



EUSUSTEL

European Sustainable Electricity; Comprehensive Analysis of Future European Demand and Generation of European Electricity and its Security of Supply

WORK PACKAGE 1

County-wise Analysis

Subtask 1.1.a

BELGIUM

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1. Energy-related and socio-economic analysis: past, present and future

1.1. Factual information

1.1.1. Geography & population

Belgium, with its population of about 10.4×10^6 people (and 4.4×10^6 of households), has a surface area of 30500 km² and a coastline of 65 km. Geographically and politically, it is divided into three regions: Flanders (13500 km²), Wallonia (16800 km²) and Brussels-Capital (162 km²). From north to south, the surface height changes gradually from 0 to more than 600 metres. It has a moderate climate, with an annual rate of 1555 hours of sunshine, approximately 200 days of rainfall¹ and a limited number of freezing days.

1.1.2. Economy

Belgium has a GDP² of 270×10^9 EUR (2003), of which more than half is generated by the service sector ($\pm 74\%$). Other main sectors are the industry and the building industry ($\pm 25\%$). The contribution of the agriculture is only marginal ($\pm 1\%$). The concentration of chemical industry in Antwerp is among the highest in the world.

1.1.3. Energy

Belgium has no domestic resources since it has closed down its last coal mines in the 1980's. As Belgium has a high population density, less free space, a moderate climate and almost no height differences, the potential for renewable energy sources is limited.

The main energy balances and indicators are summarised in the table below (based on baseline scenario from [6]).

[PJ] ³	2000	2005	[PJ]	2000	2005
Gross Inland Consumption (=TPES)	2395.68	2480.94	Final Energy Demand (TFC) by Sector	1550.22	1601.46
Solids	344.4	247.8	Industry	572.04	593.46
Oil	921.9	951.3	Residential	397.74	398.58
Natural gas	561.54	729.54	Tertiary	174.72	175.14
Nuclear	521.64	492.66	Transport	405.72	433.86
Electricity	15.54	16.38	Final Energy Demand (TFC) by Fuel	1550.22	1601.46

¹ Days with precipitation of more than 0.1 mm - climate data valid for Ukkel.

² A list with abbreviations can be found at the end of this document.

³ Based on conversion 1toe = 42×10^9 J

Renewable energy forms	30.66	43.68	Solids	141.12	116.76
Net Imports⁴	2038.68	2174.34	Oil	677.04	660.24
Import Dependency [%]	77.8	80.2	Gas	413.28	488.04
Energy Intensity Indicators (1990 = 100)			Electricity	280.14	292.74
Industry (Energy on Value Added)	103.6	96.4	Heat	30.66	33.18
Residential (Energy on Private Income)	92.9	84.5	Other	7.98	10.08
Tertiary (Energy on Value Added)	99.3	89	TPES/GDP (PPP) – 2002 [GJ/1000 – 95 US\$ PPP] [3]	9.24	
Transport (Energy on GDP)	100.9	96.9			

1.1.4. Electricity

Nuclear power plants form the base load of the Belgian electricity system. The contribution of those nuclear plants to electricity generation currently amounts to 55 - 60%⁵. Other main contributions come from the gas-based power plants. Recent investments tendencies are towards the gas technologies. Nowadays, the contribution of electricity produced by renewable energy sources is only marginal.

In 2004, a total of 86587 GWh of electricity was injected on the Belgian grid [19]. The consumption peak 13708 MW was reached in December. Net imports were 7793 GWh. The main electricity balances and indicators are summarised in the table below [6].

	2000	2005
Electricity Generation [TWhe]	82.64	86.61
Nuclear	48.15	45.48
Hydro & wind	0.47	0.91
Thermal (incl. biomass)	34.02	40.21
Electricity Generation – installed capacity[Gwe]	14.64	14.08
Nuclear	6.03	6.03
Hydro (pumping excluded)	0.11	0.11
Wind and solar	0.02	0.14
Thermal	8.49	7.80
Of which cogeneration units	2.25	1.69
Open cycle	5.18	3.69
Supercritical Polyvalent/Clean Coal and Lignite	0.00	0.00
Gas Turbines Combined Cycle	2.53	3.50
Small Gas Turbines	0.78	0.60
Fuel Cells	0.00	0.00
Geothermal Heat	0.00	0.00
Average efficiency for thermal electricity production [%]	38.3	43.3

⁴ Primary nuclear energy is considered as domestic.

⁵ Depends on refuelling cycle (12 – 18 months)

1.1.5. Environmental issues

As Belgium is highly populated, with a lot of industry and transport, the environment is constantly under pressure. The geographical location of Belgium in Europe makes it a transit country, which enlarges the pressure even more.

The main balances and indicators concerning the CO₂-emissions are summarised in the table below [6].

	2000	2005
CO₂-emissions [Mt of CO₂]	115.9	113.6
Electricity and Steam production	22.5	21.8
Energy Branch	5.5	4.8
Industry	31.0	29.7
Residential	20.0	19.1
Tertiary	8.2	8.0
Transport	28.6	30.3
CO₂-emissions Index (1990 = 100)	109.0	106.9
Carbon intensity [t of CO₂/toe of GIC]	2.03	1.92
CO₂-emissions/Capita [t of CO₂/inhabitant]	11.31	10.96
CO₂-emissions to GDP [t of CO₂/MEUR '00]	466.6	411.2
Carbon Intensity indicators		
Electricity and Steam production [t of CO ₂ /MWh]	0.25	0.23
Final energy demand [t of CO ₂ /toe]	2.38	2.29
Industry	2.38	2.10
Residential	2.11	2.01
Tertiary	1.96	1.91
Transport	2.96	2.94

The Belgian Agency for Radioactive Waste and Enriched Fissile Materials (ONDRAF/NIRAS) is a separate government agency created in 1980. It is responsible for the nuclear fuel and the radioactive waste management. Both the technical as well as the financial side (by the means of long-term financing programs) of the nuclear waste management are part of its responsibility [7].

1.2. Trends [1]

Growth rates [% per year]	'73-'79	'79-'90	'90-'98	'98-'99	'99-'05
TPES	0.7	0.0	2.4	0.5	-1.3
Coal	-1.0	-0.3	-2.2	-12.7	0.5
Oil	-1.5	-2.8	3.4	-1.6	-1.7
Gas	4.5	-1.2	5.4	6.9	-1.2
Comb. Renewables & Wastes	41.7	17.8	2.9	37.5	-23.8
Nuclear	130.2	12.8	1.0	6.2	-0.7
Hydro	4.9	1.3	4.6	-12.1	0.6
Geothermal	-	-	-	-	-
Solar/Wind/Other	-	-	-	-	-10.9
TFC	0.3	-0.6	2.8	0.2	-0.7
Electricity Consumption	4.2	2.6	3.1	0.7	-1.2
Energy Production	2.4	5.0	0.0	7.5	-1.7
Net Oil Imports	-0.8	-3.4	4.0	-7.7	-1.0
GDP	2.4	2.3	1.8	2.7	2.3
Growth in the TPES/GDP Ratio	-1.6	-2.2	0.5	-2.2	-3.5
Growth in the TFC/GDP Ratio	-2.0	-2.8	1.0	-2.5	-3.0

2. Energy studies

2.1. AMPERE

The AMPERE⁶ Commission was established in 1999 to investigate policies for future *electricity* generation in Belgium. The Commission made a critical review of the different electricity generation technologies on a technical, economic, environmental and future potential scale (scope = 2020). The study has been done within the future regulatory framework (of a liberalised market), a projected economic evolution and the knowledge of a nuclear phase-out (as explained below).

On the assumption of a nuclear phase-out, the Commission advises to focus on CCGT-, RES- and CHP-technologies (and further R&D of these technologies) to fill up the supply side. It states that the available coal technologies are not a valuable option for electricity generation, concerning the stringent environmental requirements. As a consequence, the Commission realises that the electricity system will be largely reliant on natural gas, so the implementation of guidelines regarding the supply of natural gas will be necessary. Besides that, it stresses on the management of the decentralised electricity production, especially within the liberalised framework.

⁶ The AMPERE Commission (Analysis of Methods for the Production of Electricity and Re-evaluation of Energy Vectors) consist of a group of high-level Belgian energy specialists. In October 2000 a final document was published. The report has been assessed by an international Peer Review Group in April 2001.

On the demand-side, the Commission stresses on the potential of an enforced DSM and the need of RUE to reach the Kyoto targets. This can be done by e.g. consumer information, energy labels, energy audits, third party financing, transparent full-cost pricing (including the external environmental cost)...

Concerning the nuclear phase-out, the Commission advises to keep the nuclear option open as it is a very economical method for electricity production. Closing down of the depreciated nuclear plants (after a lifetime of 40 years) can be more expensive than the prolongation of their lifetime. It is important to maintain a high-level nuclear expertise (by participating in national and international R&D-programmes on nuclear topics, new power plant concepts, waste treatment...).

In 2001, an international Peer Review Group recognised the efforts of the AMPERE Commission. However, it advised a broader mandate for the Commission as the consequences of certain actions have not been evaluated and it had some objections to the opinion of the Commission concerning the potential of coal technologies.

The “Commission ENERGY 2030”, which had its kick-off on May 2005, will give an answer on these remarks, as it will define, evaluate and interpret scenarios. By September 2006, it has to provide the Belgian Government with coherent guidelines and recommendations to optimize the future nature (2030) of energy provision & the fuel mix in Belgium, so as to guarantee a reliable, clean and affordable, i.e., a “sustainable energy provision system”.

2.2. Other studies

- Federal Plan Bureau [4]: This study analyses the long term evolution of the Belgian energy system. As a base scenario, it uses the existing demographic, economic... trends, and based on those trends, the Bureau makes a projection of the evolution the energy demand, production capacity and technology, emissions... In alternative scenarios, the impact of changing parameters like fuel prices, energy policy, no nuclear phase-out... is analysed. This study will be mentioned again, further on in the environmental policy paragraph.
- Fraunhofer [21]: This study concentrates on the role of the demand reduction to achieve the Kyoto-targets. According to this institute, Belgium can reach those targets by an efficient implementation of existing – in the EU – measures (minimum energy performance standards, voluntary agreements, benchmarking covenants, energy/CO₂-taxation...). But there is the need for sufficient and well-allocated staff and a good cooperation between the several regional approaches.
- Indicative Plan regulator Electricity & Gas [10], [11], [12]: Until now, the regulator was obliged to present every 3 year an indicative programme on the production means for electricity and the supply of natural gas. The regulator defines a strategy which has to result in a LT sustainable electricity and gas supply. In its latest plans on electricity and gas, the regulator emphasises on the increasing natural gas dependency, the importance of import capacity but also on the importance of coping with peak demands.

- Development plan TSO [20]: Like the regulator, the TSO (ELIA) is obliged to present every 2 year a development plan for the transmission grid. Within the targets of energy (demand, spreading of demand and production...), environment (sustainability) and economy (most economical solution), the TSO wants to facilitate the opening of the market by upgrading the import capacity. As a second spearhead, ELIA wants to reduce the dependency of the transmission grid of the Belgian production park. Every decision has to fit in the overall energy policy.

3. Policy

3.1. General framework

Belgium is a federal country and is divided into three regions: Flanders, Wallonia and Brussels-Capital. The regional governments are responsible for designing and implementing policies for energy efficiency, renewables, CHP, RUE, non-nuclear energy R&D and gas and electricity (< 70 kV) market regulation on the distribution level. The federal government is responsible for the gas and electricity regulation on the transport level, nuclear energy (including R&D, generation, waste...) and other issues that need to be dealt with on a national level (e.g. large storage facilities and tariffication). The global framework stresses on a further implementation of existing and planned measures towards a complete liberalisation of the energy market.

In 2002 – 2003 [22], the federal government decided to phase-out progressively all its nuclear electricity generating capacity. The law dictates that all nuclear power plants have to be closed down after an industrial operating time of 40 years. This means that the first sites have to be dismantled in 2015 and the last in 2025. Besides to this, it is not allowed to build any new nuclear power plant to generate industrial electricity⁷. In case of severe problems with the security of supply, the decision can be reviewed by Royal Decree.

⁷ As an interesting remark, the law does not prohibit the construction of new nuclear plants for other means (e.g. sea water desalination)

3.2. Electricity policy

On federal level, the CREG⁸ was established by law in 1999 as an autonomous organism concerning the organisation of the Belgian electricity and gas market. The CREG has two main tasks: firstly, it is an advisory body towards the policy makers and secondly, it is a supervisory and control body concerning the implementation of the several laws and regulations.

As mentioned above, the CREG presents every 3 year an indicative plan concerning the production methods of electricity. First of all, the report has to present an estimation of the mid- and long-term evolution of the electricity demand. Once the demand is known, the resulting needs of production methods can be defined. The choice of the primary energy sources has to be made with a special focus on fuel diversification, promotion of the use of RES and the fulfilling of the constraints of the regions concerning the environment. Production methods with low CO₂-emissions have to be promoted. Besides the strategy concerning the future electricity production, the CREG has to evaluate the obligations of the public services concerning electricity production, with inclusion of their efficiency and cost. The evaluation of the security of supply, in combination with the needed recommendations is another important topic to be treated.

Concerning the RUE and CHP-policy, the CREG advises to follow the strategies of the different regions (see infra, environmental policy). According to the CREG, the impact of those measures may not be overestimated. It suggests investing both in base load and in peak load, by installing CCGTs and gas turbines, but it alerts to an exaggerate dependency of gas technologies. That is why R&D-activities in advanced coal technologies have to be supported. As a last issue, the CREG advises to strengthen the Belgian import capacity, to fulfil the future import and transit demands.

The Flemish electricity market was completely liberalised on 1 July 2003. The VREG⁹ supervises the organisation and functioning of the Flemish electricity and gas market. It advises the regional government to optimise the energy market. The authority of the VREG is limited to the authorities of the regional government, as mentioned above. The Walloon electricity market was opened for industrial users on 1 July 2004 and will be open for residential users in 2007. CWaPE¹⁰ is the Walloon regulatory body and BIM¹¹ the Brussels one. Their regulatory responsibilities are comparable to those of the VREG.

A recent study of London Economics [14] shows some weak points in the structure and functioning of the Belgian electricity market. Even though Electrabel - the dominant incumbent generator – does not abuse its market power, it puts new entrants off the generation market. Electricity imports have only a small influence on the position of this main generator. According to [14], this dominancy results in a lack of liquidity on the electricity wholesale market. Again, Electrabel does take initiatives to tackle the problems on the trading market, but these are not sufficient to persuade new entrants. An intervention of a third party will be necessary.

⁸ www.creg.be

⁹ www.vreg.be

¹⁰ www.cwape.be

¹¹ www.ibgebim.be

On the supply market, the number of players is increasing (in Flanders at a higher rate than in Wallonia), but still, Electrabel stays dominantly present in all Belgian regions. There is lack of information and accurate data on consumption, which makes it very difficult for new players to enter the market. The decision to work with a “default supplier” enforces even more the dominant players.

According to [14], merging in the electricity market is a European tendency which results in some big players who are dominant on their domestic market and competing on the international level. Nowadays, consolidation and a vertical re-integration process are going on. The same happens in Belgium, but the horizontal concentration is a more urgent problem to tackle. The best remedy to solve this problem is to deal with the dominance of Electrabel.

As a reaction to this study, the CREG recognises the fact that the market does not yet work perfectly, as not all categories of consumers can enjoy all liberalisation profits [13]. Prices are too high because decreasing distribution and transmission costs does not compensate the additional costs of the regional governments. Concerning the vertical integration, the CREG stresses on a further ownership unbundling between producers, suppliers and network operators. On the issue of market concentration, the CREG is not in favour of the breaking up of Electrabel. However it will study the possibilities to take away a share of the production capacity of dominant producers and distribute that share among other market participants. To conclude, the CREG does not want to go back to an over-regulated market, but it will closely monitor price evolution.

3.3. Environmental policy

Both the regional and the federal governments have their own policy to reach the environmental goals as stated in the Kyoto protocol. Belgium has committed itself to reduce its CO₂-emission by 7.5% by 2008-2012. The followed and planned energy related measures since 1990 are summarised below.

On the federal level, the development of RUE, RES and CHP by subsidising, standardisation and tariffication are emphasized. In the “Federal Plans concerning Sustainable Development: 2000 – 2004 [16] & 2004 – 2008 [17]”, the strategy is outlined.

The promotion of RES is mainly the responsibility of the regional level, but anyhow, some arrangements have to be made at the federal level. The introduction of a green certificate system, financial support (both for production as for R&D), the promotion of bio-fuels, the obliged purchase of green energy and the quota for minimum delivery have to result in 6% of green electricity by 2010. One of the biggest obstacles for green energy is the cost. To tackle this problem, the government stresses on the internalisation of all costs, based on a life cycle analysis. By this, different production methods (“classic to green”) will be able to compete on a fair base. Besides that, it is important for investors to have a clear view on the long term policy to have a certain rate of “security of investment”.

As in the neighbouring countries, Belgium investigates further the implementation of the Kyoto flexibility mechanisms¹² and the feasibility of a CO₂ and/or energy tax. If such fiscal measures do not fit in a European or international framework, it is important to examine the consequences of a unilateral introduction on the Belgian competition position.

An important part of a GHG emission reduction plan, is an evaluation method. Therefore, the federal government plans to define by mid 2005 some indicators on emissions, energy use and energy intensity. The use of the indicator “factor” is a first example. A “factor 4” by 2020 means a doubling of the prosperity with only half of pressure on the natural resources.

To deal with the complex Belgian political structure, collaboration and good communication between the different regions is of high importance. To enhance the intergovernmental debate on climate policy, an “Expanded Interministerial Conference for the Environment” was established. The composition of a “National Climate Plan [15]” in which all measures are summarised and which has to give an annual evaluation, fits in the same strategy.

To stimulate the rational use of energy, sector-oriented DSM-programs and the use of covenants for the industrial sector (for an amelioration of the specific energy consumption and/or a reduction of the specific CO₂-emissions) are implemented.

On the regional level, there is an allocation of emissions to the different regions [23]. Flanders has to reduce its emissions by 5.2%, Wallonia by 7.5% and the Brussels-Capital region is allowed to increase its emissions by 3.475% compared to 1990. With this allocation, Belgium allocates more emission rights to its regions than it was allocated according to its Assigned Amount. This shortage in emission rights will be tackled by the Federal Government through the flexible mechanisms of the Kyoto protocol.

Flanders commits the distribution companies to provide a 3-yearly plan concerning RUE and the use of more RES. It has a long-term policy plan on RUE, RES, CO₂-emission reductions, market diffusion of RES and other energy efficient technologies and a long term R&D strategy. Under the supervision of the VREG, Flanders has introduced a Green Certificate system for RES (3% by 2004 and 5% by 2010), and comparable to that system, it has introduced a CHP-certificate system as well, for the promotion of CHP.

Wallonia is in favour of a linear distribution of the 7.5% CO₂-reduction-target between the different regions and within a region between all economic sectors and actors, which are emitting CO₂. Wallonia stresses on the importance of the cost-efficiency of the CO₂-reduction measures and on the development of relevant indicators to observe the progress. If costs are not reasonable, one has to use flexibility mechanisms. It sets a target of 12% green energy (both by RES and CHP) by 2010. It supports the preparations of energy-efficiency and GHG emission covenants. With the introduction of SUE, Wallonia wants to promote more efficient energy consumption as well as

¹² Flexibility mechanisms: (1) International emission trade, (2) Joint Implementation (= investments in CO₂-reduction projects in other industrialised countries); (3) Clean Development Mechanism (= investments in CO₂-reduction projects in development countries)

more efficient energy production. The funding of a permanent discussion forum on climate change has to support the climate policy.

The potential for RES in the region Brussels – Capital is not that big, it focuses on the promotion of RUE on public and private level. By large scale communication and information campaigns, the promotion of better roof insulation, the replacements of old boilers, the performing of energy audits and the granting of energy certificates, Brussels – Capital wants to reduce its energy use. Concerning RES, Brussels – Capital wants to promote solar energy for public services and the use of solar panels on roofs. It has a quota of green electricity use of 2.5% of electricity consumption by 2006.

The Planbureau and Econotec investigated the impact of all the abovementioned measures in a BAU-scenario [4]. With the assumption of an annual augmentation of the total final energy consumption of 1.1%, energy-related and not-energy-related CO₂-emissions are expected to increase¹³. Between 1990 and 2012, overall GHG emissions are expected to grow with an annual rate of 0.6%. As CO₂-emissions in 2001 have increased by 12% compared to the 1990 level, the necessity to take extra measures is clear. A combination of fiscal and non-fiscal measures will be necessary to reach the Kyoto targets. RES and CHP have to be encouraged by a green certificate system with minimum quota. Fines of the certificate system – as a result of not reaching the quota – can be used for the establishment of an Energy Fund. This fund can for example be used for a support tariff system for the promotion of RUE. A last issue is to assure the transparency of the market. This is very important for potential investors to have a certain “security of investment” in a stable political framework. A stable framework, which is also necessary for dealing with nuclear issues, especially waste treatment.

¹³Between 1990 and 2012: Energy-related CO₂-emissions: +0.5%/year; Not-energy-related CO₂-emissions: +2.7%/ year; Total CH₄-emissions: -2.6%/ year; Total N₂O-emissions: +2.1%/ year

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5. Abbreviations

AMPERE - Analysis of Methods for the Production of Electricity and Re-evaluation of Energy Vectors

BAU - Business As Usual

BIM – Brussels Instituut voor Milieubeheer

CCGT - Combined Cycle Gas Turbine (steam and gas)

CHP - Combined Heat Power

CREG - Commission for Regulation of Electricity and Gas

CWaPE - Commission wallonne pour l'Energie

DSM - Demand Side Management

GDP – Gross Domestic Product

GIC – Gross Inland Consumption

LT – Long term

RES - Renewable Energy Sources

RUE - Rational Use of Energy

SUE - Sustainable Use of Energy

TFC – Total Final Consumption

TPES – Total Primary Energy Supply

TSO – Transmission System Operator

VREG - Flemish Regulator for Electricity and Gas