade implies high transportation costs.

Table 13: Impacts on trade of energy intensive products in taxation case B21a (EU28)

	% change of Exports		% change of Imports	
EU28	2020	2025	2020	2025
Ferrous metals	-7.85	-9.05	6.42	7.49
Non ferrous metals	-5.75	-6.66	5.12	5.87
Chemical Products	-1.96	-2.36	1.94	2.29
Paper Products	-1.57	-1.81	1.37	1.56
Non metallic minerals	-0.81	-1.02	0.42	0.48
Entire economy	-0.22	-0.25	0.00	0.02

Source: GEM-E3

The consequences of gas and electricity price rise is thus more severe for the energy intensive sectors whose production costs rely heavily on energy inputs. Driven by depressed domestic demand, lower exports and higher imports, domestic production of energy intensive industries is significantly reduced in all scenarios (Table 15, Table 14 and Table 16). As a result, trade surplus of the EU in the energy intensive industries decreases over the period 2015-2050.

Table 14: Impacts on production of energy-intensive industries (EU28)

(% change from reference cumulatively over 2015-2050)	Ferrous metals	Non ferrous metals	Chemical Products	Paper Products	Non metallic minerals
B21a - Taxation case	-2.69	-1.43	-0.97	-0.39	-0.61
B21b - Taxation case	-2.98	-1.73	-1.17	-0.59	-0.86
B22 - Price mark-ups	-2.68	-1.42	-0.97	-0.44	-0.52
B24 - Generation Mix	-1.34	-0.88	-0.67	-0.50	-0.41

Source: GEM-E3

Table 15: Impacts on imports of energy-intensive products (EU28)

(% change from reference cumulatively over 2015-2050)	Ferrous metals	Non ferrous metals	Chemical Products	Paper Products	Non metallic minerals
B21a - Taxation case	4.64	3.21	1.36	0.87	0.25
B21b - Taxation case	4.50	3.16	1.29	0.82	0.08
B22 - Price mark-ups	4.74	3.35	1.31	0.38	0.80
B24 - Generation Mix	1.51	1.19	0.43	0.23	0.05

Source: GEM-E3

If price changes are perceived by firms as a permanent rather than a temporary shock the effects are higher on the European economy. The model-based simulations have assumed that price changes are permanent but their intensity changes over time as the price increases tend to vanish in the long term. So the model captures dynamic re-adjustment of the EU economy and shows some degree of attenuation of adverse effects in the long term.

Table 16: Impacts on exports of energy-intensive products (EU28)

(% change from reference cumulatively over 2015-2050)	Ferrous metals	Non ferrous metals	Chemical Products	Paper Products	Non metallic minerals
B21a - Taxation case	-5.95	-4.47	-1.49	-1.24	-0.72
B21b - Taxation case	-6.18	-4.73	-1.60	-1.40	-0.81
B22 - Price mark-ups	-6.02	-4.56	-1.43	-1.22	-0.71
B24 - Generation Mix	-2.53	-2.08	-0.75	-0.75	-0.38

Source: GEM-E3

Nonetheless the model does not capture readjustment effects stemming from changes in R&D and induced productivity. The change in the relative prices of factors of production creates incentives for the firms to invest more funds on R&D to improve energy efficient methods of production. Technological progress creates the potential for a rebound effect in the European competitiveness, compensating for the increased price of energy inputs. Nonetheless, the induced technological change cannot fully offset the effect of higher prices on unit production costs as energy (and in particular electricity and gas) is an essential input in production. Negative effects will be mitigated but will still persist although the long run resilience of the economy to energy price increases will be higher. Despite not fully capturing the induced technological progress, the model results show significant improvement of energy intensity and reduction in emissions.

In conclusion the modelling indicates that 17% to 25% higher electricity and gas prices will reduce the European GDP growth by 0.2% - 0.45%, with the magnitude being dependent on the trade openness of the sectors who contribute the most to the value added of the economy and the form of revenue use, and it is expected that this reduction will be accompanied by a transformation towards higher shares of services and less energy-dependent goods.

Scenarios B21a and B21b: Taxation of electricity and gas

These scenarios explore the impacts of rising taxation of electricity and gas as a possible cause of electricity and gas price rise. As described in the previous section, domestic rise of electricity and gas prices in the EU asymmetrically has negative effects on GDP, domestic activity and private income due to crowding out effects and through the weakening of foreign competition. The intensity of impacts assuming taxation as the cause of price rise is similar to findings of simulation of impacts by other possible causes. But it is worth mentioning that the indirect effects of how taxation revenues are recycled aback to the economy constitute an important consideration as the results show that the recycling scheme is not at all neutral regarding the impacts on the economy. Two different recycling schemes have been examined:

i) The revenues are used to reduce social security contributions of employers and thus help reducing labour cost (**B21a**).

ii) The revenues from increased energy taxation are directed to households so as to increase their income and sustain private consumption (**B21b**)

The negative effects on GDP are significantly more pronounced in the second case. Consumption changes resulting from an increase in the disposable income of households fail to compensate for the competitiveness loss in EU due to higher electricity and gas prices. The increased costs of production undermine the competitiveness of European sectors and the demand for EU products from abroad falls by 0.28% in 2025 (compared to the reference). Although public transfers support households' income the incurred loss in competitiveness drives the EU GDP down (-0.44% cumulatively) as exports deteriorate (-0.23% cumulatively over the period 2015-2050 as compared to the reference).

Additional income of households is spent on both domestic and imported goods. Thus part of the additional income translates into demand for goods produced by non-EU countries. In this scenario imports are sustained from higher household demand for imported goods as preference shifts over relatively cheaper imported goods (-0.03% cumulatively over the period 2015-2050). At a sectoral level, the increase in total production cost of energy intensive sectors (-1.5% on average in 2025 compared to the reference) is higher among the two taxation cases and this implies stronger adverse effects on production and exports (they reduce by 2.0% and 3.5% respectively in 2025 in the second taxation case).

Recycling tax revenues so as to reduce social security contribution rates implies lower labour costs and this partly offsets cost impacts of electricity and gas prices on production costs and mitigates price increasing trends in the economy. Thus competitiveness losses are also alleviated and so depressive effects on domestic demand are mitigated, compared to the alternative taxation case. The decrease in the cost of labour sustains demand for labour and as a consequence the reduction in wage income is mitigated, hence the effect of higher energy prices on private consumption (-0.3% in 2025 compared to the reference) is lower than in the alternative taxation case.

The beneficial effects of recycling taxation revenues towards reducing labour costs hold true also for energy-intensive industries although they are not labour intensive. This finding is attributed less to direct consequences on competitiveness but rather to general economic multiplier effects because the labour cost reductions has overall demand sustaining effects in the economy hence positively affecting domestic demand addressed to energy-intensive industries. In addition, negative effects of taxation cases on investment and construction are also mitigated in case of recycling in favour of reducing labour costs which also favours demand addressed to energy-intensive industries.

Taxing electricity and gas and recycling revenues to households has found to exert the highest, among all cases, negative impact on energy intensive sectors. In cumulative terms, the mitigation of negative effects on production due to recycling taxation revenues in favour of labour costs is 0.30 percentage points (annual change) for metal products and 0.20 percentage points for the rest of energy-intensive products.

Table 17: Impacts on production by sector in the two taxation cases (EU28)

(cumulative % change from reference over the period 2015-2050)	B21 - Taxation case (a)	B21a - Taxation case (b)
Agriculture	-0.12	-0.30
Industry (energy intensive)	-1.03	-1.26
Consumer goods industries	-0.23	-0.42
Equipment goods	-0.15	-0.46
Construction	-0.23	-0.50
Transport	-0.17	-0.31
Services	-0.08	-0.23

Source: GEM-E3

Labour cost reductions result in net competitiveness gains for labour intensive industries (e.g. services) and as a consequence exports increase and imports decrease, despite the increase of electricity and gas prices. The gains from trade are, however, not sufficient to drive positive effects on domestic production of the services sector, because of lower domestic demand. The impacts on domestic activity are mitigated for all sectors in the recycling case towards labour costs (Table 17).

The overall effect on the trade balance of non-energy intensive sectors is found to be positive. The loss of exports of energy-intensive products is partly compensated by higher exports of services and other low energy-intensive products. These sectors benefit from cost reductions due to labour and capital unit costs which as mentioned above decrease in the taxation scenarios as a result of the overall depression of activity (Table 18).

Table 18: Trade balance (EU28)

(% change from reference cumulatively over 2015-2050)	Agriculture	Energy intensive industries	Consumer goods	Equipment goods	Transport	Services
B21a - Taxation case	-1.8	-17.3	0.1	-3.1	0.2	1.1
B21b - Taxation case	-1.7	-17.6	0.3	-2.4	0.2	1.0

The signs stand for deficit (-) or surplus (+)
Source: GEM-E3

Scenario B22: Higher mark-ups on electricity and gas costs

In scenario B22 higher costs mark-up in the electricity and gas prices, assumed to be the cause of electricity and gas price rises, imply higher operating surpluses in the electricity and gas sectors. Households and firms collect higher dividends and funding of investment is potentially higher although for individuals the additional income is also used for consumption purposes. Consequently, investment is found to be less affected in this scenario than in any other of the EU price increase scenarios. This result has to be considered with caution because it is due to modelling assumptions reflecting the general equilibrium approach of the model. Market failures or non-optimal capital flows seen in reality as driving less efficient outcomes of mark-up based revenues; these are not captured by the model.

Sustaining investment has dynamic impacts in the economy which are captured by the model. Although the negative effects on GDP are of the same order of magnitude as in the other EU price rising scenarios, the long term effects on GDP are lower: the pace of vanishing GDP impacts is much faster than in any other scenario.

Nonetheless, the mark-up scenario shows higher negative effects on GDP than the labour cost recycling taxation case during the period of peaking price differential for electricity and gas.

Scenario B24: Higher price only for electricity driven by generation mix

For scenario B24 it is assumed that non-optimal investment in expensive renewables takes place in electricity generation and drives higher electricity prices (9% above reference in 2025), as capacity expansion hence generation mix deviates from optimality as simulated in the context of the reference scenario. It is also assumed that in order to finance the additional investment requirements in electricity sector, funds are drawn from households which implies that income is reduced and private consumption has also to decrease. The additional investment expenditure in electricity sector, although accounted for in total investment, is not driving additional productive capacity as it is assumed that capacity remains unchanged and that only unit cost of investment in electricity sector increases. Obviously this assumption corresponds to loss of efficiency in the economy and lower demand by households. In addition, the high capital requirements in electricity sector stress capital markets and lead to higher average cost of capital which has adverse effects on costs in other sectors and as a consequence activity decreases, economy-wide, also driven by lower private consumption. Gas prices are assumed not to change relative to reference. So average energy costs in industry is less affected than in other scenarios.

The increase in investment costs due to capacity expansion towards inefficient renewable energy forms implies higher demand for equipment goods used to build the renewables. This effect is however small and fails to counteract the effects of dropping demand driven by crowding out effects to the detriment of private consumption.

Compared to taxation scenarios, B24 shows significantly higher negative impacts on GDP and on production by sector but also significantly lower negative effects on energy-intensive industry. The latter effect is due to the energy price costs which increase in B24 much less than in the taxation scenarios.

Scenario B23: Low electricity and gas prices in the non – EU countries

The B23 scenario differs from the other because it is assumed that electricity and gas prices reduce in the non-EU countries and not in the EU, which is quite different from assuming price rise indigenously in the EU.

In the B23 scenario the non-EU countries collect benefits from getting higher access to low cost energy resources and to more productive extraction of gas; as electricity and gas prices reduce in these countries, economic growth is boosted and demand addressed also to the EU increases. In addition, product prices in the non-EU countries decrease and so EU can import goods at lower prices relative to the reference. The non-propagation of energy price decreases in the EU implies competitiveness losses for the European goods and services which implies trends towards EU imports and lower exports by the EU. This exerts negative effects on the EU economy. So, in the B23 scenario the EU is affected by two mainly counteracting mechanisms: higher demand from abroad and lower prices of the goods sold in the EU which have positive effects on demand and deteriorated trade competitiveness which has negative effects on activity.

The additional growth in non EU countries driven by lower energy costs is found to amount to 0.6% for GDP and 0.8% for consumption, cumulatively over the period 2015-2050 compared to the reference case. This increase sustains the demand primarily for non-energy intensive European goods and services hence exports of EU increase (0.6% over the period 2015-2050 as compared to the reference). In addition EU is benefitting from cheaper imports and private consumption increases marginally by 0.01% over the period 2015-2050 compared to reference.

The decrease in energy costs induce competitiveness gains for energy intensive industries located outside the EU and increase imports' penetration in the European market. Imports by the EU increase by 2.0% over the period 2015-2050. Nevertheless the recorded reduction in the production of the European energy intensive industries is lower than in other scenario examined (-0.6% over the period 2015-2050) due to higher global demand. Changes in domestic (EU) demand induced by negative income effect (i.e. the increase in prices reduces real income thus demand) are moderated since the cost of living does not increase. Therefore changes in production in the EU (for energy intensive industries) are driven primarily by changes in foreign trade. Trade balance in the EU worsens as a consequence of the shift towards the consumption of cheaper imported products and GDP remains stable (0.02%) as compared to the reference.

Table 19: Macroeconomic effects on the EU of asymmetrically lower prices in non-EU world

(% change from the reference case)	2020	2025	Cumulative (2015-2050)
GDP	-0.03	-0.04	-0.02
Private Consumption	-0.02	-0.02	0.00
Investment	0.01	0.01	0.02
Imports	0.49	0.61	0.45
Exports	0.31	0.36	0.24
Impacts on production of energy-intensive industries	-0.86	-0.99	-0.60
Impacts on imports of energy-intensive products	3.57	4.04	2.34
Impacts on exports of energy-intensive products	-2.03	-2.30	-1.34
Impacts on Unemployment Rate (p.p. diff.)	0.01	0.01	
Real Average labor cost	-0.01	-0.01	

Source: GEM-E3

4.3. Chapter conclusions

The aim of the present chapter has been to quantify economic impacts on the EU economy of future price differentials for electricity and gas between the EU and the non-EU world. From a modelling perspective, scenarios have been quantified using the GEM-E3 global general equilibrium model, in which electricity and gas price rise in the EU has been hypothetically driven by taxation and other possible causes. A different scenario has been also quantified in which electricity and gas price reductions take place in the non-EU world and do not propagate to the EU. These are obviously stylized scenario cases. The results are compared to a reference scenario, also quantified using GEM-E3, which mirrors the recently published Reference 2013 scenario of the European Commission.

The model results clearly show that a strong asymmetric **rise of electricity and gas prices** in the EU would have adverse effects on the economy, **depresses domestic demand**, activity and investment. The energy intensive industries could suffer from loss of competitiveness due to energy prices and see diminishing shares in global markets. Adjustments in capital and labour markets towards lower capital and labour prices driven by lower demand would not appear to offset competitiveness losses. Substitutions towards less energy intensive production and consumption patterns, as far as captured by the model, are also unable to fully alleviate consequences. It is worth considering more closely the causes of energy price rises because they have different economic effects. **Raising taxation of electricity and gas but using tax revenues to reduce labour costs, through social security accounting, was found to be the most beneficial among the cases examined for GDP and private consumption, but also for competitiveness.** However, despite labour cost reductions the negative effects in the EU economy remain. Recycling taxation revenues as lump-sum transfers to households was found to be less beneficial for GDP, welfare and sectoral activity than reducing labour costs. This is a finding which is shared by a vast literature on possible double dividend analysis (for environment and employment).

Electricity and gas price rises driven by market power in electricity and gas supply was found to exert negative effects on the economy in the medium term but to present a different dynamic pattern showing rapid deceleration of negative impacts. This is due to the dynamics of investment which is shown to sustain in this scenario due to higher returns on capital. Nonetheless the economic effects remain detrimental to private consumption and welfare.

A different case of price differential is when prices of electricity and gas decrease in the non-EU world but not in the EU. Assuming that productivity and cheap resources drive the price drop, **the non-EU world benefits from lower costs allowing for higher growth**. Hence, global demand increases in this scenario and the EU collects benefits from higher demand addressed also to the EU and from lower cost imports, the latter being beneficial to domestic private consumption. The EU still bears negative effects on activity stemming from the undermining of competitiveness, but **the overall the effects are neutral or even slightly positive on the EU, as benefits collected from abroad almost offset impacts of competitiveness losses.** So this case fully contrasts the cases where electricity and gas price differentials are due to indigenous reasons in the EU.

Details are provided by sector of activity. The results confirm the vulnerability of energy intensive industries in particular those that are exposed to foreign competition, such as metals and chemicals. In all scenarios, activity in these industries is significantly more reduced than in other industries. It was found that some of the low energy-intensive sectors, such as the services, may even profit from capital and labour cost decreases in some of the scenarios.

Annex 1. Electricity and gas price evolution: results by Member State

As part of the data-collection exercise for this report, Member States provided the Commission with data on energy prices for electricity and natural gas for median industrial and domestic consumption bands in two years, 2008 and 2012. In this data (referred to as *Metadata* in the report), prices were broken down first into the categories of energy and supply costs, network costs and taxes and levies. These sub-headings were then broken down further into individual components: for example, network costs were divided into the cost of transmission and the cost of distribution; taxes and levies were decomposed into excise taxes, VAT and other special levies.

This Annex is based on the results from the Metadata analysis, intended to improve understanding of the exact composition of each price component (energy and supply, network, taxes and levies). Throughout the report the Metadata was used only in cases where a comparable – though not as disaggregated – data is not available from Eurostat, namely in the case of breakdown by price component of retail prices for natural gas for households and industrial users.

The level of detail in which Member States reported their energy prices in the *Metadata* varied significantly. In some cases, network costs were reported as a single, undifferentiated item; in others, they were broken down into as many as five separate components. The same is true of energy and supply costs and taxes and levies.

There were also significant differences in the ways in which Member States categorised certain kinds of charges. The heading energy and supply costs, for example, does not always designate the same set of charges and activities in each country. It is important to bear these inconsistencies in mind when considering the data, as they complicate the task of comparing the breakdown of Member States' prices. To take the most salient example, the part of the electricity bill relating to support for renewable energy generation is counted variously as an energy and supply cost (Belgium, United Kingdom, Spain), as a part of network charges (Czech Republic, Slovakia, Denmark) or most commonly as a levy (Austria, Germany, various other Member States).

EU	For the EU as a whole, between 2008 and 2012 retail electricity prices rose for both industrial and domestic consumers, by 17.28% and 12.87% respectively. For domestic consumers, this equated to a rise of 2.98c per kWh, of which 1.76c were attributable to taxes (including VAT). Looking at the HEPI weighted average for capital cities of 15 EU Member States[14], energy and supply costs rose by 3.39% and network costs by 32.33%. Gas prices also rose across the EU, although to a lesser extent than electricity prices – domestic prices rose by 13.67% and industrial ones by 5%. The main driver in this change for domestic consumers was non-tax costs, although proportionally the greatest change was in taxes and levies.
AT	Between 2008 and 2012, Eurostat data shows that average Austrian electricity prices for domestic users rose by 14.2% to a level slightly above the EU average. This was mainly due to significant increases in energy and supply costs and network costs, although taxes and levies were the component which rose most sharply. Domestic gas prices also rose by over 23% to a level slightly over the EU average. For industry, the electricity price rises were more moderate, increases in the grid tariff and taxes (charges such as the community levy and renewables surcharge) tempered by

[14] Austria, Belgium, Denmark, Germany, Spain, Finland, France, Greece, Ireland, Italy, Luxembourg, Netherlands, Portugal, Sweden, UK.

	a decrease in energy and supply costs.
BE	Domestic electricity prices in Belgium were above the EU average in 2012. There was an increase of 3.3% from 2008 to 2012, of which a major part was due to rising distribution charges. For industrial consumers, electricity prices were consistently below EU averages but grew by 15.2%, again driven by increased distribution charges. Industrial gas prices fell by 10.7% in the same period thanks to decreasing energy and supply costs.
BG	Bulgarian gas prices rose sharply between 2008 and 2012, by 42.2% for domestic consumers and by 49.2% for industrial users. The main driver behind these rises were energy and supply costs, although VAT rises and (for industry) distribution costs were also significant factors. Electricity prices also rose, although not at the same rate, with the main driver being energy and supply costs, including the additional price for green energy. All electricity price components increased at roughly a similar rate (14-17%).
CY	In Cyprus, domestic electricity prices rose by 42.6% from 2008 to 2012, to levels well above the EU average. Industrial prices were volatile, rising 31.66% to levels almost double the EU average. The greatest percentage of the increase was in generation and supply costs, but the rise in VAT was also an important factor.
CZ	Eurostat databases show that Czech electricity prices for all users decreased slightly between 2008 and 2012. Increases in network costs, among which is counted the charge related to support for renewable generation and CHP, were offset by declining production supply costs. In the same period, domestic gas prices rose steeply (by nearly 25%), the changes driven by increases in energy and supply costs, while for industrial users this component actually decreased, leading to a fall of 13.4%.
DE	Industrial and domestic electricity prices in Germany each rose by over 20% from 2008 to 2012, driven in particular by an increase in taxes and levies. The EEG-Levy (financing renewable generation) and an increase in VAT were each important factors in the rise in this component. In parallel, gas prices decreased, falling in particular for domestic users by nearly 15% as the cost of energy and supply reduced.
DK	Electricity prices were among the highest in Europe for Danish users between 2008-2012, despite a significant fall in energy and supply costs. The single largest part of Denmark's electricity price was composed of the country's electricity tax, which in 2012 represented over 31% of the price paid by domestic users and a higher proportion for industry. The Increasing network costs also played a role in this, in particular the "Public Service Obligation", primarily financing support to RES[15]. Gas prices also rose in the same period, by 23.58% for industrial users, from cent EUR 3.86 / kWh to cent EUR 4.77 / kWh.
EE	Estonia's electricity prices remained below EU averages between 2008 and 2012, but proportionally saw some of the steepest rises, driven in particular by increases in taxes and levies, including charges introduced by the country's Renewable Energy Act. Gas prices also rose, by over 35% for industrial consumers, as distribution and transmission costs went up and VAT was increased.
ES	Domestic electricity prices rose steeply in Spain, from a level slightly below the EU average in 2008 to one above it in 2012. This increase of 46.1% was attributable in particular to increased distribution costs (which includes other, non-network costs and charges such as RES and tariff deficit financing), increased VAT and the increase in the special regime premium for RES and CHP generation. The pattern was the same, although increases less pronounced, for industrial users. Spanish domestic gas prices also rose by 39.5%, due to increases in VAT and network costs.

[15] See http://www.energy-regulators.eu/portal/page/portal/EER_HOME/EER_PUBLICATIONS/NATIONAL_REPORTS/National%20Reporting%202010/NR_En/E10_NR_Denmark-EN_v2.pdf

FI	Increases in Finnish electricity prices from 2008 to 2012, of 22.5% for domestic and 11.3% for industrial consumers were driven in particular by growing network costs and an increase in taxes and levies. Industrial gas prices in this period increased by 42.6% to a level above the EU average. The major contributor to this increase was a rise in taxes and levies (in particular carbon dioxide tax) and a rise in energy and supply costs.
FR	In France, electricity price increases of around 27% between 2008 and 2012 were driven primarily by increases in all individual components. Increases in network costs were a significant factor, in particular for industry. Gas prices rose sharply for domestic consumers, by 17.99%, although taxes were not the major factor in this rise.
GR	Greek electricity prices rose steeply for both industrial and domestic consumers (29% and 37.3% respectively), although in both cases they remained below the EU average. In part these increases can be explained by the introduction of non-recoverable tax rates where previously there had been none. In 2012, gas prices in Greece were comfortably above the EU average for both domestic and industrial consumers.
HR	Although below the EU average, Croatia's domestic electricity prices rose by 16.9% between 2008 and 2012. Industrial price rises were more modest, in part due to a decrease in the network costs paid by industry. The country's gas prices rose sharply, by 70.4% and 104.6% for domestic and industrial consumers respectively. A VAT increase was one factor here, but the main cause was a major rise in the natural gas shipping rate.
HU	For Hungarian industrial consumers, electricity prices slightly decreased between 2008 and 2012, mainly due to decrease in energy supply costs. Rises for domestic consumers were mostly in line with the overall consumer price index, resulting from a fall in wholesale prices offset by rising transmission costs and increased VAT. Gas prices for both industry and domestic use fell, due to decreased supply costs.
IE	Gas prices rose in Ireland by 3.4% for domestic and 6.2% for industrial use, driven in each instance by an increase in taxes and levies. In both instances, Irish prices remained below EU averages. Electricity prices fell for industry by 1.8% thanks to a fall in energy and supply costs, while domestic prices rose by 9.1%. Tax increases, specifically the introduction of an energy tax, were a significant factor in rises for each sector.
IT	Electricity price rises in Italy were primarily driven by increases in taxes and levies, which for industrial users more than doubled and for domestic consumers increased by over 42%. Gas prices fell for industrial consumers but domestic prices rose by 34.4%.
LT	Lithuanian electricity prices rose by 46.6% for domestic and 39.8% for industrial uses, the largest portion of the increases owing to the rising energy price. For gas, there was a major rise in domestic bills of nearly 60%. Rising gas supply prices affected domestic consumers most significantly, with the increase in distribution costs also having a significant impact on all users.
LU	The most significant rises in Luxembourg's energy costs were for gas, where industrial prices rose by 25.4% and domestic ones by 15.6%. Major increases in wholesale gas prices drove this increase; distribution and transport tariffs decreased, and the tax component of gas bills fell or remained constant. Over the 2008-2012 time period, electricity prices increased only slightly, at just over 6% domestically and 3.5% for industry, thanks to a fall in the price of wholesale electricity.
LV	Although below EU averages, Latvia's electricity prices increased significantly (by 36.5% for domestic and 43% for industrial use). Rising charges to support renewable energy played a significant role in these increases, as did an increase in VAT. Distribution and transmission tariffs also went up. Gas prices rose by 12% for domestic consumers, affected again by rises in VAT.
MT	Malta's industry faced electricity prices above the EU average between 2008 and 2012. Industrial and domestic prices grew at a similar rate (11.2% to 10.7%). The rises were attributable to increases in the single largest component in bills, energy and supply costs.
NL	Energy and supply costs for electricity fell in the Netherlands, but increases in network (in

	particular transmission) costs of nearly 20% for domestic users and 13.4% for industry plus rising taxes and levies meant that there were price increases of 5.7% and 6% for households and industry respectively. Gas prices for industry fell by 0.9%, although they rose for households by 11.5%, due in part to a significant increase in the cost of transmission.
PL	Domestic consumers in Poland experienced electricity price increases of 18%, driven by energy and supply cost increases of 30% as well as rising cost of transmission and distribution. For industry, price rises were more modest, and the burden of network costs and taxes and levies actually decreased. Gas prices rose at similar rates for industry and household, by 11.8% and 12.4% respectively, with the main factor being the gas and supply costs.
PT	In Portugal, taxes and levies rose on domestic electricity consumption rose by over 107%, the most significant factor in an overall price increase of 35.3%. The major increase was in VAT, followed by increases in capacity payments and old stranded generation costs. For industry, transmission and distribution costs were the major contributor to a price rise of 48.9%. Domestic gas prices increased by 35.6%; again, the main driver of this increase was the rise VAT.
RO	Romania's electricity prices bucked the EU trend by decreasing over the 2008-2012 period, as both energy and supply and network costs fell. Domestic prices decreased by 2.5% and industrial ones by 7.2%. Gas prices, too, fell significantly; 18.5% for domestic consumers and 1.8% for industry, due to falling energy and supply costs.
SE	Electricity prices rose only very slightly (0.5%) for Swedish industry, but by a more significant margin (19.3%) for domestic users. Although energy and supply costs went down, significant increases in network costs (of over 43%) and taxes and levies ensured a net price rise. Gas prices also rose, by 24.8% for households, a decrease in energy and supply costs offset by in particular by increased taxes.
SI	Electricity prices for Slovenian industry fell by 4.3% between 2008 and 2012, thanks to the falling wholesale electricity price and reduced transmission and distribution costs. These decreases were partially counterbalanced by an increase in taxes and levies, in particular the excise tax on electricity consumption. Increases in network taxes and VAT pushed gas prices for industry up by 20.8%. Domestic electricity prices increased by 33.4% overall, with every individual component increasing. Rising energy and supply costs were the main price component but the cost of network distribution also contributed.
SK	In Slovakia, there were modest increases in the prices industry paid for energy, of 0.5% for electricity and 6% for gas. Household users faced greater rises, totalling 12.8% for electricity and 10.5% for gas. For electricity, network costs and taxes and levies accounted for a greater proportion of the rise than did energy and supply costs. For industry, the cost of charges related to the country's Renewable Energy Act in particular increased more than fourfold, pushing up network costs.
UK	In the UK, gas prices for domestic consumers rose steeply between 2008 and 2012, by around 20.9%. This was mainly due to increased wholesale costs. In the same period, gas network costs in the UK decreased. For industry, there was a more modest rise of 6%, although in each case the UK remained below the EU average. For domestic electricity users, a price increase of 11.4% was driven by rising energy and supply costs; network costs actually decreased by 21.4% in this period. Under the heading of energy and price costs were counted a number of schemes, such as the Renewables Obligation, the EU ETS and energy efficiency schemes which could be counted as levies and which acted to increase energy costs even though wholesale prices fell. For industrial users, an increase in network costs of 24.5% was the most significant factor in an electricity price increase of 12.8%. The single largest component of electricity bills remained the wholesale energy price, but overall increases in bills were driven by rising taxes and network costs.

Annex 2 Methodology for a bottom up analysis of industry sectors

The bottom-up case studies presented in the study compile data from energy intensive industrial sectors and sub-sectors, where the relative importance of gas and electricity as energy inputs in the overall energy and total production costs is high. Geographical coverage across the EU and the presence of big and small players have been factors in selecting the following sectors:

- Bricks and roof tiles – NACE code 2332
- Wall and floor tiles – NACE code 2331
- Flat glass – NACE code 2311
- Ammonia - refers to several Prodcom codes mainly under NACE 2015 'Manufacture of fertilisers and nitrogen compounds'
- Chlorine - refers to several Prodcom codes under NACE 2013 'Other inorganic basic chemicals' and also NACE 2014 'Other organic basic chemicals'
- Aluminium – NACE code 2442
- Steel – NACE code 2410

A standard questionnaire was circulated to potential respondents in each sector and sub-sector identified with the help of industry associations. Between August and October 2013, about 110 questionnaires were filled by respondents. Responses were checked for completeness. For each sector and subsector, industrial sites that responded to the questionnaires were sampled according to four main criteria:

- Geographical: include as many Member States as possible while accounting for the relative importance of each Member State in terms of total EU production capacity in the respective sector or sub-sector;

- Production capacity: ensure that the sample reflects the actual distribution of capacities across the EU and its regions;

- Production technology: ensure that the sample reflects the actual distribution of technologies across the EU and its regions;

- Size: ensure that the sample mirrors the reality of each sector in terms of proportion of SMEs and larger companies.

Based on the number and type of respondents in each sector as well as their Member State of origin, the criteria above have had different weight in the definition of samples and implied that, for some sectors, not all questionnaires received could be fully used.

The need to deal with the confidentiality of highly sensitive commercial information implied that data was presented anonymously, aggregated and/or indexed in order to ensure that it could not be attributed to any specific plant.

A way of dealing with the confidentiality constraint has been to present sector-specific results by broad regions (e.g. Central Northern Europe, Southern Europe, etc.). The composition of geographical regions may vary across sectors analysed due to the location of respondents, as well as again due to the confidentiality constraint.

The use of geographical aggregates implied that no analysis at country level was possible. In order to address this shortcoming, an assessment has been conducted also for four Member States - Germany, Italy, Poland and Spain – for which a sufficient number of questionnaires were collected across all covered sectors so as to allow country-specific analysis whilst ensuring the anonymity of plants.

The analysis looked first at the level and components of gas and electricity prices paid by industry operators and at their evolution over the period 2010-2012 (chapter 1). The collection of data on electricity and gas consumption and production volumes allowed presenting the relation between energy intensity and energy prices for anonymous exemplary plants. An attempt was made in order to assess the impact of energy prices and their components in terms of unit production costs (chapter 2). For some subsectors and after ensuring for comparability in terms of consumption range, it was possible to collect data on the level of electricity and gas prices paid by plants in some non-EU countries, allowing for comparison with the situation in the EU (chapter 3 and Annex 4).

The analysis of energy prices composition distinguishes the following price components: (i) production cost, (ii) network fees, (iii) non-recoverable taxes and levies (excluding VAT), (iv) RES support schemes: depending on the Member State where an installation is located, these are either part of the network fees or levies. Attribution to network fees or levies is sometimes subject to yearly change.

Energy efficiency and indirect costs (e.g.: emission costs) and the extent to which these indirect costs were passed on by utilities onto the final consumers have also been analysed. Changes in costs and efficiency indicators over a short period of time (between 2010 and 2012) does not provide a fully-fledged analysis on the observable trends in the industries.

A further underlying component of the electricity price is represented by the CO_2 indirect cost, that is, the CO_2 allowance price which is accounted for by electricity producers either as opportunity or as real cost and is passed over in the electricity price paid by consumers. However, with only few exceptions, this component cannot be easily detected as normally it does not appear in the electricity bill. Therefore, in the case studies presented, an attempt has also been made to estimate the average CO_2 indirect costs by sector and region. The impact of indirect costs is considered to be already implicitly included in the other price components reported, in particular in the energy supply component. In order to estimate CO_2 indirect costs, the average electricity intensity of respondents in each sector and region has been calculated and associated to regional CO_2 emission factors for electricity production as well as to assumptions in terms of CO_2 price pass-through rate from producers to final consumers. The results are presented in **Error! Reference source not found.** in chapter **Error! Reference source not found.**.

All energy prices collected via the questionnaire and processed in the analysis exclude exemptions or reduction of taxes, levies and transmission costs and represent the final unit price paid by respondents.

The following tables show data on sampling for each case study:

- ***Bricks and roof tiles***

Size of the sample

Number of questionnaires used in the case study

Received	Selected in the sample	Energy prices trends	Energy bill components	Energy intensity	International comparison
23	13	13	13	8	6

Northern Europe includes 5 plants: IE, UK, BE, LU, NL, DK, SE, NO, LT, LV, FI, EE
Central Europe includes 3 plants: DE, PL, CZ, SK, AT, HU
Southern Europe includes 5 plants: FR, PT, ES, IT, SI, HR, BG, RO, EL, MT, CY
Note that sampled plants do not come from all the MS in one region. The specific countries cannot be indicated due to confidentiality reasons.

- ***Wall floor tiles***

Size of the sample

Number of questionnaires used in the case study

Received	Selected in the sample	Energy prices trends	Energy bill components	Energy intensity	International comparison	Production costs and margins
24	12	12	12	6	6	9

Central and Northern Europe includes 3 plants: IE, UK, BE, LU, NL, DK, DE, PL CZ, LV, LT, EE, SE, FI
South-Western Europe includes 5 plants: ES, PT, FR
South-Eastern Europe includes 4 plants: IT, SI, AT, HU, SK, HR, BU, RO, EL, MT, CY
Note that sampled plants do not come from all the MS in one region. The specific countries cannot be indicated due to confidentiality reasons.
Source: CEPS, calculation based on questionnaires

- ***Float glass***

Size of the sample

Number of questionnaires used in the case study

Received	Selected in the sample	Energy prices trends	Energy bill components	Energy intensity	Production costs	Margins
10	10	10	7	10	7	4

All together, the 10 sampled plants represent about 19% of European production.
Western Europe includes 6 plants: IE, UK, FR, BE, LU, NL, DE, AT, DK, SE, FI
Eastern Europe includes 2 plants: BG, RO, CZ, HU, EE, LT, LV, SK, PL
Southern Europe includes 2 plants: IT, MT, CY, PT, ES, EL, SI
Note that sampled plants do not come from all the MS in one region. The specific countries cannot be indicated due to confidentiality reasons.
Source: CEPS, calculation based on questionnaires.

- ***Ammonia***

Size of the sample

Number of questionnaires used in the case study

Received	Selected in the sample	Energy prices trends	Energy bill components	Energy intensity	Production costs
10	10	10	10	10	7

All together, the 10 sampled plants represent about 26% of EU27 production

The sample includes 2 small, 4 medium and 4 large-sized plants, representing all together about 27% of total EU production capacity. The 10 plants are located in 10 different member states.

Western-Northern Europe includes: IE, UK, FR, BE, LU, NL, DE, AT, DK, SE, FI
Eastern Europe includes: RO, CZ, HU, EE, LT, LV, SK, PL
Southern Europe includes: IT, MT, CY, PT, ES, EL, SI, BG
Note that sampled plants do not come from all the MS in one region. The specific countries cannot be indicated due to confidentiality reasons. The number of sampled plants per region cannot be disclosed due to confidentiality.
Source: CEPS, calculation based on questionnaires.

- ***Chlorine***

Size of the sample

Number of questionnaires used in the case study

Received	Selected in the sample	Energy prices trends	Energy bill components	Energy intensity	Production costs
11	9	9	9	9	5

All together, the 9 sampled plants represent about 12% of EU27 production

Central-Northern Europe includes 6 plants: IE, UK, BE, LU, NL, DE, PL, CZ, LV, LT, EE, DK, SE, FI
Southern-Western Europe includes 3 plants: ES, PT, FR
For remaining MS, no questionnaires were received and no averages could be calculated.
Note that sampled plants do not come from all the MS in one region. The specific countries cannot be indicated due to confidentiality reasons.
Source: CEPS, calculation based on questionnaires.

- ***Primary aluminium***

The evidence presented in the case study for aluminium is based on data collected via a questionnaire from a sample of 11 out of the 16 primary smelters in the EU, representing more than 60% of EU primary aluminium production in 2012. These data were also validated and integrated using the CRU database

No sampling by geographical region is presented. The averages calculated for the whole sample are compared to averages obtained for two subsamples: subsample 1 refers to plants which procure electricity through long-term contracts or self-generation (or long term contracts) while subsample 2 refers to plants which procure electricity in the wholesale market.

- ***Steel***

Size of the sample

Number of questionnaires used in the case study

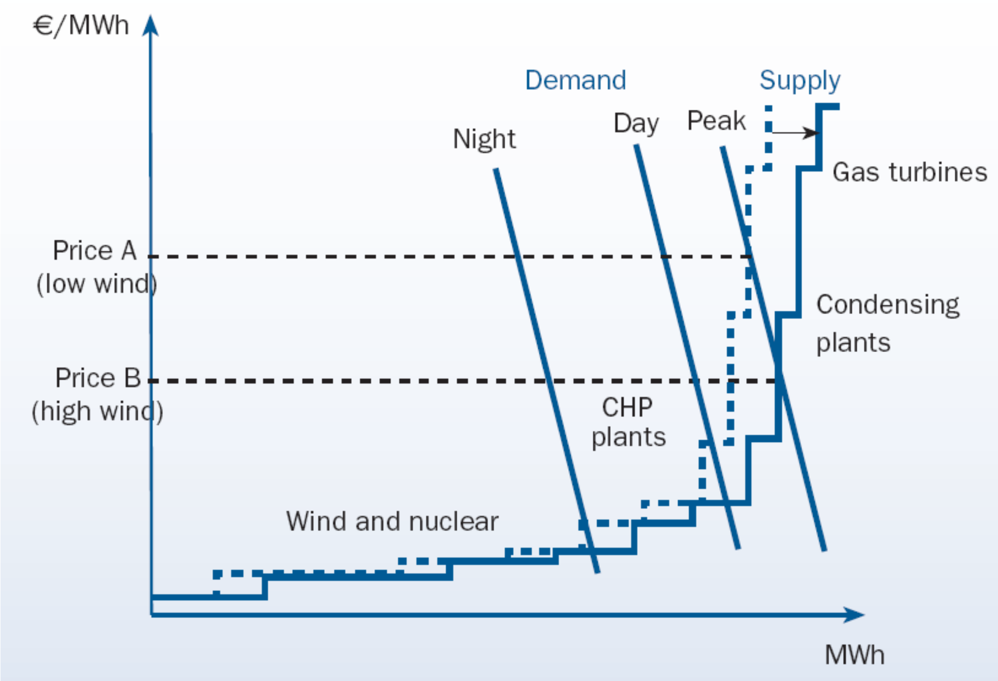
Received	Selected in the sample	Energy prices trends	Energy bill components	Energy intensity	International comparison	Production costs and Margins
17	17	15 (gas) 17 (electr.)	14 (gas) 17 (electr.)	11 (gas) 14 (electr.)	3	*

North-Western Europe includes 9 plants: FR, BE, LU, NL, IE, UK, DE, AT, DK, FI, SE
Central and Eastern Europe includes 3 plants: PL, SI, HU, RO, BG, CZ, SK, EE, LV, LT
Southern Europe includes 5 plants: IT, ES, PT, EL, MT, CY
Note that sampled plants do not come from all the MS in one region. The specific countries cannot be indicated due to confidentiality reasons.
Source: CEPS, calculation based on questionnaires.

Annex 3. The merit order effect

Estimates of the surcharge for renewable energy are estimates of the difference between market prices and revenue of supported technologies. It is however important to note that these estimates are not representing the total costs of renewable energy for at least two reasons: a) they include the decrease in wholesale market prices caused by renewable energy (the merit-order effect [16]), but *negatively*; when renewable energy reduces wholesale electricity prices, the support level appears larger, as the gap between wholesale prices and support levels increases, and b) large fractions of the industry in Member States is partly or wholly exempted[17] from the surcharge in order to avoid carbon leakage and to ensure that the industry remain competitive.

Figure 6: Schematic description of the merit-order effect (Poyry 2010)



<u>What is the merit-order effect?</u>

The quantity of the merit-order effect depends on the shape of the merit-order (thereby its name). The figure below shows how wind electricity injection has different price impacts depending the time of the day and the marginal supply at that time. An overall estimation of its overall impact therefore requires an assessment of the impact throughout the year, hour by hour.

The merit-order effect is evaluated in several scientific studies which indicate that the additional supply of electricity from renewable sources reduces the spot price, and sometime so much that it outweighs the costs of the subsidies. The table below shows some of the results of the literature for Member States in Europe; it shows that for wind electricity in Spain and Ireland the benefits for electricity consumers in terms of reduction in whole-sale prices outweigh the costs of subsidies. For a range of renewable technologies that was in the

[16] Renewable electricity typically has insignificant operational costs, and thus shifts the merit-order to the right, thus decreasing the whole-sale market price for electricity. The merit-order effect is essentially a shift of wealth from incumbent producer's surpluses to consumers.
[17] 47% of German industry's electricity consumption is fully part of the EEG system (financing of RES in Germany)

market in 2006 in Germany, the picture is the same. However, after the significant increase in PV in Germany in the period 2009 – 2012, the costs of subsidies increased, and the balance got negative, with costs of subsidies being larger than the benefit of the reduction in whole-sale prices.

Author:	Member State:	Technology:	Merit-order effect: [€/MWh]	Merit-order effects minus support cost [€/MWh]
Gil. et al. 2013	Spain	Wind	44.9	16.7
Sensful et al. 2008	Germany (2006)	RES-E	95	26[18]
Saenz de Miera et al. 2007	Spain	Wind	51.4	12.4
O'Mahoney et al. 2011	Ireland	Wind		47.7[19]
Öko-Institut (2012)	Germany	RES-E		-45[20]

More information on the merit-order effect and its magnitude can be found elsewhere[21]. The benefits of reduced whole-sale market price caused by renewable electricity should however be allocated efficiently to cover the external costs of increased renewable electricity, like the costs of increased storage and flexibility in the grid.

[18] Assuming an average value of renewable energy at spot market of 40 €/MWh.

[19] The benefit is calculated at 141 € Million for 2009. 47.7 €/MWh is calculated by dividing by the amount of wind power in 2009: 2955 GWh.

[20] Figure 13 in Öko-Institut (2012) Strompreisentwicklungen im Spannungsfeld von Energiewende, Energiemärkten und Industriepolitik. Der Energiewende-Kosten-Index (EKX)

[21] More literature is listed below:

1.Delarue, Erik D., Luickx, Patrick J., D'haeseleer, William D. 2009. The Actual Effect of Wind Power on Overall Electricity Generation Costs and CO2 Emissions. Energy Conversion and Management 50 (2009) 1450–1456.

2.Gil, Hugo A., Gomez-Quiles, Catalina, Riquelme, Jesus,2012. Large-scale wind power integration and wholesale electricity trading benefits: estimation via an ex post approach. Energy Policy 41(February), 849–859.

3.Jonsson, Tryggvi, Pinson, Pierre and Madsen, Henrik. 2009. On the Market Impact of Wind Energy Forecasts. Energy Economics (2009).

4.Munksgaard, J. and Morthorst, Poul Erik. 2008. Wind Power in the Danish Liberalised Power Market – Policy Measures, Price Impact and Investor Incentives. Energy Policy 2008.

5.O′Mahoney, Amy, Denny,E leanor, 2011.The merit order effect of wind generation in the Irish electricity market ,Washington,DC.

6.Saenz Miera, Gonzalo, Del Rio Gonzales, Pablo and Vizciano, Ignacio. 2008. Analysing the Impact of Renewable Energy Support Schemes on Power Prices: The Case of Wind Energy in Spain. Energy Policy 36 (2008) 3345–3359.

7.Sensfuss, Frank. Ragwitz, Mario and Genoese, Massimo. 2007. Merit Order Effect: A Detailed Analysis of the Price Effect of Renewable Electricity Generation on Spot Prices in Germany. Fraunhofer Institute Systems and Innovation Research. Energy Policy 36 (2008) 3086–3094.

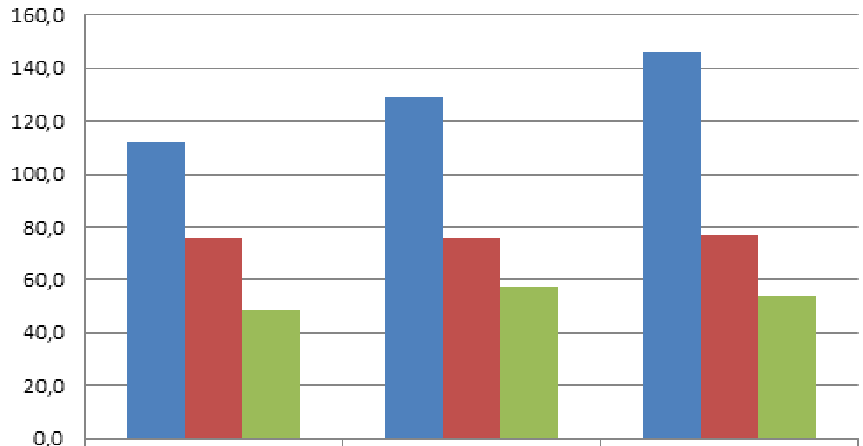
8.Unger, Thomas, Erik Ahlgren, 2005. Impacts of a common green certificate market on electricity and CO2-emission markets in the Nordic countries. Energy Policy 33(16),2152–2163.

9.Weigt, Hannes. 2008. Germany's Wind Energy: The Potential for Fossil Capacity Replacement and Cost Saving. Applied Energy 86 (2009) 1857–1863.

Annex 4. International comparison of prices of electricity and gas paid by a sample of EU producers

ELECTRICITY

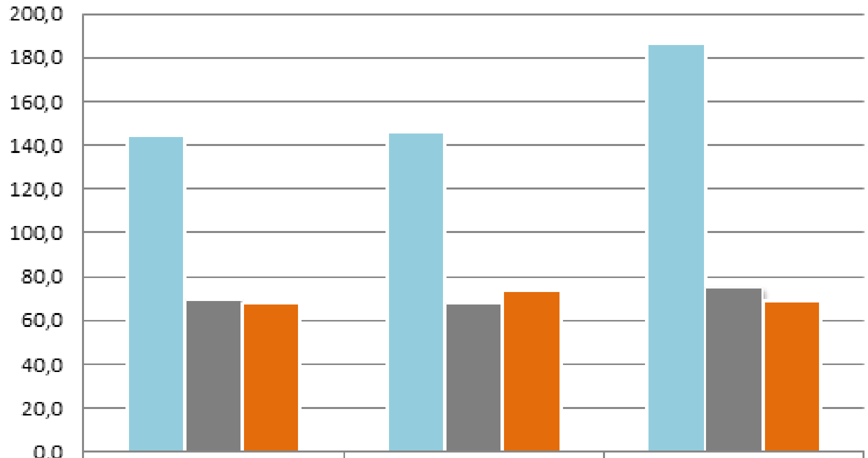
Figure 7 Prices of electricity: comparison of two EU-based brick and roof tile plants and one plant of comparable capacity in Russia (€/MWh)



	2010	2011	2012
EU Plant "A"	111,8	128,7	145,9
EU Plant "B"	75,8	75,4	77,1
RU Plant	49,0	57,4	54,0

Source: CEPS, calculations based on questionnaires.

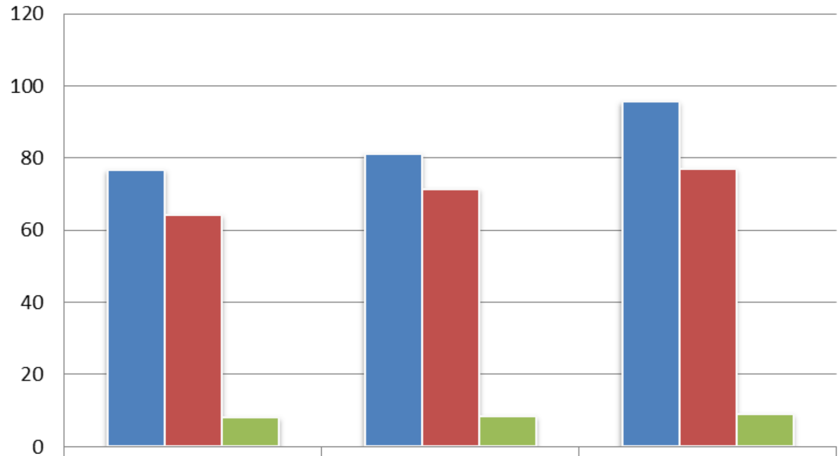
Figure 8 Prices of electricity: comparison of two EU-based brick and roof tile plants and one US-based plant of comparable capacity (€/MWh)



	2010	2011	2012
EU Plant "C"	144,1	146,1	186,7
EU Plant "D"	69,2	67,5	75,1
US Plant	68,5	73,4	69,1

Source: CEPS, calculations based on questionnaires.

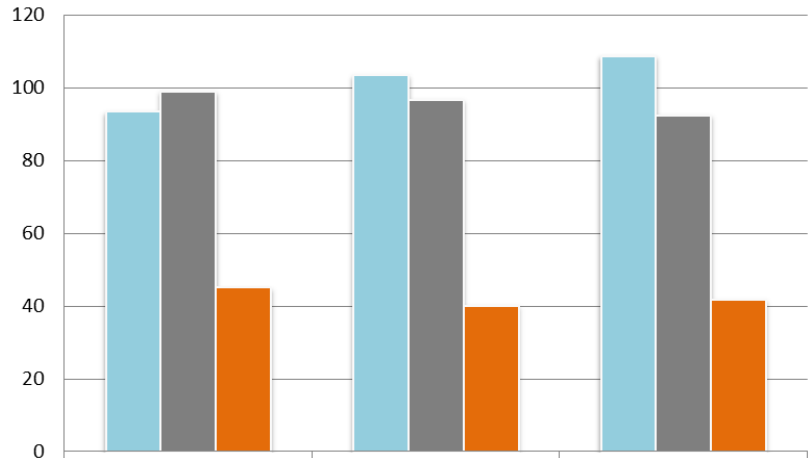
Figure 9 Prices of electricity: comparison of two EU-based wall and floor tile plants and one plant of comparable capacity in Russia (€/MWh)



	2010	2011	2012
EU plant "A"	76,7	81,1	95,6
EU plant "B"	64,1	71,4	76,9
RU plant	8	8,3	8,9

Source: CEPS, calculations based on questionnaires.

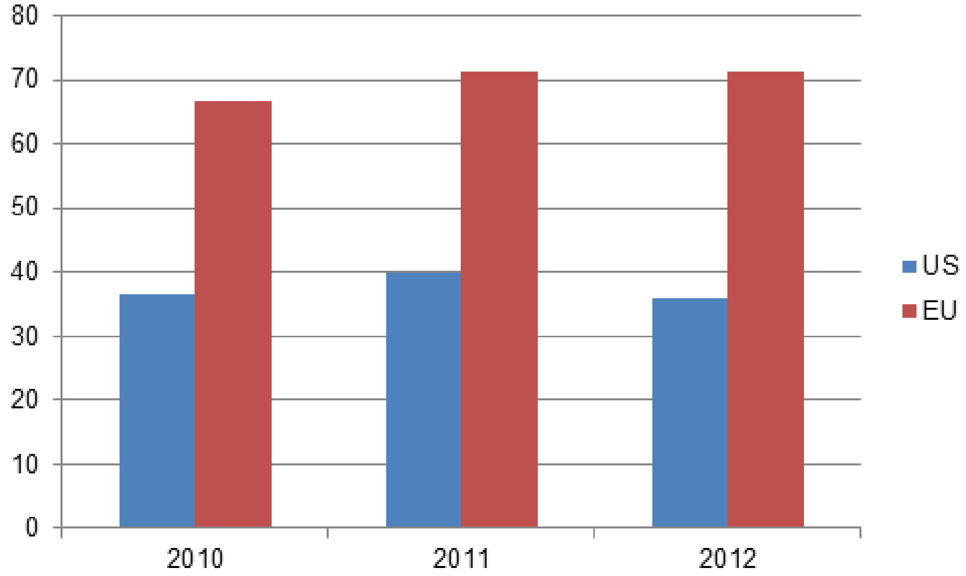
Figure 10 Prices of electricity: comparison of two EU-based wall and floor tile plants and one US-based plant of comparable capacity (€/MWh)



	2010	2011	2012
EU plant "C"	93,3	103,4	108,7
EU plant "D"	98,9	96,7	92,4
US plant	45	40,1	41,7

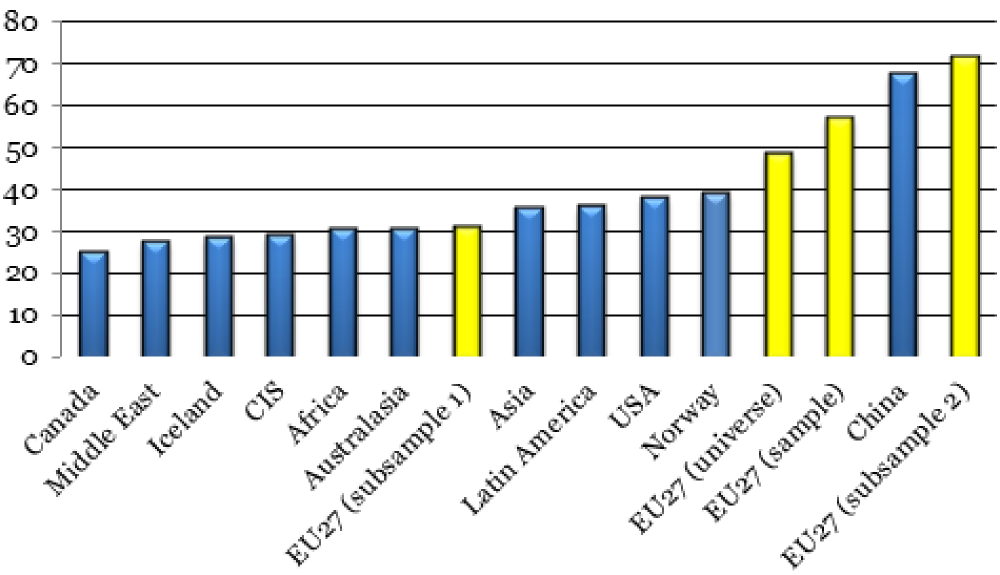
Source: CEPS, calculations based on questionnaires.

Figure 11 Electricity price: comparison between three US-based plants and seventeen steelmakers in the EU (€/MWh)



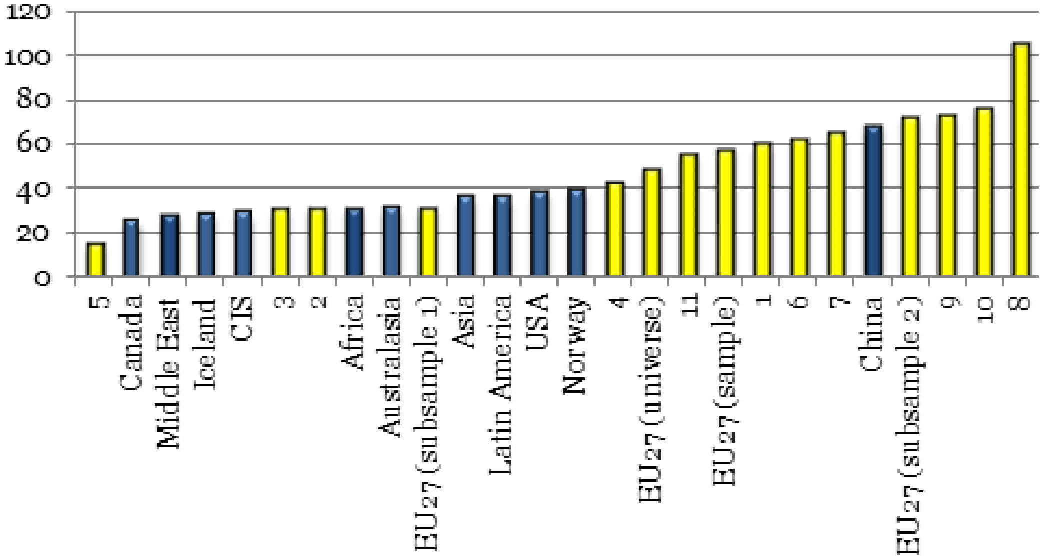
Source: CEPS, calculations based on questionnaires.

Figure 12 Electricity prices for aluminium smelters in different world countries and regions, 2012 ($/MWh, delivered at plant)



Source: The EU27 (universe) data comes from CRU, the data for the 2 subsamples (a total of 11 smelters, including EU27 subsample 1, EU27 subsample 2 and EU27 sample) comes from CEPS, calculations based on questionnaires. CRU for all international data.

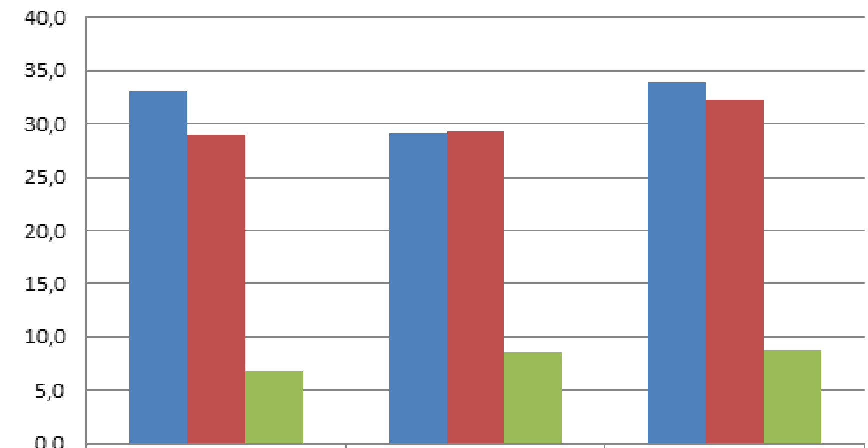
Figure 13 Electricity prices for aluminium smelters in different world countries and regions, 2012 ($/MWh, delivered at plant)



Source: CEPs, calculations based on questionnaires for the 11 EU-based smelters. CRU for EU27 and international data

NATURAL GAS

Figure 14 Prices of natural gas: comparison of two EU-based brick and roof tile plants and one plant of comparable capacity in Russia (€/MWh)



	2010	2011	2012
EU Plant "A"	33,1	29,2	33,9
EU Plant "B"	29,0	29,2	32,3
RU Plant	6,8	8,6	8,7

Source: CEPS, calculations based on questionnaires.

Figure 15 Prices of natural gas: comparison of two EU-based brick and roof tile plants and one plant of comparable capacity in the US (€/MWh)

	2010	2011	2012
EU Plant "C"	32,6	34,6	42,5
EU Plant "D"	31,2	33,4	39,5
US Plant	25,2	17,4	14,1

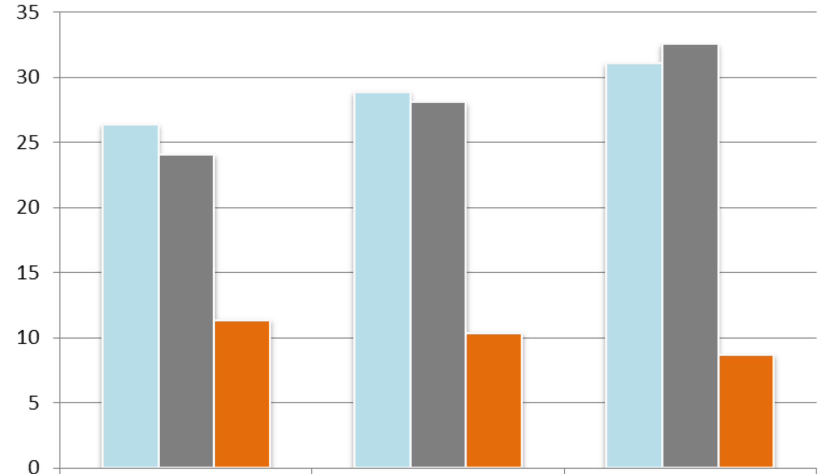
Source: CEPS, calculations based on questionnaires.

Figure 16 Prices of natural gas: comparison of two EU-based wall and floor tile plants and one plant of comparable capacity in Russia (€/MWh)

	2010	2011	2012
EU Plant "A"	25,9	30,2	35,6
EU Plant "B"	21,1	23,1	27,5
RU Plant	8,1	8,3	8,9

Source: CEPS, calculations based on questionnaires.

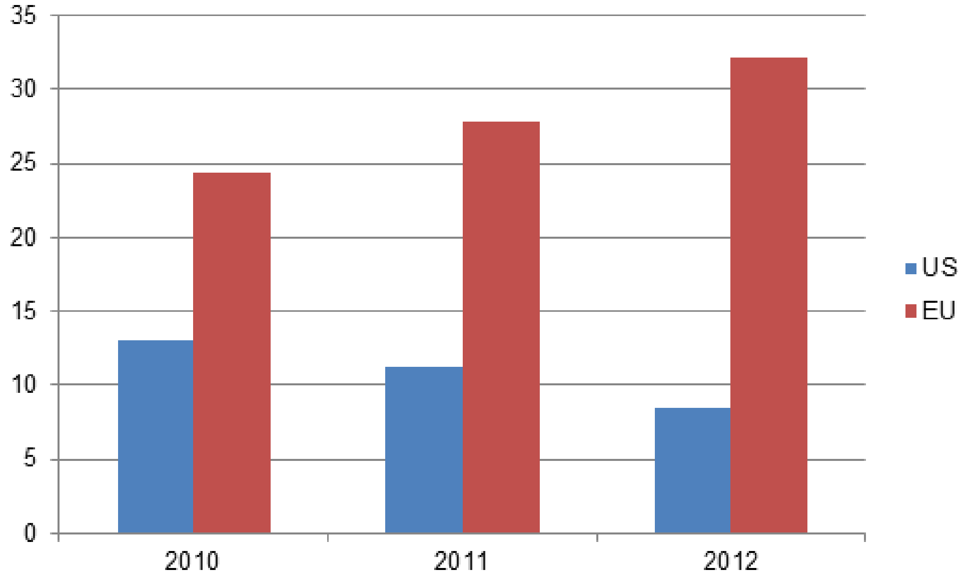
Figure 17 Prices of natural gas: comparison of two EU-based wall and floor tile plants and one plant of comparable capacity in the US (€/MWh)



	2010	2011	2012
EU Plant "C"	26,4	28,9	31,1
EU Plant "D"	24,1	28,1	32,6
US Plant	11,4	10,4	8,7

Source: CEPS, calculations based on questionnaires.

Figure 18 Natural gas price: comparison between three US-based plants and fifteen steelmakers in the EU (€/MWh)



Source: CEPS, calculations based on questionnaires.

Annex 5. Vulnerable consumers

Defining the concept of vulnerable customers

Increases in electricity and household gas prices have given rise to questions on the ability of lower income households to cope with rising energy bills. The question has been raised as to what kind of measures should be taken to protect *vulnerable customers*, though there is currently no universal definition of this concept.

Some Member States state that the concept has not been defined as vulnerable customers are covered by national social policy. Others use factors such as old age, retirement, unemployment, low income, disability, poor health, requiring an uninterrupted electricity supply, large family, being a carer or living in a remote area to define the concept.

The Third Energy Package requires Member States to define the concept of vulnerable customers as a first step in addressing the issue of vulnerability. The table below provides guidance for defining the concept, setting out the main elements that may drive and/or exacerbate vulnerability in the energy sector. Although energy vulnerability is not identical to energy poverty, the latter is implicitly addressed in the focus on the former.

	Market Conditions	Individual Circumstances	Living Conditions	Social/Natural Environment
Key Factors	Final energy price levels Level of competition	Income level Health and disability IT skills/internet access Education: literacy/ numeracy skills	Under-occupancy Type of heating system Quality of housing stock	State of economy Climate
Exacerbators	Debt policies Selling and pre-contractual practices Bill transparency/ accessibility Available payment methods Inclusiveness of corporate system designs and service provision	Age Single-parent/ large family/ carer Retired/unemployed Immigrant or ethnic minority Prepayment meters	Equipment efficiency (boilers etc.) Location Tenancy	Governance (local/regional/ national) Social inclusion

When defining energy vulnerability, one size may not fit all and a single, EU-wide concept may not be the best approach. Vulnerability is not a static state and may evolve in parallel to energy sector developments. Furthermore, consumer status may fluctuate depending on health, employment and other factors. There is a need for continuous efforts from Member State authorities to ensure that those who need support receive it at the appropriate time, whether short- or long-term. Some consumers may be vulnerable throughout their lifetimes, while others may have a one-off need for financial or other support or be pushed into temporary vulnerability by events such as unemployment.

Examples of Member State instruments and practices

The Commission has worked with stakeholders, primarily the Citizens' Energy Forum and its Vulnerable Consumers Working Group (active since March 2012), to provide examples of instruments and practices in place in Member States, for guidance purposes only. The instruments it cites are wide-ranging and cover areas from social and housing policy through to energy. They represent real-life examples rather than best practice, with the aim of providing ideas of what it is possible to implement to support vulnerable customers. It is intended that this list will be a running inventory and be made publicly available so it can be updated as new practices are introduced at a national level. Its examples are divided under six main headings: *household energy efficiency, financial support, protection, information and engagement, information sharing between stakeholders, and physical measures*.

Developing the policy mix

Member State authorities can use the table and the examples of Member State instruments and practices to help define energy vulnerability and introduce policies to ensure the best possible support for vulnerable consumers. Finally, it should be noted that social tariffs may distort the market, do not encourage energy-efficient behaviour, and have a proportionally higher financial impact on those who fall just outside the vulnerable classification.

Annex 6. Short description of the GEM-E3 model

The GEM-E3 model is a multi-regional, multi-sectoral, recursive dynamic computable general equilibrium (CGE) model. The model allows for a consistent comparative analysis of policy scenarios since it ensures that in all scenarios, the economic system remains in general equilibrium. The scope of the GEM-E3 model is general in two terms: it includes all simultaneously interrelated markets and it represents the system at the appropriate level with respect to geography, the sub-system (energy, environment, economy) and the dynamic mechanisms of agent's behaviour. The model formulates separately the supply and demand behaviour of the economic agents which are considered to optimize individually their objective while market derived prices guarantee global equilibrium. The model considers explicitly the market clearing mechanism and the related price formation in the energy, environment and economy markets: prices and quantities are computed endogenously by the model as a result of supply and demand interactions in the markets.

Total demand (final and intermediate) in each country is optimally allocated between domestic and imported goods, under the hypothesis that these are considered as imperfect substitutes. Agents' utility is derived from consumption by purpose (food, clothing, mobility, entertainment, etc.) which is further split into consumption by product. Substitutions are possible depending on relative prices.

The model is dynamic, recursive over time, driven by accumulation of capital and equipment. Technology progress is explicitly represented in the production function, either exogenous or endogenous, depending on R&D expenditure by private and public sector and taking into account spillovers effects. Moreover it is based on the myopic expectations of the participant agents.

The model is calibrated to the base year data set that comprises a full Social Accounting Matrices for each country/region represented in the model. The SAMs of the of the GEM-E3 model are based on the GTAP v8 database. Bilateral trade flows are also calibrated for each sector represented in the model, taking into account trade margins and transport costs. Consumption and investment is built around transition matrices linking consumption by purpose to demand for goods and investment by origin to investment by destination. The initial starting point of the model therefore, includes a very detailed treatment of taxation and trade.

Regional model resolution

Abbreviation	Country	Abbreviation	Country	Abbreviation	Country	Abbreviation	Country or Region
AUT	Austria	GRC	Greece	SVN	Slovenia	ARG	Argentina
BEL	Belgium	HUN	Hungary	SWE	Sweden	TUR	Turkey
BGR	Bulgaria	IRL	Ireland	ROU	Romania	SAU	Saudi Arabia
CYP	Cyprus	ITA	Italy	USA	USA	CRO	Croatia
CZE	Czech Republic	LTU	Lithuania	JPN	Japan	AUZ	Oceania
DEU	Germany	LUX	Luxembourg	CAN	Canada	FSU	Russian Federation
DNK	Denmark	LVA	Latvia	BRA	Brazil	REP	Rest of energy producing countries
ESP	Spain	MLT	Malta	CHN	China	SAF	South Africa
EST	Estonia	NLD	Netherlands	IND	India	ANI	Rest of Annex I
FIN	Finland	POL	Poland	KOR	South Korea	ROW	Rest of the World
FRA	France	PRT	Portugal	IDN	Indonesia		
GBR	United Kingdom	SVK	Slovakia	MEX	Mexico		

Sectoral model resolution

Sector	Sector	Power generation technologies
Agriculture	Non-metallic minerals	Coal fired
Coal	Electric Goods	Oil fired
Crude Oil	Transport equipment	Gas fired
Oil	Other Equipment Goods	Nuclear
Gas Extraction	Consumer Goods Industries	Biomass
Gas	Construction	Hydro electric
Electricity supply	Transport (Air)	Wind
Ferrous metals	Transport (Land)	PV
Non-ferrous metals	Transport (Water)	CCS coal
Chemical Products	Market Services	CCS Gas
Paper Products	Non Market Services	