



INTERNATIONAL ENERGY AGENCY

Energy Policies of IEA Countries



LUXEMBOURG

2004 Review

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The International Energy Agency (IEA) is an autonomous body which was established in November 1974 within the framework of the Organisation for Economic Co-operation and Development (OECD) to implement an international energy programme.

It carries out a comprehensive programme of energy co-operation among twenty-six* of the OECD's thirty member countries. The basic aims of the IEA are:

- to maintain and improve systems for coping with oil supply disruptions;
- to promote rational energy policies in a global context through co-operative relations with non-member countries, industry and international organisations;
- to operate a permanent information system on the international oil market;
- to improve the world's energy supply and demand structure by developing alternative energy sources and increasing the efficiency of energy use;
- to assist in the integration of environmental and energy policies.

* *IEA member countries: Australia, Austria, Belgium, Canada, the Czech Republic, Denmark, Finland, France, Germany, Greece, Hungary, Ireland, Italy, Japan, the Republic of Korea, Luxembourg, the Netherlands, New Zealand, Norway, Portugal, Spain, Sweden, Switzerland, Turkey, the United Kingdom, the United States. The European Commission also takes part in the work of the IEA.*

ORGANISATION FOR ECONOMIC CO-OPERATION AND DEVELOPMENT

Pursuant to Article 1 of the Convention signed in Paris on 14th December 1960, and which came into force on 30th September 1961, the Organisation for Economic Co-operation and Development (OECD) shall promote policies designed:

- to achieve the highest sustainable economic growth and employment and a rising standard of living in member countries, while maintaining financial stability, and thus to contribute to the development of the world economy;
- to contribute to sound economic expansion in member as well as non-member countries in the process of economic development; and
- to contribute to the expansion of world trade on a multilateral, non-discriminatory basis in accordance with international obligations.

The original member countries of the OECD are Austria, Belgium, Canada, Denmark, France, Germany, Greece, Iceland, Ireland, Italy, Luxembourg, the Netherlands, Norway, Portugal, Spain, Sweden, Switzerland, Turkey, the United Kingdom and the United States. The following countries became members subsequently through accession at the dates indicated hereafter: Japan (28th April 1964), Finland (28th January 1969), Australia (7th June 1971), New Zealand (29th May 1973), Mexico (18th May 1994), the Czech Republic (21st December 1995), Hungary (7th May 1996), Poland (22nd November 1996), the Republic of Korea (12th December 1996) and Slovakia (28th September 2000). The Commission of the European Communities takes part in the work of the OECD (Article 13 of the OECD Convention).

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REVIEW TEAM

An IEA review team visited Luxembourg in April 2004 to review the country's energy policies. This report was drafted on the basis of information received during and prior to the visit, including views expressed by various parties during the visit.

The team greatly appreciated the co-operation and the openness demonstrated by the participants during this policy review process.

Pierre Audinet managed the review and drafted the report, in consultation with the team. Monica Petit prepared the figures.

Members of the team were:

- Mr. Marc Deprez, *team leader*, Ministry of Economy, Belgium
- Ms. Helen Donoghue, European Commission
- Mr. Thomas Levander, Swedish Energy Agency, Sweden
- Mr. Jun Arima, International Energy Agency
- Mr. Pierre Audinet, *Luxembourg desk officer*, International Energy Agency

ORGANISATIONS VISITED

The team held discussions with the representatives from the following organisations:

- Agence de l'Énergie
- Administration de l'Environnement
- Compagnie Grand-Ducale de l'Électricité (CEGEDEL)
- Fédération des Industriels Luxembourgeois (FEDIL)
- Groupement Pétrolier Luxembourgeois (GPL)
- Institut Luxembourgeois de Régulation (ILR)
- Ministry of Economic Affairs – Energy and Communications Directorate
- Ministry of Environment

- Société de Transport de l'Electricité (SOTEL)
- Société de Transport de Gaz (SOTEG)
- Société Electrique de l'Our (SEO)
- SUDGAZ
- TWINerg
- Ville de Luxembourg

SUMMARY OF CONCLUSIONS AND RECOMMENDATIONS

There have been commendable developments in energy policies in Luxembourg since the last in-depth review. With the Electricity Law of July 2000 and Gas Law of April 2001, more than half of the electricity and gas markets were opened for competition by April 2004. The independent regulator in charge of both the electricity and gas markets has been established. A new combined-cycle gas turbine (CCGT) power plant came into operation in May 2002, providing a solution to the needs of large consumers for stable electricity supply and predictable prices, reducing Luxembourg's import dependence on a single supplier of electricity and diversifying its natural gas supply sources. Luxembourg ratified the Kyoto Protocol in 2001 and submitted its National Allocation Plan based on the EU Directive on Emissions Trading in April 2004. Despite a high dependence on imported energy, it currently faces no significant energy supply problems. Luxembourg consumers have also been enjoying lower energy prices, compared with neighbouring countries.

In the years to come, a major policy challenge for Luxembourg is how to achieve its Kyoto target. While greenhouse gas (GHG) emissions in 2002 were 21% below 1990 levels, this is entirely attributable to a 70% decrease in the industrial sector due to the restructuring of the iron and steel industry. Such restructuring cannot be repeated. On the other hand, Luxembourg's population is growing, mainly as a result of immigration. Because of its small size, any development in emissions (*e.g.* the start of a new CCGT plant) could end in enormous movements in terms of percentage.

A large number of foreign drivers are refuelling in Luxembourg where taxation on automotive fuels is low compared to neighbouring countries and whose location at the crossroad of Europe makes it extremely challenging to achieve the Kyoto target. While the tax differential of automobile fuels does not depend only on Luxembourg, this needs to be addressed in the wider context of further tax harmonisation efforts at the European Union level but efforts from Luxembourg are also imperative.

The National Allocation Plan anticipates that the bulk of emissions reductions will be achieved through the implementation of Kyoto mechanisms. While this is explainable given Luxembourg's specific circumstances and the high cost of domestic climate change mitigation policies, Luxembourg could explore more possibilities to reduce GHG emissions domestically. Energy efficiency could contribute not only to GHG emissions reduction, but also to energy security, which purchasing credits from abroad will not achieve.

Luxembourg's energy demand per capita remains among the highest in IEA member countries. While the government has been implementing regulatory

measures and introducing voluntary agreements, more emphasis should be placed on energy efficiency to achieve the 3Es – Energy security, Economic development and Environmental sustainability. The government needs to intensify its efforts to assess the costs and benefits of measures to improve energy efficiency. The performance of voluntary agreements with industry should be closely monitored. In the building sector, rapid implementation of the *carte de l'habitat* in a simplified manner, enhancing standards for new buildings and the refurbishment of existing buildings should be explored. In the transport sector, economic and regulatory measures to curb the increase in passenger transport, such as vehicle taxation and road pricing, should be considered.

Luxembourg does not often comply with its 90 days stockholding obligation under the International Energy Program (IEP). This will weaken the IEA's solidarity at a time of great oil market uncertainty and instability. The government should now swiftly develop a plan with concrete measures to achieve its obligation by creating a centralised stockholding agency and increasing the level of physical oil stocks on national territory. The current dominance of short-term leasing contracts could limit Luxembourg's capacity to cope with supply disruptions.

As of April 2004, Luxembourg has liberalised its gas market up to 76% and its electricity market up to 57%. Both markets will be opened for full competition in 2007. While few customers have switched suppliers, many of the existing contracts have been renegotiated. It should be borne in mind that Luxembourg's gas and electricity markets have several specificities: its domestic market is very small; the demand is led by a few large energy-intensive industries; and the number of players is limited. The government should make efforts to generate as much benefit from competition as possible. Even with continuing state ownership in the gas and electricity sectors, the government should continue to refrain from interfering in the daily management and strategic decisions of the companies, which is a prerequisite to ensure a level playing field. Because of the country's size and location, effective competition in gas and electricity markets is very much affected by the market condition of neighbouring countries. Therefore, the regulator should keep in touch with its counterparts in those countries, in particular in such areas as network access and interconnection. Despite technical and economic challenges, the potential benefit of linking two domestic electricity grids (CEGEDEL and SOTEL) should be explored with a view to expanding the market size and enabling greater choice for Luxembourg consumers.

Electricity generating capacity from renewable energy has expanded rapidly thanks to generous buy-back tariffs and direct subsidies. However, the current buy-back tariff scheme does not have any time limit or degression element to lower the tariff over time. This lack of an incentive for investors to increase productivity could be very costly to the economy. While the number of installed photovoltaic (PV) cells per capita in Luxembourg is very high thanks

to the generous subsidy and feed-in tariff scheme, given Luxembourg's natural resource endowment, this may not be the most cost-effective option to achieve its energy policy objectives. The responsibilities for promoting renewable energy have been shifted from the Ministry of Economic Affairs to the Ministry of Environment. Splitting renewable energy policy from the overall energy policy could make it difficult to compare the cost-effectiveness of renewable energy policy with other policy options.

Despite growing challenges and complexities arising from market liberalisation and climate change mitigation, Luxembourg has only six permanent staff in the Energy Directorate and two permanent staff for energy regulation at the *Institut Luxembourgeois de Régulation*. Even taking into account the small size of the country, this could hamper the capacity of Luxembourg to address the above challenges.

RECOMMENDATIONS

The government of Luxembourg should:

Energy Policy and Market Trends

- ▶ *Recognise the increasing importance of larger markets and international policy developments, allocate sufficient resources – particularly staffing – to participation in the relevant processes and to carrying out the necessary strategic planning.*
- ▶ *Review energy tax policies to better internalise environmental externalities within the wider efforts for tax harmonisation at the EU level.*
- ▶ *Enhance close co-operation and co-ordination among all the ministries involved in energy policy.*
- ▶ *Expand the responsibilities of the energy regulator to include approval of grid access tariffs.*
- ▶ *Consider participating in IEA Implementing Agreements.*

Energy Efficiency

- ▶ *Establish a national energy efficiency strategy incorporating targets and strong cost-effective measures at national and sectoral levels.*
- ▶ *Closely monitor the performance of the voluntary agreement with the industrial sector. Require participants in the voluntary agreement to provide details on how they will implement energy efficiency.*

- ▶ *Complement the existing voluntary agreement with company-based sectoral efficiency improvement targets.*
- ▶ *Conduct more evaluation of the results of efficiency measures.*
- ▶ *Enhance energy efficiency standards for existing and new buildings, and enhance their monitoring with stronger oversight of implementation. Take first steps to implement the carnet de l'habitat.*
- ▶ *Formulate and implement economic and regulatory measures such as the revision of vehicle taxation and road pricing to curb growth in energy demand in passenger transport.*
- ▶ *Consider participating in the IEA Implementing Agreements on "Electric and Hybrid Vehicles", "Hydrogen" and "Advanced Motor Fuels".*

Energy and the Environment

- ▶ *Develop as soon as possible an action plan to reduce GHG emissions in a cost-effective manner. Efforts should be focused on road traffic since that sector represents the most important increase in emissions up to the year 2012.*
- ▶ *Prepare a strategy on how the recourse to Kyoto mechanisms will be implemented.*
- ▶ *Evaluate the cost-effectiveness of the various subsidies.*
- ▶ *Continue to explore more possibilities to reduce GHG emissions domestically, bearing in mind the goals of energy policy and of cost-effectiveness, even if the largest share of emissions reductions may be obtained through an active international strategy.*

Oil

- ▶ *Urgently develop a plan to achieve the IEP obligation with concrete measures within a specific time period through:*
 - *Creating a centralised stockholding agency.*
 - *Increasing the level of physical oil stocks on national territory.*
 - *Limiting the number of short-term leasing contracts of 3 months in favour of longer-term leasing contracts of 6 months or more.*
- ▶ *Given the limited scope for strong competition in the oil products sector and the large volumes of oil products sold in Luxembourg, make sure that the calculation of price ceilings does not generate undue rent.*

Natural Gas

- ▶ *Maintain an arm's length relationship with the companies having state-ownership in the gas sector.*
- ▶ *Ensure close co-operation between the regulator and its counterparts in neighbouring countries.*
- ▶ *Finalise and implement the ten-year gas security of supply plan.*

Electricity

- ▶ *Maintain an arm's length relationship with companies having state-ownership in the electricity sector.*
- ▶ *Keep under technical review the possibility of interconnecting the SOTEL and CEGEDEL networks in view of integrating further the Luxembourg market into the European electricity market.*
- ▶ *Ensure close co-operation between the regulator and its counterparts in neighbouring countries.*
- ▶ *Further consider cost-effective ways of supporting highly efficient co-generation, including linking financial support to efficiency criteria and environmental benefits or phasing out subsidies to co-generation.*

Renewables

- ▶ *Review the cost-effectiveness of the current scheme for PV.*
- ▶ *Review the tariff scheme and consider introducing degressivity over time. Try to find a more cost-effective system for renewables.*
- ▶ *Explore the possibilities of broadening the base of financial support for renewables promotion in Luxembourg.*
- ▶ *Assess renewable energy policies in the broader portfolio of energy policy.*

BACKGROUND

Luxembourg is the smallest IEA country with a population of around 446 000 in 2002, and a total surface area of 2 586 km². The maximum distance between north and south is 82 km and the maximum distance between west and east is 57 km. Agricultural and wooded areas account for 89.1% of the land, built-up areas for 7%, and roads, railways and watercourses for 3.9%. The country is divided into three districts and 12 cantons (Figure 1).

GDP increased by 5.1% per year between 1990 and 2001 and then slowed down in 2002 to 1.3%, when it reached US\$ 26.1 billion¹, *i.e.* US\$ 58 526 per capita. At current exchange rates and in purchasing power parity (PPP), GDP per inhabitant remains the highest of OECD countries.

ENERGY TRENDS

ENERGY SUPPLY AND DEMAND

Total primary energy supply (TPES) rebounded in the late 1990s and early 2000s to more than 4.2 Mtoe in 2003, after having decreased by 27% between 1973 and 1998, from 4.5 Mtoe to 3.3 Mtoe (Figure 2).

The initial reduction was brought on by the restructuring of the iron and steel industry, where production declined significantly in the 1970s to 1990s to stabilise in the 2000s. Because of this reduction in production and energy efficiency gains, energy consumption by the iron and steel industry dropped from 1.8 Mtoe (equivalent to 86% of energy use in industry) in 1974 to 0.4 Mtoe in 2002, which still represents 12% of total final consumption. In addition, between 1993 and 1997, ARBED (now ARCELOR) replaced its three blast furnaces with electric arc furnaces² and ceased using coal.

1. On average in 2002, € 1 = US\$ 0.943.

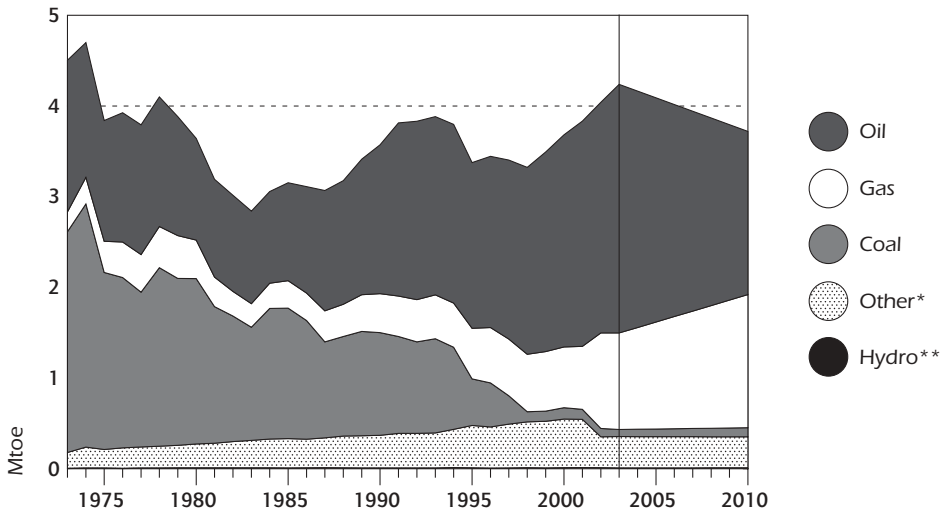
2. 1993: Schiffange (furnace of ARES); 1994: Differdange (furnace of ProfilARBED); 1997: Esch-Beval (furnace of ProfilARBED).

Figure 1
Map of Luxembourg



Figure 2

Total Primary Energy Supply, 1973 to 2010



* includes solar, wind, combustible renewables and electricity trade.

** negligible.

Sources: *Energy Balances of OECD Countries*, IEA/OECD Paris, 2004; and country submission.

In 2003, oil accounted for 65% of TPES followed by gas (25%), renewables (8.4%) and coal (1.8%). From 2001 to 2002, the share of natural gas increased significantly from 18.1% to 26.1% thanks to the commissioning of the TWINerg combined-cycle gas turbine (CCGT) at Esch-sur-Alzette in 2002. From a longer-term perspective, the fuel breakdown changed substantially from 1990 when oil accounted for 46.0% of TPES, followed by coal (31.7%), natural gas (12.0%) and renewables (1%).

Reduction of coal use can be attributed to the restructuring of the iron and steel industry, including the replacement of blast furnaces with electric arc furnaces. Expansion of oil use is entirely due to growing oil consumption in the transport sector.

FINAL ENERGY CONSUMPTION

Total final energy consumption (TFC) reached 3.8 Mtoe in 2002, growing regularly by 2.2% per annum in 1990-2001. TFC registered a more modest growth of 1% in 2002 over 2001, as a result of slower economic growth and efficiency improvements in the industrial sector. In 2002, transport

represented 57% of TFC, against 35% in 1990. In 2002, industry represented a declining share, 24% against 45% in 1990 and the commercial and residential sector represented 19% of TFC.

Oil represents the largest share of TFC, with 66.8% in 2002, followed by natural gas (16.6%), electricity (12.8%), coal (2.4%), heat (0.9%) and biomass (0.4%). In 1990, the share of oil was 55% followed by coal, including blast-furnace gas (18.5%), natural gas (14.2%) and electricity (12.0%). It is noteworthy that the share of coal has dropped significantly while those for oil and electricity increased.

In 2002, the most important items of final energy consumption in Luxembourg were: diesel and gasoline for road transport (31% and 16% respectively of TFC), jet kerosene for international civil aviation (10% of TFC), fuel oil used for heating in the residential sector (8% of TFC), electricity used in the iron and steel industry (4% of TFC) and by the commercial and public services (2% of TFC).

In addition, between 1993 and 1997, ARBED (now ARCELOR) replaced its three blast furnaces with electric arc furnaces and ceased using coal. The blast furnaces were producing gas which was used directly by the industry and to generate electricity. Gas from blast furnaces amounted to 0.7 Mtoe in 1974 and disappeared in 1998 after electric arc furnaces replaced all blast furnaces. As a consequence, electricity generation decreased and electricity consumption replaced gas from blast furnaces in industry. Overall, energy consumption in the industrial sector decreased by 55% (Figure 4) from its maximum in 1978 (2 Mtoe) to 2003 (0.9 Mtoe).

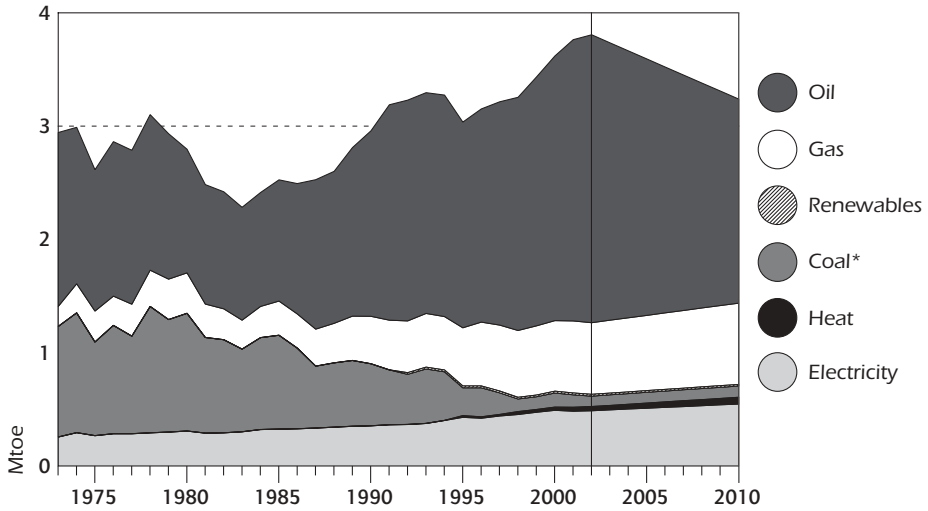
Due to the tax differential on gasoline, automotive diesel and LPG (in the latter case the quantities involved are much smaller) between Luxembourg and its neighbours, Belgium, France and Germany (see below the section on energy prices and taxation), a large number of drivers refuel in Luxembourg. The Ministry of Environment estimates that more than two-thirds of automotive fuels sold in Luxembourg are consumed abroad (see Chapter 5).

Several hundred thousand vehicles per day cross the border. Although a large share of these trips are made by trucks crossing Luxembourg on their way to other destinations, a fifth of them are made by non-resident workers employed in Luxembourg.

Car ownership in Luxembourg has increased rapidly and in 2001 amounted to 618 cars per thousand inhabitants in comparison with an average of 488 in the European Union (EU-15).

Figure 3

Total Final Consumption by Source, 1973 to 2010

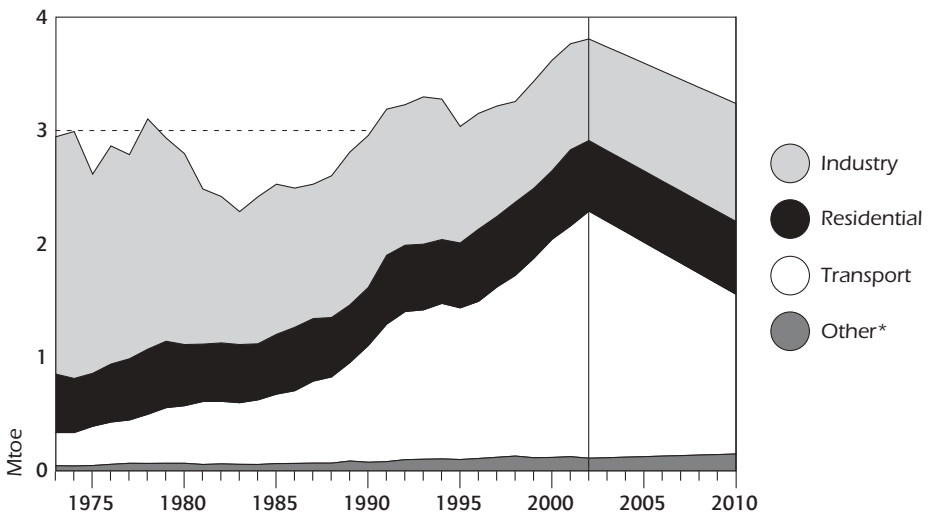


* includes blast furnace gas.

Sources: *Energy Balances of OECD Countries*, IEA/OECD Paris, 2004; and country submission.

Figure 4

Total Final Consumption by Sector, 1973 to 2010



* includes commercial, public service and agricultural sectors.

Sources: *Energy Balances of OECD Countries*, IEA/OECD Paris, 2004; and country submission.

ARCELOR Group

ARCELOR was created by the merger of ACERALIA (Spain), ARBED (Luxembourg) and USINOR (France) to create one of the world leaders in the steel industry.

Officially launched on 19 February 2001, the merger became effective on 18 February 2002, when the ARCELOR share was listed on several stock exchanges. The choice of the name ARCELOR was announced on 12 December 2001.

The ARCELOR group is developing its activities in four core businesses: it is the world's biggest producer of flat carbon steel and long carbon steel, among the leaders in stainless steel production, and among the largest firms in Europe for distribution, transformation and trading. In 2002, its worldwide crude steel annual production was 44 million tonnes, with a total workforce of more than 104 000 persons, and for a turnover of € 27 billion.

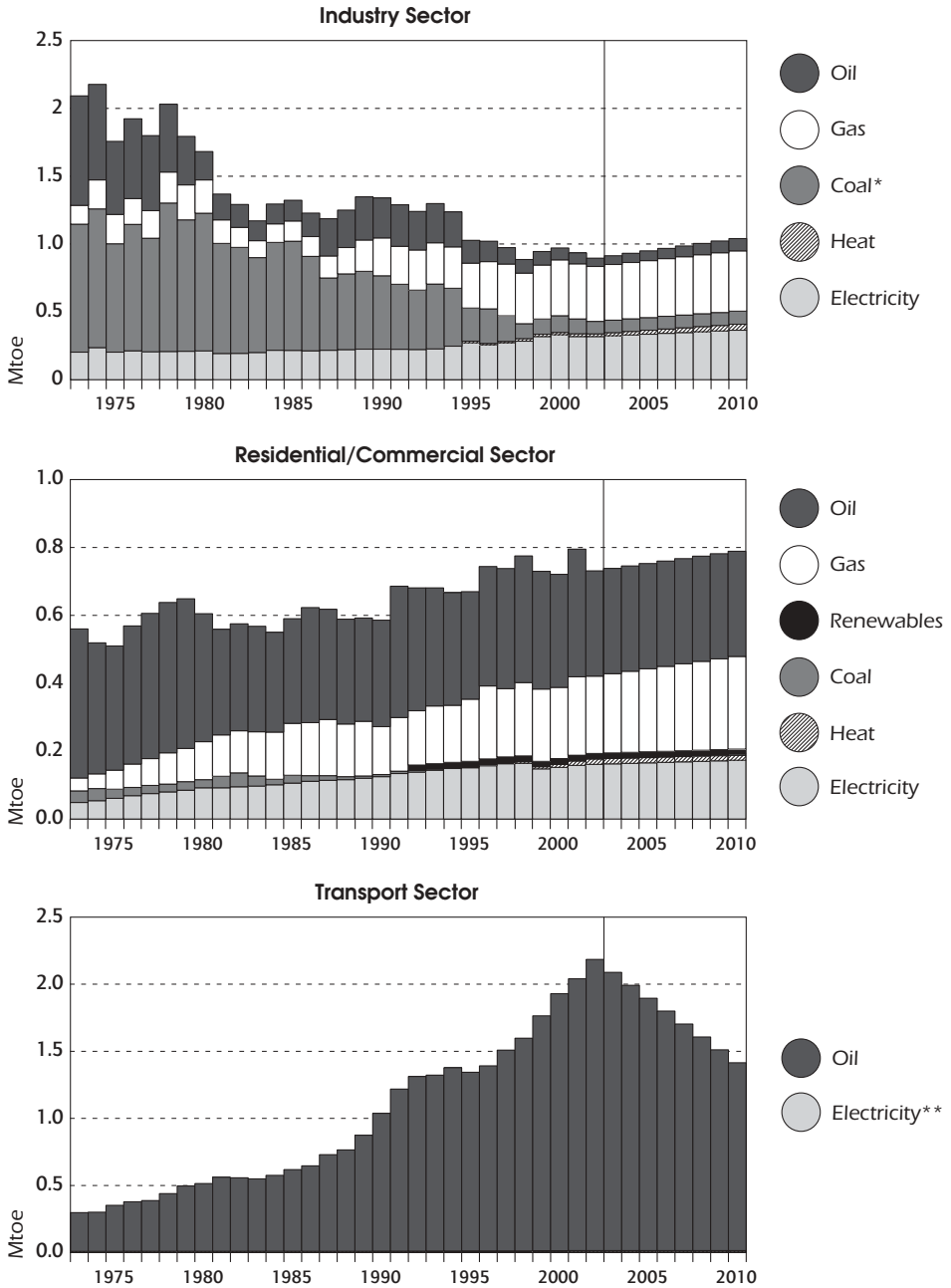
The share of ARCELOR output produced in Luxembourg represented around one-third of the country's industrial output, more than 12% of final energy consumption in 2002 and contributed to around 10% of Luxembourg's GDP ; 6% of the company workforce works in Luxembourg, and the Luxembourg State still owns 5.9% of the capital.

The consumption of kerosene for international civil aviation also increased significantly (+186% between 1990 and 2002 to 0.4 Mtoe in 2002), reflecting the growth of freight transport at Luxembourg's airport, which is used as a base for regional needs beyond those of Luxembourg.

Energy consumption in the residential and commercial sector (which comprises the administrative and agriculture sectors) increased together with the growth in the number and wealth of households and the growth of tertiary activities. In these sectors, natural gas and electricity have increased their share at the expense of coal and oil. Heat consumption has developed since 1995 as a result of the government's policy to encourage district heating.

Figure 5

Total Final Consumption by Sector and by Source, 1973 to 2010



* includes blast furnace gas.

** negligible.

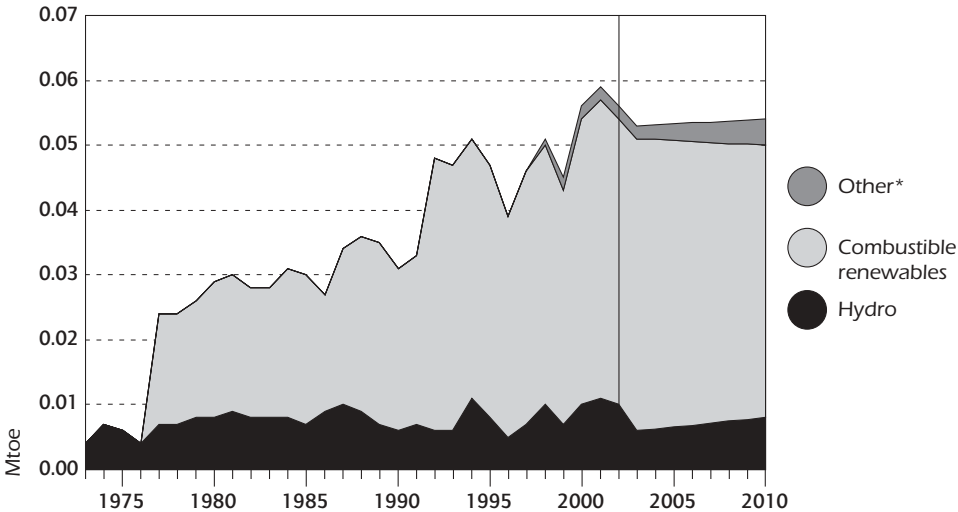
Sources: *Energy Balances of OECD Countries*, IEA/OECD Paris, 2004; and country submission.

ENERGY PRODUCTION, IMPORTS AND EXPORTS

Primary energy production stems only from renewable sources (Figure 6). Although production is modest (0.06 Mtoe in 2002) it has doubled since 1990. Most energy production is from combustible renewables and waste and a small amount is from hydro.

Figure 6

Energy Production by Source, 1973 to 2010



* includes solar, wind and other.

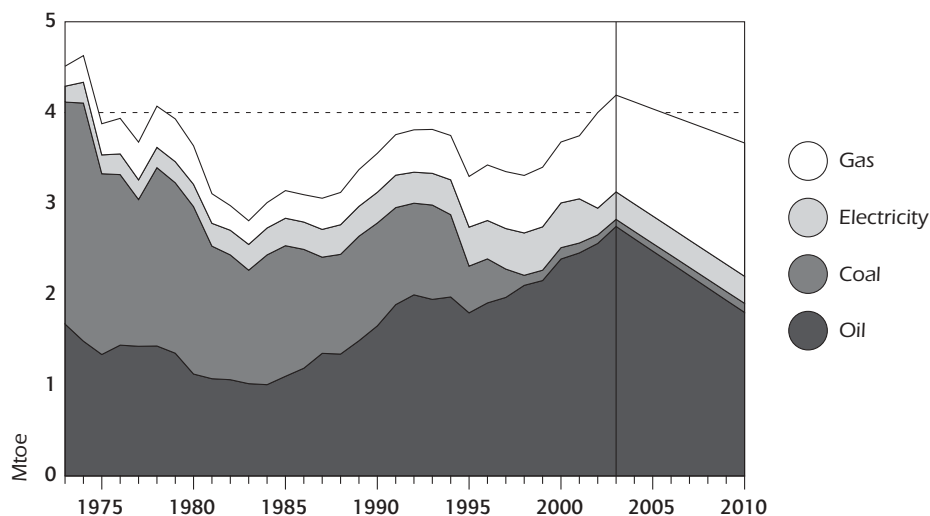
Sources: *Energy Balances of OECD Countries*, IEA/OECD Paris, 2004; and country submission.

Electricity generation, which used to be modest in comparison with consumption since the closure of ARBED's blast furnaces led to a stop electricity production from furnace gas, has grown again substantially with the commissioning in 2002 of the combined-cycle gas turbine of Esch-sur-Alzette. As a result, electricity generation multiplied by close to six times compared to 2001. In 2002, net electricity imports decreased to 0.3 Mtoe (from 0.5 Mtoe in 2001). This was mainly due to increased electricity exports enabled by the production of the Esch-sur-Alzette plant rather than a reduction in imports.

As domestic energy production is small, dependence on imports remains important. In 2002, total net energy imports amounted to 4.0 Mtoe, close to 100% of TPES (Figure 7). Oil is the main imported fuel with 2.6 Mtoe of net imports, followed by natural gas which saw its imports grow to produce more electricity (1.0 Mtoe), electricity (0.3 Mtoe) and coal (0.1 Mtoe).

Figure 7

Net Energy Imports, 1973 to 2010



Sources: *Energy Balances of OECD Countries*, IEA/OECD Paris, 2004; and country submission.

FORECASTS

The Energy and Communications Directorate within the Ministry of Economic Affairs expects energy supply to decrease at an annual rate of 1% between 2002 and 2010, and TFC to decrease at an annual rate of 2% over the same period. Such numbers are based on the following assumptions:

- Slower economic growth than earlier (2.3% per annum projected for 2002-2010 against 5.1% in 1990-2001).
- Gradual decrease of oil consumption in transport following tax harmonisation with Luxembourg's neighbours (1.4 Mtoe in 2010 against 2.2 Mtoe in 2002, a 35% decrease).
- Slower turnover in household equipment since demand for appliances is largely saturated.

Net energy imports are projected to decrease by 8% between 2002 and 2010 as net imports of electricity will stabilise in the same pattern observed today, coal imports will grow marginally and the growth of gas imports (+40%, reaching 1.5 Mtoe in 2010) will be more than compensated by a fall in oil products imports (-30%, reaching 1.8 Mtoe in 2010).

Domestic energy production will continue to be renewable energy and electricity produced using natural gas, and will increase only slightly. As a consequence, Luxembourg's heavy dependence on imported energy will be

largely maintained but the growth of gas imports and decrease in oil products imports will bring diversification in external supply.

ENERGY POLICY

GOVERNMENT STRUCTURE

In 1999, the Ministry of Energy was transformed into the Energy and Communications Directorate within the Ministry of Economic Affairs. The directorate has six staff in charge of energy policy. The Ministry of Environment is in charge of the policy to curb air pollution and CO₂ emissions. Both ministries are responsible for energy efficiency and renewable energy issues.

In 2000, following the implementation of the law of 24 July 2000 which transposes the European Directive on Electricity in Luxembourg, the government expanded the responsibilities of the Institut Luxembourgeois de Régulation (ILR) – until then covering only telecommunications – to ensure electricity market regulation. Similarly, in 2001 the law of 6 April 2001 transposing the EU Directive on Gas in Luxembourg mandated the same regulatory authority to regulate the gas market. The regulatory authority has two staff involved in electricity and gas market regulation.

The ILR is responsible for monitoring the electricity market since the implementation of the July 2000 law liberalising the electricity market. Its missions cover:

- Control of electricity transmission rates.
- Monitoring of network access conditions.
- Monitoring of market shares and avoidance of abuse of dominant positions.

ENERGY POLICY OBJECTIVES

Energy policy goals in Luxembourg are largely aligned with the objectives of the European Union and also with the main goals of IEA countries. They consist of:

- Facilitating the development of a single energy market in both electricity and gas at the Luxembourg level, connected to the European markets. With the Electricity Law of July 2000 and Gas Law of April 2001, 57% of the electricity market and 74% of the gas market were open for competition at the beginning of 2004.
- Reducing greenhouse gas emissions (GHG) from the energy sector. Luxembourg ratified the Kyoto Protocol in 2001. Under the EU Burden Sharing Agreement, Luxembourg committed itself to reducing its emissions by 28% by the Kyoto first commitment period. The National Plan for a

Sustainable Development, finalised in 1998, remains a reference for policy goals and domestic measures to reduce GHG emissions in Luxembourg (see Chapter 4). It submitted its National Allocation Plan based on the EU Directive on Emissions Trading in April 2004.

- Diversifying energy supply. This was the main motive behind the commissioning of the CCGT plant in 2002.
- Reducing price distortions through the elimination of tax differentials on energy products with neighbouring countries.

ENERGY RESEARCH AND DEVELOPMENT

Owing to the size of the country, Luxembourg does not carry out a fully-fledged public energy R&D programme. Luxembourg imports its technology and the government does not plan to start financing energy R&D.

ENERGY PRICES AND TAXATION

VAT on oil products has been 15% since January 1993, except for light fuel oil and unleaded gasoline (12%). A reduced VAT of 3% applies to automotive fuels used in public transport. VAT on steam coal for households is 12%. Since January 1984, VAT on natural gas and electricity for households has been 6%.

There were no changes in excise tax levels in recent years. Excise taxes on automotive diesel and gasoline increased each year between 1993 and 1996. Gasoline taxes increased again at the beginning of 1999 and in 2000.

Table 1

Increases in Gasoline and Automotive Diesel Excise Taxes, 1992 to 2003

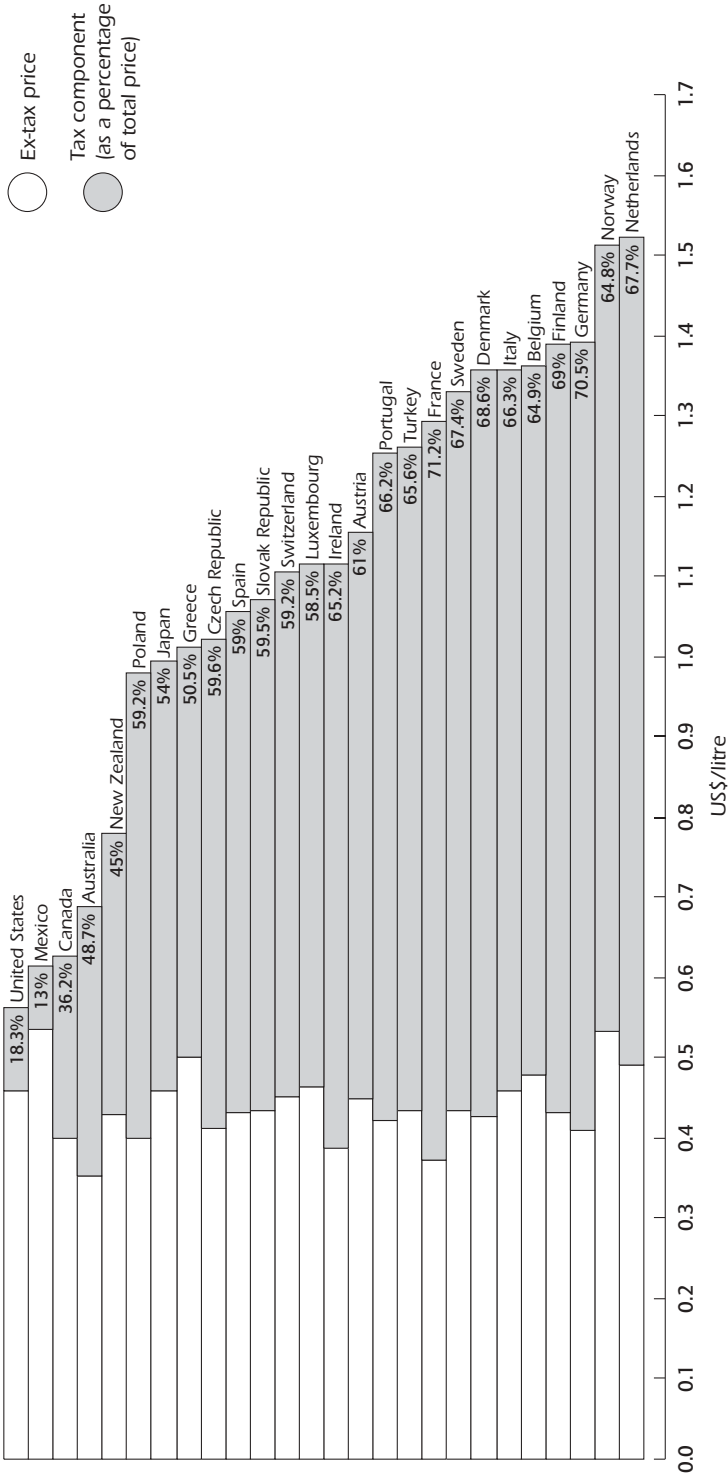
(euro per litre)

	<i>Automotive Diesel</i>	<i>Unleaded Gasoline</i>
1992	0.166	0.252
1993	0.216	0.282
1994	0.243	0.323
1995	0.252	0.347
1996	0.253	0.347
1997	0.253	0.347
1998	0.253	0.347
1999	0.253	0.368
2000	0.253	0.372
2001	0.253	0.372
2002	0.253	0.372
2003	0.253	0.372

Source: *Energy Prices and Taxes*, IEA/OECD Paris, 2004.

Figure 8

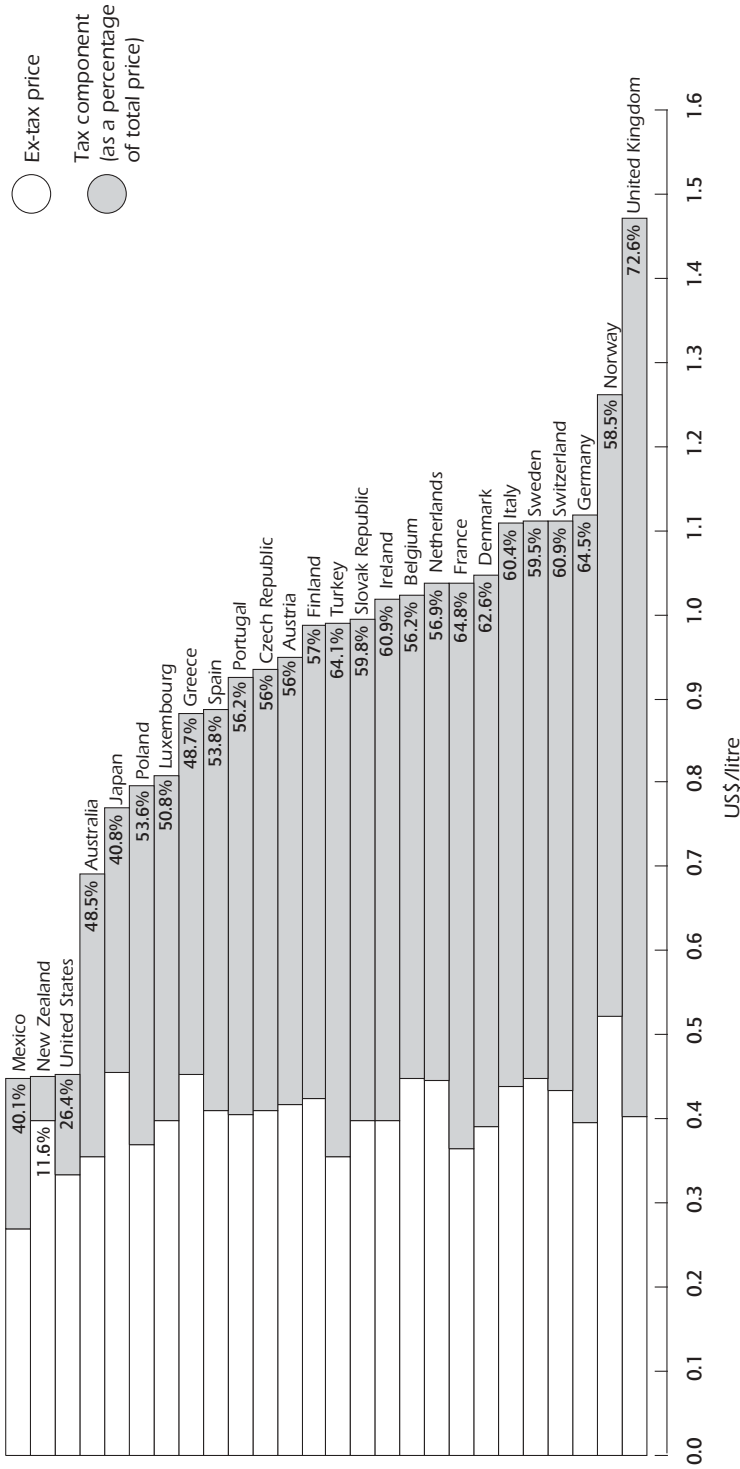
OECD Unleaded Gasoline Prices and Taxes, Second Quarter 2004



Note: data not available for Hungary, Korea and the United Kingdom.
 Source: *Energy Prices and Taxes*, IEA/OECD Paris, 2004.

Figure 9

OECD Automotive Diesel Prices and Taxes, Second Quarter 2004



Note: Data not available for Canada, Hungary and Korea.
 Source: *Energy Prices and Taxes*, IEA/OECD Paris, 2004.

Excise taxes on gasoline and diesel are significantly lower than the IEA Europe average, and in particular compared to Luxembourg's neighbours. This is a strong incentive for drivers from neighbouring countries or driving through areas close to Luxembourg to go there to refuel.

In spite of Luxembourg having increased its tax rates on both diesel and gasoline, the differentials of tax rate for these fuels have been generally increasing between Luxembourg and its neighbours (Belgium, France and Germany; see Table 2).

Table 2
Percentage of Taxes on Liquid Fuels in Luxembourg, Germany, France and Belgium, 2000 and 2003

	<i>Luxembourg</i>		<i>Germany</i>		<i>France</i>		<i>Belgium</i>	
	2000	2003	2000	2003	2000	2003	2000	2003
Unleaded gasoline (95 RON)	55.7	59.2	69.3	74.5	69.8	74.9	65.8	69.9
Automotive diesel for commercial use	42.2	46.9	54.7	62.5	54.5	60.4	44.4	53.0
Automotive diesel for non-commercial use	49.8	54.0	61.0	67.6	62.0	67.1	53.9	57.0

Note: all 2003 data are for third quarter 2003.

Source: *Energy Prices and Taxes*, IEA/OECD Paris, 2004.

The excise tax on light fuel oil for industry and households has been € 5.21 per 1 000 litres until March 2002 and decreased to € 5 thereafter. There are no excise taxes on heavy fuel oil, natural gas and coal. Until the vote of the Electricity Law in 2000, there was a concession fee of 6% on CEGEDEL, the company in charge of supplies to the public grid. The tax revenue was used to finance the social security system. The new Electricity Law replaced this concession fee with a tax applied to electricity consumption (see Chapter 7).

Table 3
Taxes and Prices in Luxembourg and in Other Selected IEA Countries, 2002

(US\$ per toe; % change 1998-2002 in brackets)

	<i>Light Fuel Oil</i>		<i>Natural Gas</i>		<i>Electricity</i>	
	Tax	Price	Tax	Price	Tax	Price
Austria	151.8 (-2)	414.7	114.8 (-10)	421.4	471.3 (+11)	1 511.3
Belgium	69.7 (+21)	316.9	..	..	..	..
France	120.5 (-30)	404.6	70.1 (-15)	472.9	256.4 (-32)	1 215.4
Germany	119.3 (+34)	381.3	..	..	217.4 (-13)	1 576.4
Italy	603.0 (-9)	927.0	..	..	602.8 (+12)	1 808.3
Luxembourg	40.0 (+21)	321.7	17.1 (-2)	303.0	73.4 (-9)	1 298.7

Source: *Energy Prices and Taxes*, IEA/OECD Paris, 2004.

Energy prices for households in Luxembourg are among the lowest in OCDE European countries (see Figure 24 in the chapter on Electricity and Renewable Energy).

INDUSTRY STRUCTURE

The State has a share in Luxembourg's main energy companies (Figure 10): it directly holds 31% of the Société de Transport de Gaz (SOTEG), the gas transport company, 42% of the Compagnie Grand-Ducale de l'Electricité (CEGEDEL), the largest electricity import and distribution company, and 40% of the Société Electrique de l'Our (SEO). When they were created (such as SOTEG in 1974), the State held shares and has gradually released part of them. Four municipalities are directly involved in gas distribution and eight in electricity distribution.

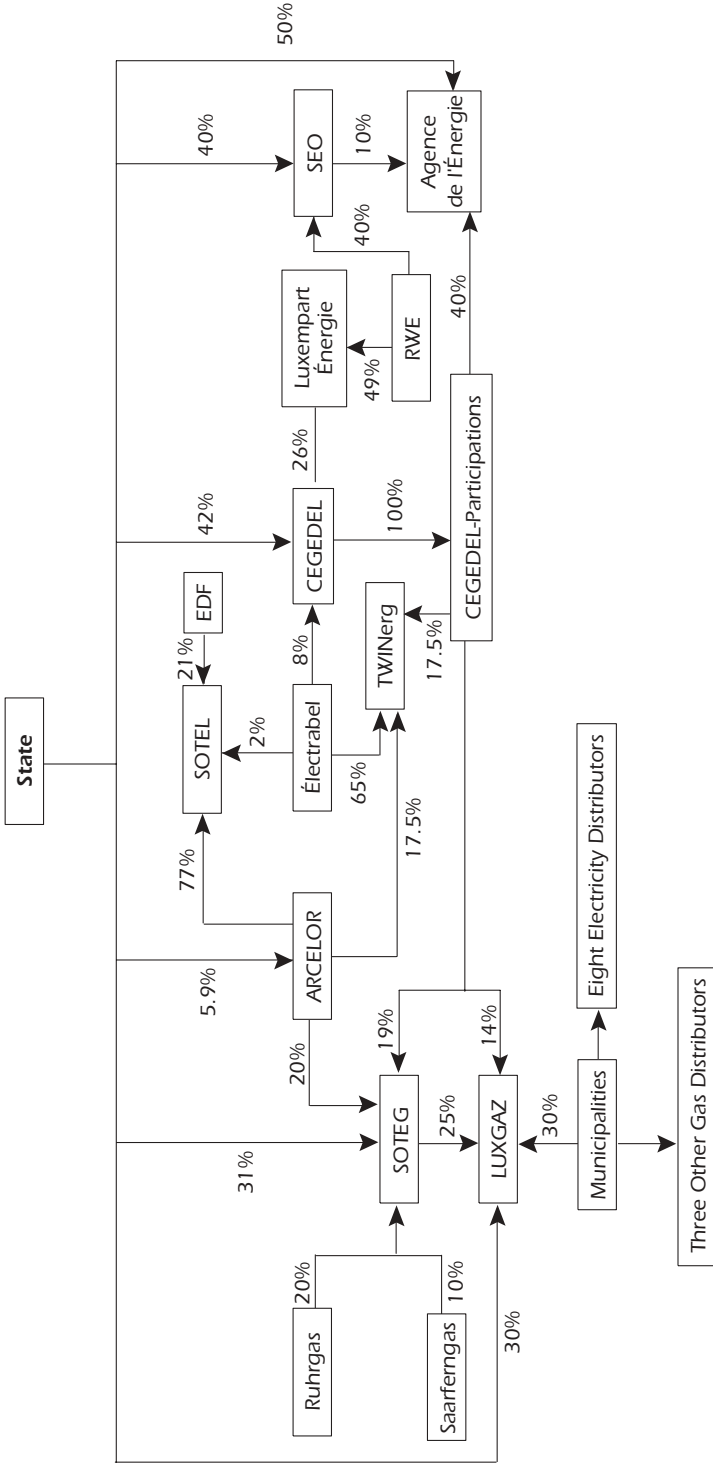
There are also cross-shareholdings between companies. Since the beginning of the 1990s, CEGEDEL became involved in gas, renewable energy and co-generation through CEGEDEL-Participations. In the 1990s, SOTEL (Société de Transport de l'Electricité) and SOTEG's capital were opened to foreign shareholders; 30% of ARBED, the iron and steel industry, used to be owned by the Luxembourg State. Now that ARBED has merged into ARCELOR, the Luxembourg State still retains a 5.9% participation in the new group, which is a shareholder of SOTEG (20%) and also owns 77% of SOTEL, the electricity company which imports and supplies electricity to its steel mills and to the national railway company.

CRITIQUE

There have been commendable developments in energy policies in Luxembourg since the last in-depth review. With the coming into force of the Electricity Law of July 2000 and Gas Law of April 2001, more than half of the electricity and gas markets were opened for competition by April 2004. The independent regulator in charge of the electricity and gas markets has been established. A new CCGT power plant came into operation in May 2002, providing a solution to the needs of large consumers for a stable electricity supply and predictable prices, reducing Luxembourg's import dependence on a single supplier of electricity and diversifying its natural gas supply sources. Beyond this specific industrial arrangement, this has improved Luxembourg's security of energy supply.

Luxembourg ratified the Kyoto Protocol in 2001 and submitted to the European Commission its National Allocation Plan based on the EU Directive on Emissions Trading in April 2004. Despite the large share of imports in its oil, gas and electricity supply, it currently faces no significant energy supply security problem. Consumers have also enjoyed lower energy prices compared with neighbouring countries because of lower taxation rates (oil, gas and electricity) and the highly concentrated nature of consumption which enabled Luxembourg to negotiate good supply terms, notably in gas.

Figure 10
Major State Shareholding in the Energy Sector, 2004



Source: Companies' Annual Reports.

In the next few years, a major policy issue for Luxembourg is how to achieve its Kyoto target of reducing GHG emissions (see Chapter 4). Energy taxes on automotive fuels in Luxembourg are among the lowest of all IEA countries, which is leading to large oil products sales in the country. While this is contributing to substantial public revenue, it is making the achievement of the Kyoto target extremely challenging. Luxembourg is planning to raise the excise duties on automotive fuels, in the framework of the EU directives on minimum levels of energy taxation³. This may not make the tax differential with neighbouring countries disappear, given in particular the differing public budget needs in these countries. The government believes that a far more cost-effective and environment-effective option for achieving the Kyoto target is to purchase emission credits from abroad, rather than curbing or diverting to neighbouring countries energy demand in transport sectors through tax increases. Nevertheless, even taking these factors into account, the current level of taxation does not appropriately incorporate environmental externalities. Although the tax differential between Luxembourg and its neighbours does not depend only on Luxembourg – this issue needs to be addressed in the wider context of further tax harmonisation efforts at the EU level – efforts from Luxembourg are imperative.

Noting that the industrial sector has relatively limited potential for further GHG emissions reduction, and bearing in mind economic efficiency, Luxembourg needs to exploit the reduction potentials in the building and transport sectors to the maximum extent possible. Certain aspects of energy policies, notably renewables, have been transferred to the Ministry of Environment. This will require closer co-operation with relevant ministries in charge of taxation, housing, transport and environment.

The new energy regulator has responsibilities, namely, giving advice to the government on grid tariffs, supervising the compensation fund for renewables and co-generation promotion and fostering competition. As state ownership in energy companies remains significant in Luxembourg, the shifting of more responsibilities to the regulator, including the approval of grid access tariffs, seems necessary. This could be part of the measures implemented within the framework of the transposition of the 2003 EU Directives on Electricity and Gas⁴.

Despite growing challenges and complexities arising from market liberalisation and climate change mitigation, Luxembourg has only six permanent staff in the Energy Directorate and two permanent staff for energy regulation at the *Institut*

-
3. EU Directive 2003/96/CE allows Luxembourg to implement a transition period until 1 January 2009 to increase its national level of taxation on diesel for vehicles to a minimum level of €302/1 000 litres and until 1 January 2012 to increase it to €330/1 000 litres. Until 31 December 2009, diesel used for commercial purposes can avail of a reduced rate of €272/1 000 litres (minimum). The EU accepted minimum will increase to €302/1 000 litres from 1 January 2010 until 1 January 2012. Current level of taxation on gasoline in Luxembourg is already above the minimum EU level.
 4. Directives 2003/55/EC and 2003/54/EC of the European Parliament and of the Council Concerning Common Rules for the Internal Market in Natural Gas and Electricity.

Luxembourgeois de Régulation. Even taking into account the small size of the country, this could hamper the capacity of Luxembourg to address the above challenges.

Luxembourg does not carry out strong domestic R&D efforts for reasons linked to the limited critical mass it is able to mobilise for such investments. However, Luxembourg is benefiting from technological improvements and is willing to take its relative share in the development of specific energy technologies (see Chapter 4 and the reference to Luxembourg participation in the development of fuel-cell buses for example). In this respect, possible participation in IEA Implementing Agreements may be worth investigating.

RECOMMENDATIONS

The government of Luxembourg should:

- ▶ *Recognise the increasing importance of larger markets and international policy developments, allocate sufficient resources – particularly staffing – to participation in the relevant processes and to carrying out the necessary strategic planning.*
- ▶ *Review energy tax policies to better internalise environmental externalities within the wider efforts for tax harmonisation at the EU level.*
- ▶ *Enhance close co-operation and co-ordination among all the ministries involved in energy policy.*
- ▶ *Expand the responsibilities of the energy regulator to include approval of grid access tariffs.*
- ▶ *Consider participating in IEA Implementing Agreements.*

ENERGY EFFICIENCY AND ENVIRONMENT POLICY

ENERGY EFFICIENCY

ENERGY INTENSITY

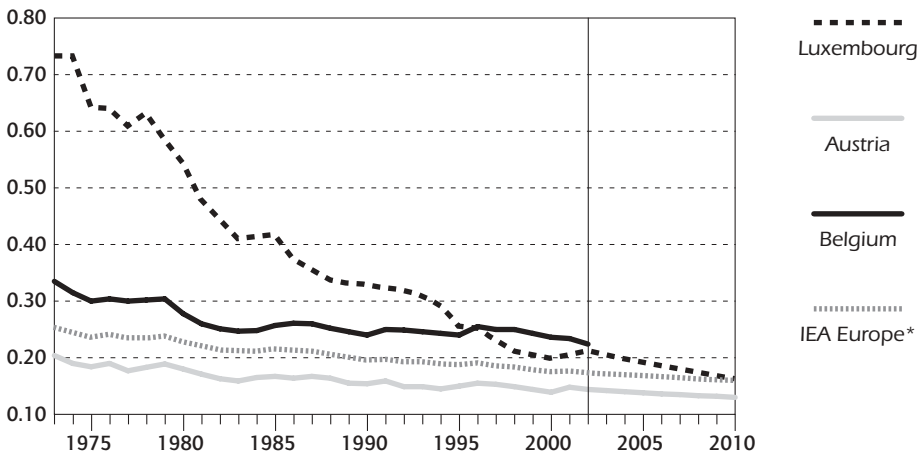
Measured as TPES per unit of GDP, energy intensity of Luxembourg has for a long time been among the highest in the IEA, reflecting the importance of the few large energy-intensive industrial consumers (iron and steel, and others), the hypertrophic gasoline and diesel consumption mentioned above and higher energy consumption by households than in the rest of IEA Europe because of the higher per capita income and lower energy prices.

However, energy intensity has decreased rapidly over the past two decades mostly because of the sharp reduction of energy use by its industry following restructuring. This has dropped from 0.53 toe/US\$⁵ in 1973 and 0.24 in 1990 to 0.16 in 2003, which is comparable with the IEA Europe average and lower

Figure 11

Energy Intensity in Luxembourg and in Other Selected IEA Countries, 1973 to 2010

(toe per thousand US\$ at 1995 prices and purchasing power parities)



* excluding Norway from 2002 to 2010.

Sources: *Energy Balances of OECD Countries*, IEA/OECD Paris, 2004; *National Accounts of OECD Countries*, OECD Paris, 2004; and country submissions.

5. Per thousand US dollars at 1995 prices and exchange rates.

than the IEA average. In the 1990s, the reduction of energy intensity was more rapid from 1991 to 1996 (-4.8%) compared to the -1.6% achieved from 1997-2002.

Nevertheless, TPES per capita is still the highest in the IEA. In 2003 it was 9.4 toe per person, 166% higher than IEA Europe and 85% higher than IEA total.

ENERGY EFFICIENCY POLICY

The Energy Efficiency Law of 5 August 1993 established a legal framework to adopt a wide range of regulations focused mainly on energy efficiency measures and also on the promotion of renewable energy. The 1993 law has five targets (see box) and by 2004, several Grand Ducal regulations described below issued since 1993 to implement the law were still applied.

Targets of the Energy Efficiency Law of 5 August 1993

- To guarantee a sufficient, secure and economic energy supply.
- To promote energy savings and the rational use of energy.
- To favour the use of renewable energy sources, co-generation and the production of primary and secondary energy.
- To alleviate the negative impact of the production and consumption of energy on the environment.
- To co-ordinate all these activities in the framework of the European Union.

The 1998 National Plan for a Sustainable Development has set an objective of 20% reduction in energy intensity⁶ between 1993 and 2010. Measures envisaged in the plan are shown in the following box.

The 1998 National Plan for a Sustainable Development: Main Energy Efficiency Measures by Sector

General

- To introduce an EU-compatible energy tax.
- To favour the use of the best available technology.
- To increase information and dissemination efforts.
- To favour investments for energy savings. The creation of a fund to promote renewable energy and energy efficiency is under discussion.

6. Defined as TPES per unit of GDP.

Buildings

- To improve the energy efficiency of new and existing buildings.
- To reach a 30% reduction between 1990 and 2020 in energy consumption for heating a constant surface in buildings.

Industries

- To improve voluntary agreements.

Transport

- To set annual taxes on vehicles according to their fuel consumption and emissions in order to encourage the purchase of less polluting vehicles.
- To increase by 30% the share of public transport use for medium distances between 1997 and 2010.
- To reduce the use of transport and to reduce travel distances.
- To reduce the use of the most polluting transport means.
- To link Luxembourg's rail network to the high-speed rail network and to improve international railways connections.

The *Agence de l'Energie* acts as a consultant for the government and for individuals on energy efficiency issues and renewables, and supports municipalities on these topics.

The Agence de l'Energie

The *Agence de l'Energie S.A.* was established in June 1991 as a company under private law whose shareholders are the government (50%), the electricity company CEGEDEL (40%) and the electricity company SEO (10%). The *Agence de l'Energie* is promoting energy efficiency and renewable energy sources in Luxembourg.

The *Agence de l'Energie* acts as a consultant for the government and undertakes studies on energy efficiency and renewable energy sources on behalf of the government (on topics such as wood energy, feed-in tariffs for wind energy and co-generation, wind map, etc.). It informs and advises individuals in the framework of the implementation of the two Grand Ducal regulations on energy efficiency and renewable energy (energy-efficient buildings, solar energy, wood-fuelled heaters, etc.). It supports municipalities (*e.g.* energy concept for a region of 13 municipalities) and wind farm projects.

The *Agence de l'Energie* manages the building of a demonstration park in Remerschen, including an energy-efficient building, a 600-kW windmill and a 10-kW photovoltaic plant. The project is financed by the Ministry of Economic Affairs, CEGEDEL, RWE and SEO.

BUILDINGS

The Grand Ducal regulation of November 1995 sets mandatory insulation standards for new buildings. It came into force on 1 January 1996. Certified architects or engineers attest that the insulation standards have been taken into consideration when designing the building. In case of non-compliance during the construction phase, penalties are imposed which can mean cancellation of work.

The Grand Ducal regulation of August 1996 organises energy audits in residential and commercial buildings carried out by engineers, advisers or specialised bodies agreed by the Energy and Communications Directorate. The audit is made at the request of the owner. The Grand Ducal regulation of 13 January 2002 reduced the rate of subsidy to the audit cost to 40% to comply with the EU requirement on state aid for environmental protection. The 2002 regulation multiplied by a factor of eight the maximum amount refunded to €30 000 when the building owner has finalised the work proposed by the expert in charge of the audit. The Energy and Communications Directorate has developed these energy audits on the basis of voluntary agreements concluded with the various professional sectors concerned: industry (FEDIL), banks (ABBL), insurance (Groupement des Assurances), hospitals (Entente des hôpitaux), trade (Confédération du Commerce) and hotels (HORESCA).

In residential buildings, the possibility to improve energy efficiency is considered high as, in 2000, more than 65% of flats were owned and not rented and owners directly benefit from lower energy bills. Luxembourg has been discussing for several years the possibility of introducing an obligation for residential owners to audit the environmental quality and energy efficiency of their houses and to register the results of this audit and possible improvements in a document identifying the house: the *carnet de l'habitat*. The *carnet de l'habitat* is envisaged to provide a kind of radiogram of the building made by an expert who analyses stability, hygiene, comfort, ecology and energy efficiency. This audit will propose concrete measures to correct possible defaults. The *carnet de l'habitat* promotes three goals: refurbishment of old buildings (beyond 15 years of age), job creation in the building sector and rational energy use to decrease GHG emissions.

In November 2002, the government adopted a proposal by the Grand Ducal regulation, determining the conditions for the calculation of subsidies to cover the costs of energy audits by home owners to establish the energy performance under the *carnet de l'habitat*. Subsidies could cover up to 75% of the costs of the audit, with a ceiling of €1 900. In future, establishing an energy rating under the *carnet de l'habitat* is considered as a condition of eligibility for financial support for energy improvements to the property. In

2003, however, the implementation of the *carnet de l'habitat* was stalled by the state council who found that the scheme should apply to all buildings, not just the residential ones. The complexity of the system is another reason for the delay in its implementation.

By 2006, Luxembourg will implement the EU Directive 2002/91/EC on "Energy Performance of Buildings".

APPLIANCES

A Grand Ducal regulation was passed in June 1996 to implement the EU directive on energy efficiency labelling for washing machines, tumble-dryers, refrigerators, freezers and their combination, and dishwashers. The Grand Ducal regulation of August 1996 implements the EU directive which sets minimum efficiency requirements for hot water boilers and the Grand Ducal regulation of August 1998 implements the EU directive on energy efficiency standards for refrigerators and freezers.

INDUSTRY AND COMMERCE

The Law of 27 July 1993 introduced specific rules for subsidies at a maximum rate of 25% for investments by companies aimed at environmental protection and the rational use of energy. The Law of December 1996, modified and completed by the law of 4 December 1997, introduced special depreciation allowances for company investments in new technologies for improving energy efficiency, the use of renewable sources of energy and the recovery of waste energy in industrial processes.

The voluntary agreement signed in March 1996 by the former Minister of Energy and the FEDIL (Fédération des Industriels Luxembourgeois) included a target for an average 10% improvement in energy efficiency of 35 of its members between 1990 and 2000.

No individual targets were set. Companies have been free to choose the best means to improve their efficiency. The FEDIL has monitored the progress of each enterprise and has made an annual synthetic report to the Ministry of Economic Affairs. In 2000, FEDIL assessed the efficiency gains made in the period 1990-2000 at 15% less energy per unit of output. In 2001, discussions started between FEDIL and the government to prepare a new voluntary agreement. This agreement was signed in April 2002 and covers the period 2000-2006. The agreement covers 54 companies representing 90% of energy consumption of the manufacturing sector. The agreement has the indicative target to reduce the participants' energy intensities by 1% per year on average. Both FEDIL and the Energy and Communications Directorate assess that final energy per unit of output could drop by 20% over the period 1990-2010.

Two other voluntary agreements were signed with the hospitals ("Entente des hôpitaux") and with the financial sector for an average 20% energy efficiency improvement – measured as above – of its members in both sectors between 1991 and 2001.

The Law of 22 February 2004 initiates a regime of subsidies to investments in the rational use of energy by companies. The Energy and Communications Directorate can provide up to 40% of the cost of an energy-reducing investment. Small and medium-sized enterprises can avail of a subsidy of up to 50% of the project costs. Eligible projects include all investments enabling final energy consumption reduction, provided the reduction goes beyond that achieved by complying with specific EU standards. In case investments are not concerned by EU standards, they are eligible if it can be proved that they would not have been carried out without the support regime.

TRANSPORT

In the National Plan for a Sustainable Development (1998), the government aims to modify the modal split to increase the share of public transport to 25% by 2020, against 12.3% in 2000 (and 11.1% in 1997).

The Ministry of Transport supports public transport by low fares (which cover less than 15% of the costs), higher frequency of buses and trains and the creation of car parks outside town centres connected with city buses. Because of the importance of freight transiting by road across Luxembourg, the government made the commitment to develop combined rail/road transportation to reduce road traffic and increase transit of freight by rail. Particular focus is given to the access and management of the rail terminal at Bettembourg to improve long-distance transport of goods from Europe to the Belgian and Dutch harbours. The government is implementing a new scheme to promote and modernise passenger rail transport that includes linking Luxembourg to the French high-speed train (TGV) network through the construction of the TGV East line.

Initiatives in the transport field include trials in real urban situations of hybrid vehicles, natural gas-fuelled vehicles and of hydrogen buses and their fuel supply systems by the bus company of the Luxembourg city (AVL – Autobus de la Ville de Luxembourg), the latter in the framework of the EU Clean Urban Transport in Europe (CUTE) project.

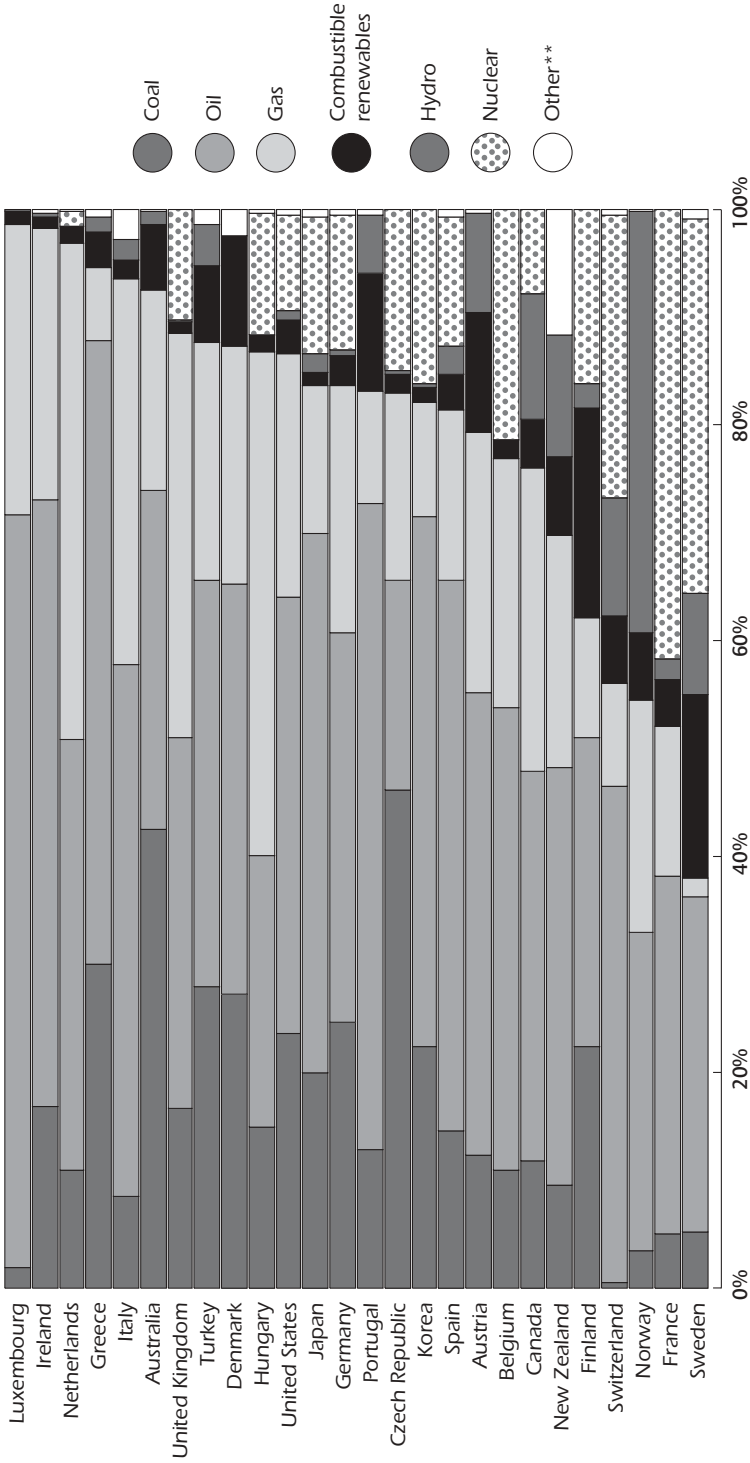
ENVIRONMENT POLICY

GREENHOUSE GAS EMISSIONS

Total GHG emissions decreased from 14 Mt CO₂-equivalent in 1990 to 11 Mt in 2002, down by 21%. This was largely attributable to the restructuring of the iron and steel industry.

Figure 12

Total Primary Energy Supply in IEA Countries, 2003*



* preliminary data.

** includes geothermal, solar, wind and ambient heat production.

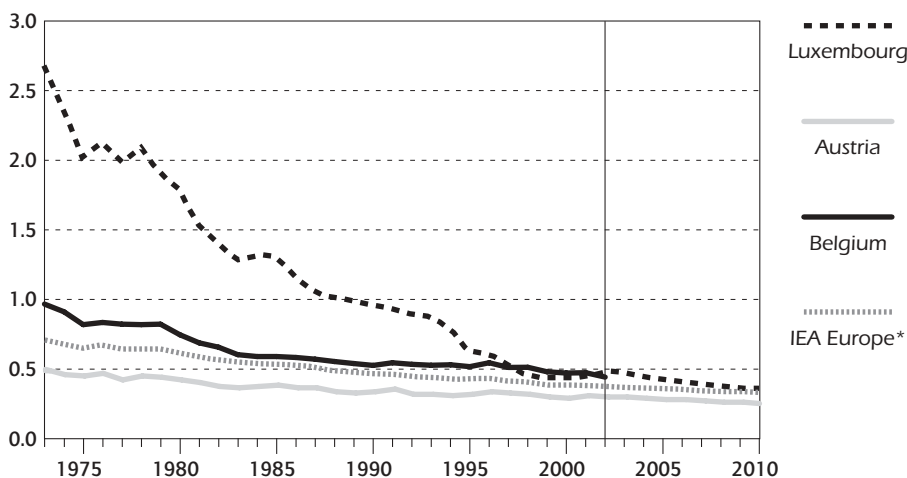
Source: *Energy Balances of OECD Countries*, IEA/OECD Paris, 2004.

Owing to the high carbon content of energy use, Luxembourg has the second-highest level of energy-related emissions per capita (19.0 tonnes in 2001) among IEA countries (average 12 tonnes) after the United States (19.8 tonnes). However, with the restructuring of GDP in the 1990s, CO₂ emissions per GDP have dropped significantly (from 0.93 kg CO₂ per GDP unit in 1995 US\$ PPP in 1990 to 0.44 in 2001, versus an IEA average that decreased from 0.57 to 0.50 kg CO₂ per unit of GDP over the same period).

Figure 13

Energy-related CO₂ Emissions per GDP in Luxembourg and in Other Selected IEA Countries, 1973 to 2010

(CO₂ emissions/GDP using 1995 prices and purchasing power parities)



* excluding Norway from 2002 to 2010.

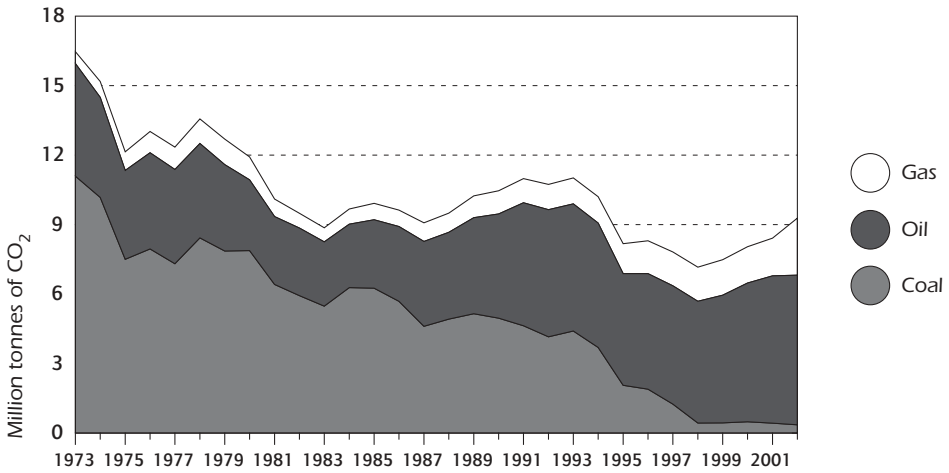
Sources: *Energy Balances of OECD Countries*, IEA/OECD Paris, 2004; *National Accounts of OECD Countries*, OECD Paris, 2004; and country submissions.

Sector-wise the structure of energy-related CO₂ emissions has radically changed in 1990-2002. Decline and restructuring of the steel industry materialised by a technological shift that almost eliminated emissions from coal. However, emissions from transport (in particular road) have surged. This is largely due to the development of the refuelling business in Luxembourg to tap the demand of foreign drivers looking for cheaper gasoline and diesel. Emissions from public electricity production have shot up with the start of the TWINerg plant, although at the European level, this production substituted:

- Electricity imports that could have been produced outside Luxembourg, emitting more CO₂, since the generator used would probably be older and less efficient than the TWINerg plant.
- Electricity produced within the industrial (iron and steel) sectors, which are also highly polluting.

Figure 14

CO₂ Emissions by Fuel*, 1973 to 2002

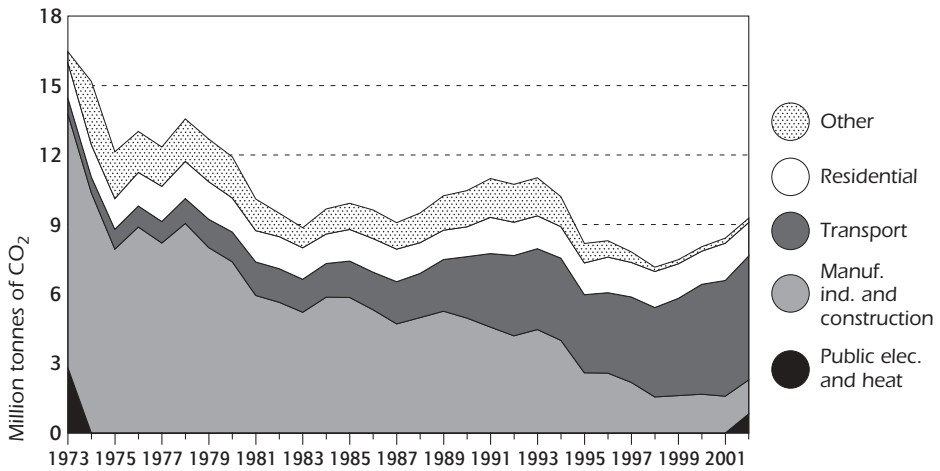


* estimated using the IPCC Sectoral Approach.

Source: *CO₂ Emissions from Fuel Combustion*, IEA/OECD Paris, 2004.

Figure 15

CO₂ Emissions by Sector*, 1973 to 2002



* estimated using the IPCC Sectoral Approach.

Source: *CO₂ Emissions from Fuel Combustion*, IEA/OECD Paris, 2004.

IEA's past estimates of future energy-related CO₂ emissions were based on the Luxembourg government's projections and showed a possible decrease by 22.8% between 1990 and 2010. However, there is some amount of uncertainty

Table 4

Trends in Energy-related CO₂ Emissions*, 1975 to 2002(million tonnes of CO₂)

	1975	1990	2002	% Change 1990-2002
Fuels				
Coal	7.50	4.96	0.36	-92.7
Oil	3.84	4.50	6.46	43.6
Gas	0.80	1.00	2.46	145.2
Sectors				
Manufacturing industries and construction	7.94	4.96	1.46	-70.6
Transport	0.86	2.65	5.35	102.0
<i>of wich : road</i>	<i>0.81</i>	<i>2.64</i>	<i>5.32</i>	<i>101.3</i>
Residential/commercial	1.36	1.31	1.48	13.4
Unallocated autoproducers of elec, CHP, heat	1.99	1.54	0.15	-90.4
Other**	0.95	0.0	0.0	..
Total	13.09	10.46	8.45	-19.2

* estimated using the IPCC Sectoral Approach.

** includes own use and losses, and transformation.

Source: CO₂ Emissions from Fuel Combustion, IEA/OECD Paris, 2004.

Table 5

Total Emissions of CO₂ and Other GHG, Projection for the Year 2012(Mt CO₂-equivalent)

Source	1990	1998	2001	2012
Industry + energy sectors	9.1	2.1	3.4	5.0
Households & residential	1.1	1.6	1.4	1.7
Road traffic	2.9	4.0	5.4	6.8
Other sources for CO ₂	0.2	0.0	0.0	0.6
Other GHGs	0.7	0.8	0.8	0.9
TOTAL	14.0	8.5	10.0	14.9
% of 1990	100	62	71	106

Source: Luxembourg National Allocation Plan, 6 April 2004.

over the projected emissions from the transport sector, as energy demand largely depends on reforms of road fuel taxes yet to be implemented. The government recently revised emissions projections from road transport,

suggesting that emissions will rise considerably compared to earlier projections. As a result, total GHG emissions could grow to 15 Mt CO₂-equivalent by 2012, compared to the target level of 10 Mt CO₂ fixed in the Burden-Sharing Agreement of the EU signed in 1998 to implement the Kyoto Protocol and reduce emissions by 28% between 1990 and 2008-2012 (see Table 5). This growth of emissions could exceed the 1990 level by 6% in 2012 and constitutes a real challenge for Luxembourg.

POLICY TO REDUCE GHG EMISSIONS

Luxembourg ratified the UN Framework Convention on Climate Change (UNFCCC) by a Law of 4 March 1994 that took effect on 7 August 1994. Luxembourg's national communication to the first Conference of the Parties to the UNFCCC was issued in March 1995. No new national communication has since been issued.

In November 1990, the government decided to stabilise CO₂ emissions at 1990 levels by the year 2000 and to achieve a 20% reduction of these emissions by 2005. According to the Kyoto Protocol, the EU as a whole agreed to reduce GHG emissions by 8% from 1990 levels by the period 2008-2012. As mentioned earlier, under the Burden-Sharing Agreement, Luxembourg is committed to reducing its emissions by 28%, the highest percentage reduction in the EU.

The Burden-Sharing Agreement became legally binding in 2001. The EU also ratified the Kyoto Protocol in 2001, although Luxembourg claimed that the Burden-Sharing Agreement should be based on the later 1998 projections. Moreover, Luxembourg puts forward the following constraints in achieving its emissions reduction target:

- Strong relative demographic growth, due mainly to immigration. Luxembourg recorded a 15.8% increase of immigrants in 1990-2001 against 8.4% on average for the IEA during the same period.
- Strong role in emissions growth of road fuel consumption since IPCC accounting methodology required the country to account for emissions of the fuels sold on its own land. Even though emissions did not occur in Luxembourg, they could have occurred elsewhere in any case.
- Strong role of one given source of emissions owing to small size of the country. This was the case for emissions from iron and steel industry in the past, and those from CCGT plant today. This makes the change on a percentage basis enormous.
- Accounted emissions based on national emissions that overlook efforts to substitute emission-intensive energy imports with cleaner domestic

production. At the time Luxembourg decided to build a CCGT power plant, it assumed that this would contribute to GHG emissions reduction replacing imported electricity mainly generated from coal.

- High energy efficiency of already existing industrial energy-consuming equipments.

These constraints either tend to push emissions upward or severely reduce the potential for domestic reductions. The only sector where significant potential exists for reducing Luxembourg's emissions is transport. Changing the taxation levels and reducing the differential with neighbouring countries could reduce energy demand for transport and associated emissions. It is not surprising in this context that one essential component of Luxembourg's emissions reduction policy will be to purchase emissions reduction credits from abroad.

Luxembourg released its National Allocation Plan in April 2004, implementing Directive 2003/87/EC of 18 October 2003 "Establishing a scheme for greenhouse gas emission allowance trading". As of July 2004, the European Commission was yet to finalise its assessment of Luxembourg's proposal. The Allocation Plan aims at a 7% emissions reduction by 2008-2012 compared to the 1990 level (see Table 6).

Table **6**
Proposed National Allocation Plan

	1990	2005-07	2008-12		
		<i>Sectoral target</i>	<i>Estimate CO₂ emissions</i>	<i>Sectoral target</i>	<i>Change in CO₂ emissions 1990-2008/12</i>
Emissions from sectors covered by the emissions trading directive	8 500	3 515	4 450	4 265	-50%
Total industry + energy	9 100	3 945	4 950	4 700	-52%
Residential + small emitters	1 100	1 400	1 700	1 400	+27%
Road transport	2 900	5 650	6 800	5 640	+94%
Other	200	10	600	400	+100%
Total emissions	13 300	11 005	14 050	12 140	-9%
Other GHG emissions	709	810	868	900	
CO ₂ equivalent	14 009	11 815	14 918	13 040	-7%

Source: Luxembourg Ministry of Environment.

OTHER EMISSIONS

The Oslo Protocol set the target of a 58% reduction in SO₂ emissions between 1980 and 2000. Because of the restructuring of the iron and steel industry and the introduction of electric arc furnaces, this target was reached before 2000. The Sofia Protocol set the target to stabilise NO_x emissions between 1987 and 1994. Total NO_x emissions in Luxembourg have decreased since 1996 but emissions from transport have increased rapidly. The Geneva Convention set the target to reduce volatile organic compounds (VOC) emissions by 30% between 1990 and 2000. According to the Ministry of Environment's estimates, the target was reached in 1998. Luxembourg faces urban ozone problems in summer. The maximum allowed level of 360 microgrammes per cubic metre has never been reached. However, the level of 180 microgrammes per cubic metre (above which the population has to be informed) has been exceeded regularly (see Table 7).

Table 7
Observed Pollution Levels
(µg/m³)

	<i>EU Maximum</i>	<i>1990</i>	<i>2001</i>	<i>2002</i>
			<i>Highest observed value</i>	
Pollution by:				
Sulphur dioxide (SO ₂)	350 ¹	385	79	63
Nitrogen dioxide (NO ₂)	40 ²	62	50	51
Nitrogen oxide (NO _x = NO+NO ₂ , in rural areas)	30 ^{2,3}	30	20	23
Ozone (O ₃)	180 ^{1,4} /360 ^{1,5}	234	200	212
Carbon monoxide (CO)	10000 ⁶	8900	500	3400
Lead (Pb)	0.52	0.22	0.03	0.03
		<i>1997</i>	<i>2001</i>	<i>2002</i>
Fine particles (PM ₁₀ , <10 µm)	40 ²	36	21	20
Benzene (C ₆ H ₆)	5 ²	8.4	2.6	2.4

1. Average on one hour.
 2. Annual average.
 3. Protection of ecosystems.
 4. Alert level to inform population.
 5. Alert level.
 6. Average on 8 hours.
- Source: STATEC, Luxembourg.

MEASURES ENVISAGED IN THE NATIONAL PLAN FOR A SUSTAINABLE DEVELOPMENT

The 1998 National Plan for a Sustainable Development sets CO₂ emission targets at sectoral levels. This plan has been discussed by the government and is currently under revision. In addition to the measures related to energy

efficiency, and in particular to the introduction of an energy tax, the other main measures which are envisaged in the plan are:

- To implement no regret policies that are cost-effective and to rely on flexible mechanisms.
- To promote environment-friendly technologies and productions.

The 1998 National Plan also set the new target of reducing SO₂, NO_x and VOC emissions by 70% between 1990 and 2010.

CRITIQUE

ENERGY EFFICIENCY

Energy demand per capita in Luxembourg remains among the highest in the IEA for country-specific reasons. The improvement observed in the energy intensity of GDP is probably much more linked to changes in the structure of Luxembourg GDP than to actual efficiency gains. While the government has been implementing regulatory measures and introducing voluntary agreements, more emphasis should be placed on energy efficiency to achieve economic efficiency, environmental protection and energy security. In particular, it should be an important component of the national climate change strategy, now under preparation. The government needs to intensify its efforts to assess the cost-benefit of the measures to improve energy efficiency and to monitor the effects of policy measures to improve their functioning.

In the context of assessing the cost-effectiveness of energy efficiency measures, a comparison with cost-benefits of renewable energy promotion policies would also be required at a time when certain renewable energies benefit from strong support with environmental impacts that could be quite limited. A result of such appraisal could possibly show that the resources devoted to the current generous subsidies to solar photovoltaic may be better utilised to support energy efficiency programmes in the building sector.

Energy intensity in the industry sector improved substantially in the 1990s, mainly thanks to the restructuring of the iron and steel industry. Improvement has been stagnant in the last three years, owing to economic slow-down. Fifty-five companies in the industrial sector have made a voluntary agreement with the government to reduce their energy intensities by 1% per year on average. They can receive certain subsidies for conducting energy audits and implementing advice from energy auditors. The nature of the 1% target is indicative and they will not be sanctioned if they cannot achieve it. While the potential for further energy efficiency improvement has been largely exploited in the steel industry – a substantial share in the industrial sector – the role of this sector is still essential, considering its share in total energy demand. Since

the implementation of voluntary agreements is supported by public funds, the participants should give clear information in advance on how they propose to meet their commitments. Their performance should be closely monitored.

More generally, Luxembourg appears to have implemented a series of energy-saving measures in the past decade. The results in the industrial sector are reasonably clear: they have lowered energy intensity, though partly by structural change. The results are unknown in the other sectors and perhaps even parts of industry. The government would benefit from realising an evaluation of the results achieved with the efficiency plans, especially the voluntary programmes.

Under the Law of 22 February 2004 implementing a support to industrial energy efficiency investments, projects which are not concerned by EU standards can be eligible so long as it can be demonstrated that they would not have been carried out in the absence of the support scheme. It is not an easy task to draw a clear line and care should be taken that this scheme does not result in creating "free riders".

It is essential to address energy efficiency improvement in the building and transport sectors where energy demand has been continuously increasing and the European emissions trading scheme does not currently apply. Voluntary agreements concluded in 1996 with the financial and medical care sectors failed for lack of interest of the parties involved and lack of resources and staff on the government side to facilitate and monitor its implementation. The government should learn lessons from this experience and either commit more resources and staff to follow up or explore other measures than voluntary agreements.

In the building sector, under the National Plan for a Sustainable Development, energy for heating per constant building area should be reduced by 30% from 1990 to 2010. Several subsidies are provided to achieve this. While the relevant ministries (housing, environment and economy) have negotiated and agreed on the energy auditing system for existing buildings, "carnet de l'habitat", it has not been put into effect until now, partly because of its complexity and the need for work on methodologies. Its rapid implementation should be explored, if necessary, in a simplified manner. In addition, the possibility of regulatory measures, namely, enhanced standards for new buildings and refurbishment for existing buildings, should also be explored. Monitoring of implementation of these standards is also essential. While this is the responsibility of municipalities, the government should have an active role in seeing that these standards are implemented.

A rapid increase of energy demand in the transport sector is largely attributable to attractive prices and the many non-resident consumers. At the same time, growing registrations of new motor vehicles is contributing to this trend. Currently, the level of vehicle taxation is very low and does not reflect energy efficiency performance. Together with promoting public transport, economic and regulatory measures to curb the increase in passenger transport should be explored.

ENVIRONMENT

Total GHG emissions have decreased from 14 Mt CO₂-equivalent in 1990 to 11 Mt in 2002, down by 21% from the 1990 level. However, this is entirely attributed to the decrease of 70% in the industrial sector, due to the restructuring of the iron and steel industry of which GHG reduction potential has already been exhausted. On the other hand, the emissions from transport have grown by 102% in the same period and will continue to grow. Therefore, GHG emissions are expected to grow to 15 Mt CO₂-equivalent by 2010. Compared to the target level of 10 Mt CO₂, this is a significant gap that Luxembourg will have to fill to achieve its commitment to reduce its GHG emissions by 28% below the 1990 level by 2008-2012 under the Kyoto Protocol.

This is very challenging for Luxembourg. Its population is growing mainly as a result of immigration. A large number of foreign drivers are refuelling in Luxembourg due to the tax differentials and Luxembourg's location at the crossroad of Europe. Owing to Luxembourg's small size, even minor changes in emission levels could result in significant movements, in terms of percentage, year on year. Restructuring of the industrial sector cannot be repeated. The sector where the most significant potential exists for reducing Luxembourg's emissions is transport, while reductions can also be achieved in the domestic sector by more stringent building regulations, and increased take-up of traditional energy efficiency measures, *e.g.* in the appliance and lighting areas. Changing the taxation levels and reducing the differential with neighbouring countries could reduce energy demand for transport and associated emissions.

Therefore, it is not surprising that the National Allocation Plan anticipates that the bulk of reductions have to be achieved by resorting to the purchase of credits from abroad through utilisation of the flexible mechanisms under the Kyoto Protocol. Although this is explainable given Luxembourg-specific circumstances and the legitimacy to seek least-cost options to reducing emissions, the government should assess how concretely such a policy might be implemented rapidly given the limited time remaining.

The government estimates that the marginal cost of domestic climate change reductions is among the highest in the EU, given the specific national circumstances (high rate of natural gas penetration, best available technology used in power generation, high energy efficiency of equipment in industry, new vehicle fleet, etc.). Luxembourg could nevertheless continue to explore more possibilities to reduce GHG emissions domestically. It should be noted that energy efficiency could contribute not only to GHG emissions reductions, but also to energy security, which purchase of credits from abroad will not achieve.

Among the areas identified by the government as potential sources of emissions reduction are energy efficiency in buildings, information dissemination for households, promotion of renewable energy sources and co-generation

(although in substituting for imports, the latter leads to net growth of domestic energy and emissions production). As regards transport, the government recognises that additional income from tax increases is a potentially useful tool for purchasing credits from abroad, as well as for curbing the growth of demand for larger vehicles. Although the government has done a lot of work to assess least-cost options to mitigate emissions, the team was not provided with a clear and quantified set of mitigation options and their implications for energy policy.

Several subsidy programmes exist, within different ministries, to give incentives to reduce energy consumption and to promote renewables. However, the total amount provided as subsidy and its effectiveness is not clear.

RECOMMENDATIONS

The government of Luxembourg should:

Energy Efficiency

- ▶ *Establish a national energy efficiency strategy incorporating targets and strong cost-effective measures at national and sectoral levels.*
- ▶ *Closely monitor the performance of the voluntary agreement with the industrial sector. Require participants in the voluntary agreement to provide details on how they will implement energy efficiency.*
- ▶ *Complement the existing voluntary agreement with company-based sectoral efficiency improvement targets.*
- ▶ *Conduct more evaluation of the results of efficiency measures.*
- ▶ *Enhance energy efficiency standards for existing and new buildings, and enhance their monitoring with stronger oversight of implementation. Take first steps to implement the carnet de l'habitat.*
- ▶ *Formulate and implement economic and regulatory measures such as revision of vehicle taxation and road pricing to curb growth in energy demand in passenger transport.*
- ▶ *Consider participating in the IEA Implementing Agreements on "Electric and Hybrid Vehicles", "Hydrogen" and "Advanced Motor Fuels".*

Energy and the Environment

- ▶ *Develop as soon as possible an action plan to reduce GHG emissions in a cost-effective manner. Efforts should be focused on road traffic since that sector represents the most important increase in emissions up to the year 2012.*

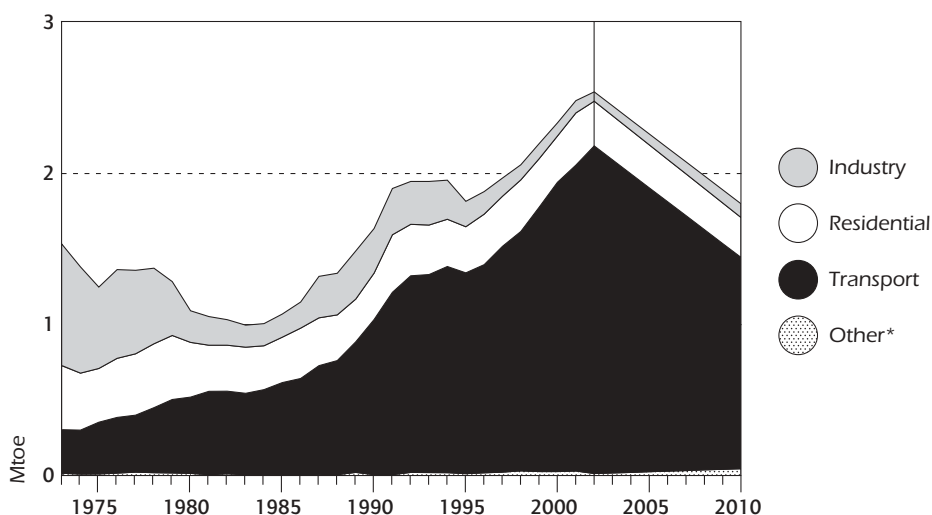
- ▶ *Prepare a strategy on how recourse to Kyoto mechanisms will be implemented.*
- ▶ *Evaluate the cost-effectiveness of the various subsidies.*
- ▶ *Continue to explore more possibilities to reduce GHG emissions domestically, bearing in mind the goals of energy policy and of cost-effectiveness, even if the largest share of emissions reductions may be obtained through an active international strategy.*

MARKET TRENDS

Oil demand increased rapidly in the 1990s, from 1.64 Mtoe in 1990 to 2.71 Mtoe in 2003, which corresponds to a growth of 4 % per annum over 1990-2003. Growth was led essentially by the sharp increase of consumption in the transport sector, which in 2002 accounted for more than 86% of final oil consumption.

Figure 16

Final Consumption of Oil by Sector, 1973 to 2010



* includes commercial, public service and agricultural sectors.

Sources: *Energy Balances of OECD Countries*, IEA/OECD Paris, 2004; and country submission.

The oil sector in Luxembourg is unique among IEA countries in that it neither produces nor refines any oil. Yet its oil economy is far out of proportion to local use, especially regarding the retail sale of transportation fuels. Because of lower taxes on gasoline and diesel fuel compared to its neighbours, motorists and truckers often fill their tanks in Luxembourg to fuel their travels across Europe. Demand from Luxembourg residents is also high, sustained by high incomes, low vehicle taxation with no incentives for fuel economy and low fuel prices.

Because of the tax differential that has been maintained over the years, Luxembourg retains a significant share of a market for transport fuel that extends beyond its borders. Per capita final consumption of oil products in

Luxembourg is three times larger than in IEA countries on average, which means that the bulk of consumption is carried out outside Luxembourg. The Ministry of Environment had calculated that in the late 1990s, excluding aviation fuels, almost 70% of the oil products being sold in Luxembourg were consumed outside Luxembourg. Because of the importance of road transport, diesel is the major fuel sold in Luxembourg. There is considerable refuelling of commercial trucking in Luxembourg as it is situated along major north-south and east-west truck routes. Diesel used in passenger cars benefits the relatively high percentage of diesel cars in neighbouring France. Diesel sales are currently comparable to the consumption of heavy fuel oil (HFO) but the latter is decreasing. Gasoline consumption lags behind diesel and HFO.

The elasticity of oil products' demand to price is reasonably high. A significant part of the demand in Luxembourg is coming from foreign consumers, and this could be satisfied in other countries if the prices in Luxembourg grow relative to the neighbouring markets. When Luxembourg increased its taxes on gasoline and diesel in 1993 and 1994, the differential of taxation between Luxembourg and its neighbouring countries decreased, along with the benefits of refuelling in Luxembourg. Automotive fuel consumption then decreased in 1995 and 1996. Purchases started to increase again when taxes continued to increase in neighbouring countries but not in Luxembourg. On the other hand, kerosene for aviation has a lower elasticity to price. Even though kerosene does not benefit from such a tax differential advantage, it still displayed a strong growth in demand in recent years.

In its projections of demand made at the beginning of the 1990s, the government foresaw the possibility of considerably reducing the tax differential on oil products prices between Luxembourg and its neighbours within a move to harmonise taxes at the European level. As a result, the government projected a significant decrease in total oil sales, in particular after 2005, in all sectors, *i.e.* industry, residential, commercial and also transport. In industry and the residential/commercial sector, natural gas is expected to replace oil. In transport, the tax differential reduction would reduce the number of drivers refuelling in Luxembourg while domestic consumption would stabilise. However, recent real term increases of tax rates in Germany or France between 1999 and 2002 make it politically more challenging for Luxembourg to catch up at a pace that would enable the country to reduce and possibly eliminate the tax differential. As a result, the government now projects that consumption of oil products could possibly grow in the future by another 25% by 2010.

TRANSPORT AND DISTRIBUTION

All oil products are imported. They essentially come from refineries located in Antwerp in Belgium (85% of oil products imports in 2002), 255 km from the city of Luxembourg. The rest comes from France (6.3%), Germany (5.0%) and

the Netherlands (3.3%). Although the most commonly used method of transport is by road (39% of products came by road in 2002; see Table 8), 60% of the products reach Luxembourg by rail, barge or pipeline.

Table **8**
Oil Product Imports by Means, 2002
 (metric tonnes)

	<i>Road</i>	<i>Rail</i>	<i>Barge</i>	<i>Pipe CEPS via Bitburg</i>
Gasoline	241 756	176 034	133 830	
Diesel	687 075	525 809	259 748	
Jet fuel				370 048
Heavy fuel oil*	6 128			
Bitumen	4 455			
Total	939 414	701 843	393 578	370 048

* low-sulphur heavy fuel oil. There are no imports and consumption of high-sulphur heavy fuel oil.
 Source: Office Commercial du Ravitaillement.

There were 240 service stations in 2002. The number of inland stations has decreased by 30 since 1998. The main reason is that owners preferred to close the service stations rather than invest to meet the new 1995 environmental regulations applied to service stations. The number of oil product distributors is also decreasing. In 2002, there were 9 companies distributing oil products in Luxembourg, 8 of them owned service stations. The 5 largest, Total, Shell, Esso, Q8 and Aral account for around 87% of oil products sales. More than two-thirds of the demand is satisfied via six motorway outlets. There are substantial barriers to further entry, particularly because of the scarcity of suitable new sites.

OIL PRICING POLICY

The government sets a ceiling on gasoline, automotive diesel, heating oil and liquefied petroleum gas (LPG) prices⁷. The pricing formula adds a standard cost of transport from Antwerp to Luxembourg, a standard distribution margin⁸ and the cost of compulsory storage to the published price of oil products at Rotterdam. These different costs are determined by the government after discussion with the oil companies (Groupement Pétrolier Luxembourgeois) and the retailers.

7. This system does not exist for heavy fuel oil, for which consumption is decreasing, or for kerosene.

8. This margin was increased in 1995 to allow investments to meet the new environmental standards applied to service stations.

The government decides when the maximum price changes according to price variations at Rotterdam. In general, prices are revised after consultation with oil companies when prices at Rotterdam change by an average of more than €10/1 000 litres. There are some eight to ten such changes per year. Companies set their price at or close to the maximum level, with the exception of small independent retailers which set prices below this level.

EMERGENCY PREPAREDNESS

The decree of 31st October 1973 defined a compulsory stock level according to EU requirements, not IEA requirements, for Luxembourg of 90 days of the previous year's consumption, of which 45 days of gasoline and 55 days of distillates should be held on national territory, and penalties. Since the application of penalties of the relevant laws is widely considered as too harsh to be accepted, the penalties are not being applied under the current legislation.

The National Oil Emergency Organisation (NESO) is established on an informal basis under the authority of the Minister of Economic Affairs. The Ministry of Economic Affairs is in charge of the administrative co-ordination, legal regulation and control of stocks, as well as data collection and its transmission to the IEA.

Under the laws of 22 September 1982 and 8 December 1981, legal authority for the draw down of stocks would be given to the government. For the moment, there only exist company-held stocks. In the case of co-ordinated stock draw, a decree would regulate imports, trade and consumption of oil products.

Reflecting the size of the country and pricing system for oil products, there exists a permanent relationship between the Administration and the association of oil-importing companies. This relationship can be easily strengthened in emergency situations and industry experts would also be involved in NESO activities.

Luxembourg has bilateral agreements with Belgium, France, Germany and the Netherlands. Most of Luxembourg's oil stocks are located in Belgium and the Netherlands. Stocks held in these countries on behalf of Luxembourg companies have to be certified by the local authorities at the beginning of each quarter. Notification is sent to the Ministry of Economic Affairs. On request of the Minister, the authorities of the host country verify the reality and the amount of stocks.

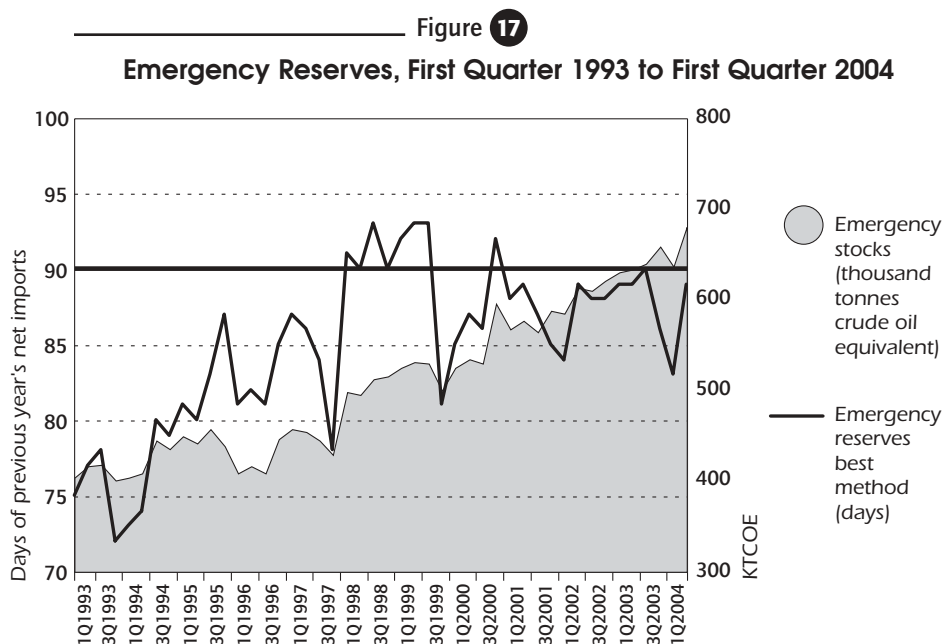
Implementing the IEP (International Energy Program) or CERM (Co-ordinated Emergency Response Measures) would require co-ordination at the Benelux level, in consultation with the other neighbouring countries, France and Germany. Luxembourg can implement emergency measures by decree "if oil

supply is endangered", as stated in the law of 22 September 1982. In the case of co-ordinated stock draw, a decree would forbid imports of oil products, except for stocks held abroad under bilateral agreements.

Luxembourg has been regularly non-compliant with the IEA oil stockholding obligation for the last ten years, albeit with some improvement since 1998. There are two main reasons for non-compliance. The first is insufficient kerosene stocks owing to insufficient jet fuel capacity within the supply system, particularly at Luxembourg's airport. The second reason is the high year-on-year growth rate of transport fuel consumption due to differentials in fuel tax between Luxembourg and its neighbouring countries, which leads to increased net imports and hence a higher absolute stockholding obligation. In January 2004, Luxembourg held 86 days of stocks, 2 days less than the level of 1 January 2003 and down from 90 days reached temporarily in October 2003.

Also, over the last ten years, the government has stated that to ensure sufficient stocks to meet the IEA commitment, it plans to change the relevant legal framework, notably with respect to the following factors:

- The creation of a stockholding agency.
- Increasing storage capacity of oil products, generally.
- Stocking of aviation fuel, in particular.



Source: IEA.

CRITIQUE

Luxembourg, being totally dependent on oil imports, with 70% of stocks held abroad and a significant share of domestic revenue arising from the sales of petroleum products, is particularly vulnerable to international oil supply disruption.

At the same time, Luxembourg does not often comply with its commitment under the IEA Treaty, an agreement on an International Energy Program, to hold at least 90 days of net oil imports in oil reserves available for domestic consumption. This is a persistent problem for Luxembourg, seen clearly in average daily net imports, and exacerbated by differences with neighbouring countries' taxes on road fuels, which provide an incentive for fuelling in Luxembourg. As a result, although Luxembourg has significantly increased its absolute level of emergency reserves over the years, it consistently fails to keep up with oil demand growth.

Recognising this problem, the government has over the years announced its intention to change the relevant legal framework creating a stockholding agency, increasing storage capacity, in particular for aviation fuel. Luxembourg's reluctance to take the measures necessary to comply with its IEP obligation weakens the IEA's solidarity at a time of great oil market uncertainty and volatility. Therefore, the government should now swiftly develop a plan with concrete measures to achieve the IEP stockholding obligation.

Moreover, over two-thirds of Luxembourg's oil stocks are held abroad under bilateral agreements, with much of these stocks leased on three-month contracts via "tickets". Under the terms of these contracts, deliverability is not guaranteed during the entire leasing period. Also, at the end of a short-term contract, there is no obligation on the part of the owner to renew the lease. Therefore, during a period of oil supply disruption, Luxembourg could easily find itself without access to oil product stocks it would have under normal circumstances and its need for oil could be a burden on other IEA countries. The government should explore a longer leasing period and, as a more substantial measure, increase the level of physical stocks on national territory.

Price ceilings are fixed by the government, based on the Rotterdam reference price plus identified margins. The argument is that as long as excise taxes keep prices lower than those in neighbouring countries, price ceilings prevent the companies from making excessive profits at the expense of consumers. This suggests that the companies would not normally compete. In practice, even within the price ceilings, the companies argue that there is some competition to the benefit of consumers, essentially via discounts for regular customers. They argue that these discounts are sufficient to trigger competition (amounting to reductions of 1% to 3% on retail prices). The government is implementing a competition authority with powers to track down anti-competitive behaviour.

RECOMMENDATIONS

The government of Luxembourg should:

- ▶ *Urgently develop a plan to achieve the IEP obligation with concrete measures within a specific time period through:*
 - *Creating a centralised stockholding agency.*
 - *Increasing the level of physical oil stocks on national territory.*
 - *Limiting the number of short-term leasing contracts of 3 months in favour of longer-term leasing contracts of 6 months or more.*

- ▶ *Given the limited scope for strong competition in the oil products sector and the large volumes of oil products sold in Luxembourg, make sure that the calculation of price ceilings does not generate undue rent.*

CONSUMPTION

Natural gas consumption and imports started in 1972. Domestic consumption of natural gas in Luxembourg is 100% dependent on imports. In 2002, gas supplies amounted to 1.05 Mtoe, *i.e.* 26% of total energy supply. Final consumption of gas was 16.6% of total final consumption. Total gas supplies grew by 52% in 2001-2002 with the start of the TWINerg combined-cycle gas turbine. As a result, the structure of gas consumption changed radically (Table 9).

Table 9

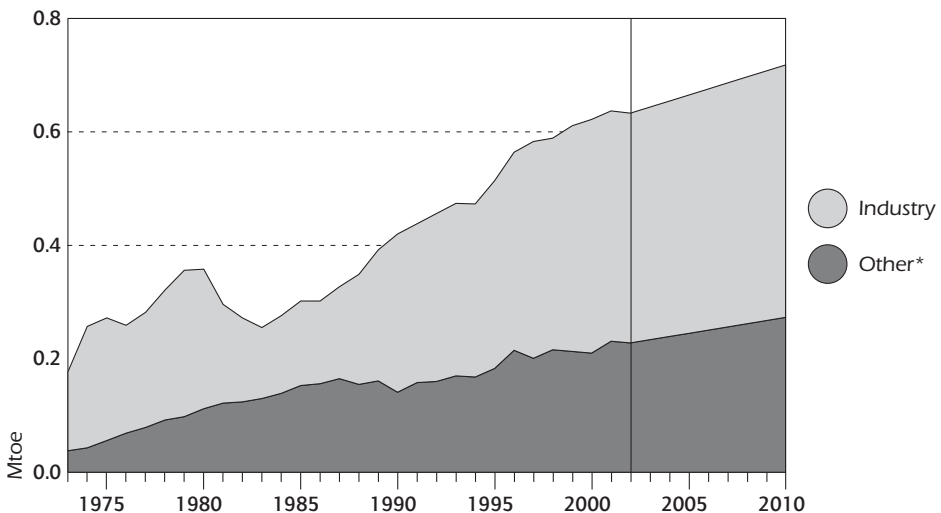
Gas Supply Shares per Sector (%)

	2001	2002
Public electricity plants	0	34
Autoproducer CHP plants	9	6
Iron and steel industry	22	17
Non-specified industry	36	21
Residential	33	22

Source: IEA.

Figure 18

Final Consumption of Natural Gas by Sector, 1973 to 2010



* includes commercial, residential, public service and agricultural sectors.

Sources: *Energy Balances of OECD Countries*, IEA/OECD Paris, 2004; and country submission.

In 2002, a little less than two-thirds of the gas used to be consumed by industry, while a third was consumed by the residential sector and the remaining was consumed in autoproducers' CHP plants. In 2002, these shares changed and now 40% of gas is consumed to produce electricity. Residential consumption grows regularly at around 3% to 4% per annum; 43% of households are supplied with gas.

Natural gas supply is expected to increase to 1.47 Mtoe in 2010, mostly in electricity generation and because industrial co-generation is expected to continue to develop. Natural gas consumption is expected to continue to increase, replacing oil products in the residential/commercial sector and, to a lesser extent, in the industrial sector.

INDUSTRY STRUCTURE AND IMPORTS

The Société de Transport de Gaz (SOTEG) was created in 1974 to import, transport natural gas and develop the transport grid. It has a *de facto* monopoly on gas imports and transport.

Until 1997, SOTEG was owned 50% by the State and 50% by ARBED, the iron and steel company which merged in 2001 with USINOR and ACERALIA to create ARCELOR. Since 1998, SOTEG has been owned 31% by the State, 20% by ARCELOR, 20% by Ruhrgas, 19% by CEGEDEL and 10% by Saarfengas.

SOTEG is in charge of providing gas to its customers at the lowest possible price. In 2003 its turnover amounted to €185 million. There is no natural gas storage.

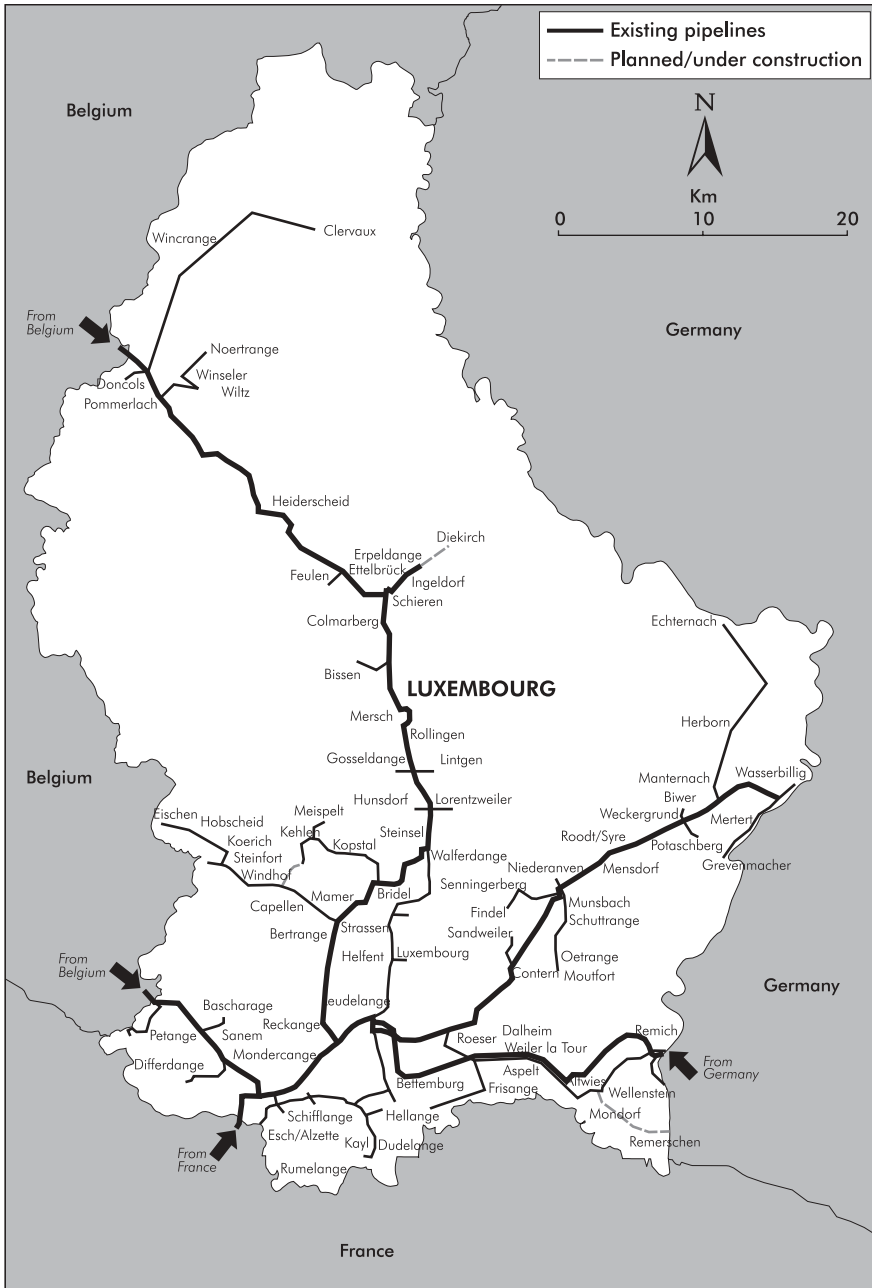
In 1991, SOTEG also signed a contract with Gaz de France for the supply of a maximum of 20 thousand cubic metres per hour. The contract with Gaz de France ended in 2000 and has not been renewed since. In 1995, SOTEG signed a contract with Distrigaz of Belgium for the supply of a maximum of 180 thousand cubic metres per hour from 1 October 1995 to 30 September 2010⁹. The contract is flexible enough to balance the market in case of large seasonal fluctuations in demand. As of 2001, Ruhrgas started to supply SOTEG with natural gas to supply the new TWINerg CCGT. The contract extends until 2015.

In 2004, the length of its high-pressure transmission grid was 375 km (Figure 19). At the end of 2001, an additional gas pipeline was opened to import gas from

9. This contract is based on an earlier agreement signed in 1990 providing for the supply of 95 thousand cubic metres per hour until 1995.

Figure 19

Map of the Natural Gas Infrastructure and Distribution Areas in Luxembourg



Source: SOTEG.

Germany. The new pipeline runs from Mittelbrunn in Germany to Leudelage in Luxembourg, with a 28 km extension especially built from Remich in Luxembourg to Leudelage. In Germany this pipeline can be connected to Megal which is used to transport gas from Russia. The new gas pipeline has a capacity of 300 thousand cubic metres per hour, well above the capacity necessary to transport the existing contracted gas, to be able to transport increased gas quantities in the future.

There are four entry points to the gas network: from Bras in Belgium and Petange in Luxembourg close to the Belgium border, from Audun in France and from Remich in Germany. The main entry points interconnecting Luxembourg to the European grid are with Belgium and Germany. There is no gas transit in Luxembourg.

Currently, Luxembourg does not seem to have a further need to increase the transmission and distribution capacities if the supply patterns do not change dramatically. The existing grids are not designed for transit because other routes outside Luxembourg are more economic. Because the Luxembourg network does not have a compressor station, its network depends on the compressors of neighbouring countries (Belgium and Germany).

Gas consumed in Luxembourg is imported from the following producing countries: Algeria, Norway, the Netherlands and Russia. Close to 90% of the approximately 0.8 billion cubic metres consumed annually comes from Belgium, and the rest is shared between Germany and France.

Natural gas is distributed by four distribution entities which have a *de facto* monopoly in their concession area. Two of these entities are directly managed by municipalities which undertake several other activities such as public transport and water distribution. Some municipalities participate directly in investments in gas distribution. These entities are as follows:

- *Usine à gaz de la Ville de Luxembourg* distributes gas in the municipalities of Strassen and Hespérange. It is owned by the municipality of Luxembourg.
- *Usine à gaz de la Ville de Dudelage*, owned by the municipality of Dudelage.
- SUDGAZ, owned by 15 municipalities. In 2003, it distributed 143 mcm of gas to 32 268 clients located mainly in the south-west and its low-pressure distribution grid was 638 km. Since SUDGAZ distributes gas in the energy-intensive industry core area, 1.2% of its consumers absorb 27% of its volumes sold.

- LUXGAZ Distribution was created in 1990. It is 30% owned by municipalities, 30% by the State, 25% by SOTEG, 13.7% by CEGEDEL and 1.3% by the Fédération des Installateurs. In mid-2004, LUXGAZ's grid was 710 km. In 2003, it had 7 803 clients in 40 municipalities to which it sold 59 mcm of natural gas. In a move to liberalise the gas market and to implement the requirements of the EU Gas Directive, accounts related to transmission and distribution were separated in 2004. The company is extending its grid in the north of the country.

NATURAL GAS PRICES TO FINAL CONSUMERS

SOTEG sets gas prices to all its customers on a cost-plus basis. These include distributors and industries with consumption above 2 mcm. Gas prices for industries may be negotiated when the gas price set at a cost-plus basis is not competitive against other relevant fuels.

Natural gas prices for households and businesses below an annual consumption of 2 mcm¹⁰ are set by the municipal companies on the basis of the price of heating oil. However, gas prices to final consumers differ between distributors. Natural gas prices for households are roughly in the same range as heating oil, although they benefit from lower levels of taxation (Table 10). Natural gas prices for households are lower than the IEA average (Figure 20). Lower rates of taxation than in neighbouring European countries explain this situation.

Table 10
Energy Prices in the Household Sector, 1999 to 2002
(\$ per toe)

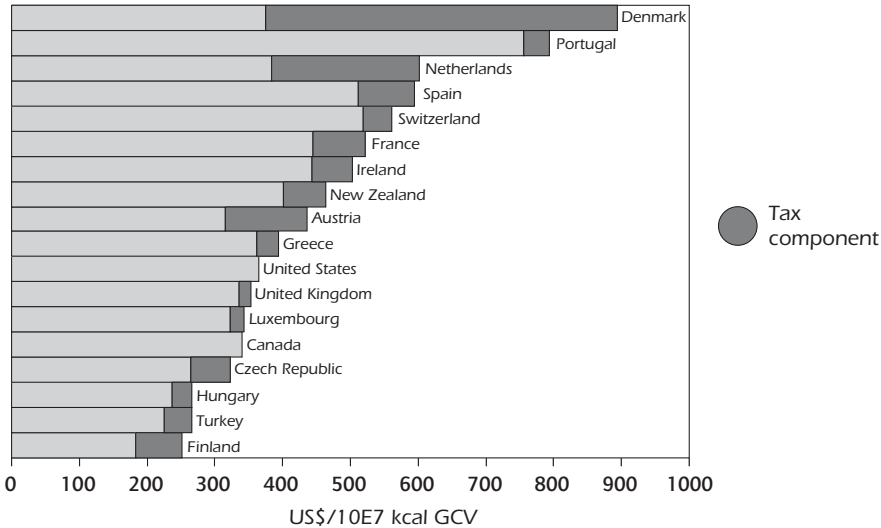
	<i>Light Fuel Oil</i>		<i>Natural Gas</i>		<i>Electricity</i>	
	<i>Incl. Tax</i>	<i>% Tax</i>	<i>Incl. Tax</i>	<i>% Tax</i>	<i>Incl. Tax</i>	<i>% Tax</i>
1999	264.2	13.1	271.8	5.7	1 374.8	5.7
2000	372.8	12.2	306.2	5.7	1 154.2	5.7
2001	329.7	12.4	333.5	5.7	1 135.7	5.7
2002	321.7	12.5	303.0	5.7	1 298.7	5.7

Source: *Energy Prices and Taxes*, IEA/OECD Paris, 2004.

10. In practice the separation of supply to industrial consumers between SOTEG and distributors is more flexible.

Figure 20

Natural Gas Prices and Taxes in the Household Sector in IEA Countries, 2003



Note: Tax information not available for Canada and the United States. Data not available for Australia, Belgium, Germany, Italy, Japan, Korea, Norway and Sweden.

Source: *Energy Prices and Taxes*, IEA/OECD Paris, 2004.

IMPLEMENTATION OF THE EC DIRECTIVE ON THE INTERNAL NATURAL GAS MARKET

Luxembourg delayed the implementation of the EU Directive on the Internal Natural Gas Market by around a year. The Law of 6 April 2001 transposed the directive. Initially, customers with a consumption of more than 15 mcm per year were eligible. This represented six customers in Luxembourg with 42% of the domestic natural gas consumption. SOTEG has unbundled its transport and sales accounts. Reflecting this new environment and the possibility of renegotiation, recent contracts of SOTEG are more flexible.

The threshold above which customers were free to choose their supplier was lowered to 5 mcm on 1 October 2003, allowing consumers representing 76% of the gas volumes sold in Luxembourg to choose their suppliers. Fifteen industrial consumers are now eligible. While only one customer has changed supplier, many contracts have been renegotiated. Following the decision taken at the European Council of Energy Ministers of 25 November 2002 to accelerate the liberalisation of energy markets, from 1 July 2004 all industrial

gas consumers have become eligible to choose their suppliers and from 1 July 2007, the market will be fully open to competition.

The Institut Luxembourgeois de Régulation (ILR) was made responsible for monitoring the gas market in the context of the April 2001 law. In this context, ILR has similar responsibilities as in the electricity sector: to control the setting of transport rates in the gas grids; to allow non-discriminatory network access and to prevent the abuse of dominant market position by any of the market players.

Following the recommendation by the regulator, the government approves tariffs for access to the grid.

SECURITY OF GAS SUPPLY

Article 3 of the law of 6 April 2001 on the organisation of the natural gas market stipulates that, in the interest of security of supply, public service obligations can be defined as applying to the suppliers, transporters and distributors¹¹. The same article foresees the establishment of a ten-year security of supply plan to be updated every three years. Article 7 of the same law plans to issue authorisations for natural gas supply companies to operate on the Luxembourg market. The procedure for these authorisations has further been defined in a Grand Ducal regulation of 19 May 2003.

The ten-year security of supply plan should make reference to the following topics:

- Evolution of demand for natural gas.
- Development of the natural gas supply situation.
- Diversification of the supply sources.
- Security of supply.
- Technical security.
- Development of transport and distribution grid and interconnections with neighbouring countries.

Luxembourg has not recently changed its security of supply policy, but the government plans to have major changes introduced when transposing the second European Union directive concerning the internal market of natural gas. Extreme weather conditions, market failure and interruption of a large

11. See, *Security of Gas Supply in Open Markets*, IEA Paris, 2004.

supply source are not yet addressed and no supplier of last resort exists. Today's supply contracts are expected to fully take care of such situations. Demand-side response is not addressed by the policy. However, a voluntary agreement exists with the industry sector in order to raise its energy efficiency.

Luxembourg imports all of the gas consumed on its territory, and does not have any storage facilities. Importers are therefore requested to diversify their supply and not to rely on a single supplier. Issues regarding protection of specific market segments and main standards for security of supply will be decided whilst implementing the second EU internal market directive.

CRITIQUE

Natural gas consumption in Luxembourg has increased rapidly in recent years. Since 2002, imports of natural gas have increased significantly after the commissioning of the TWINerg plant and the development of co-generation. This increase in consumption enabled a new pipeline to be built from Germany, diversifying sources and supply routes for natural gas. Final consumption of natural gas has nevertheless stabilised or slightly decreased in 2001-2002, owing to slower economic growth.

There have been many developments in terms of gas market reform. Despite a little delay, Luxembourg transposed the EU Directive on the Internal Natural Gas Market in 2001 and has been liberalising the gas market up to 76% with the scope of full market opening in 2007. Accounts for gas trading (purchase and sales) and transport have been separated. While only one consumer has changed supplier, many contracts have been renegotiated.

The 2001 law foresees the establishment of a ten-year security of supply plan. It seems, however, that a first version of this plan is yet to be completed, the delay being partly due to the government looking for ways of including this plan along with measures to implement the 2003 EU Directive on Natural Gas. In the context of a more open market, entirely depending upon imports, the government will need to finalise this plan as soon as possible.

The team recognises the specificity of the Luxembourg natural gas market. The market size is very small; the bulk of demand is coming from few energy-intensive consumers and the number of players is limited, with SOTEG as the main gas supplier. Under such specific market conditions, it is possible that further liberalisation may not bring significant additional benefits to consumers. Nevertheless, several issues need to be borne in mind to ensure the benefit of market reform as much as possible. First, noting that SOTEG remains the main supplier and has still some state shareholding, SOTEG should continue to be free in its strategic decision-making and management so that it can compete on a level playing field with the other suppliers in the market. Second, because of its small size, geographic location and total import

dependence, the effective competition in the Luxembourg gas market is affected by the market condition of neighbouring countries. For instance, if tariffs and conditions for use of pipelines prevent newcomers from competing on a level playing field, Luxembourg's consumers' freedom of choice could be limited. Cross-border tariffs should also not impede competition with foreign suppliers. Therefore, the regulator should keep in touch with its counterparts in those countries on such issues as network access and interconnections in particular. From this viewpoint, as discussed in Chapter 3, adequate staffing of the energy regulator is necessary.

RECOMMENDATIONS

The government of Luxembourg should:

- ▶ *Maintain an arm's length relationship with the companies having state-ownership in the gas sector.*
- ▶ *Ensure close co-operation between the regulator and its counterparts in neighbouring countries.*
- ▶ *Finalise and implement the ten-year gas security of supply plan.*

DEMAND, SUPPLY AND TRADE

In 2002, electricity consumption was 5.7 TWh (0.49 Mtoe) and the peak load reached 623.4 MW by December. Industry was the largest energy consumer, with 65% of electricity consumption (Figure 21). The rest is consumed by the residential and commercial sector. These shares remain relatively stable. Industrial electricity consumption accelerated at the end of the 1990s because of the replacement of blast furnaces by electric arcs in the iron and steel industry which, alongside electricity used in electric arcs, eliminated electricity generation from blast furnace gas in 1998. Electricity consumption in the industrial sector grew by 39% in 1990-2002. The consumption of the residential and commercial sector also grew by 23% in 1990-2002. In total, electricity consumption grew by 36% in 1990-2002, 2.8% per annum, which is higher than the average for IEA Europe, 27% and a little above 2% per annum.

Table 11
Electricity Balance, 2001 and 2002
 (GWh)

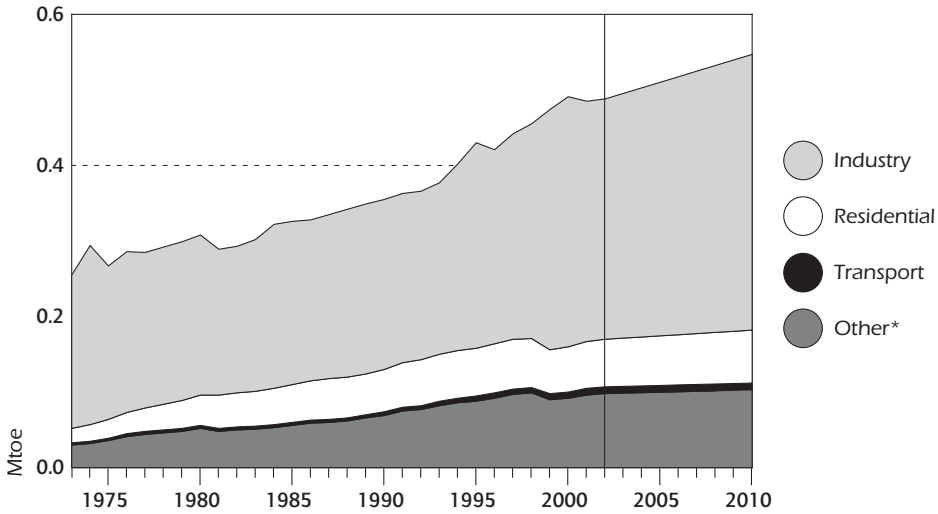
	2001	2002
Imports (A)	5 370.5	5 143.8
CEGEDEL	3 349.2	3 441.5
SOTEL	2 021.3	1 702.3
Exports (B)	0	2 058.3
Production (C)	442.6	2 731.7
Thermal plants	35.4	2 312.4
Co-generation	260.8	287.8
Renewables	146.3	131.5
Hydroelectricity	114.4	97.4
Public hydroelectricity plants	57	47.4
Moselle plants	51.5	44.5
Private plants	5.9	5.4
Wind	23.7	24.7
Biogas	8.2	9.3
Photovoltaic	0.05	0.08
Available electricity (A-B+C)	5 813.0	5 817.2

Note: Imports and exports of electricity from the Vianden pumped storage plant are not included as the plant is not connected to the Luxembourg grid (see below).

Source: Energy and Communications Directorate, Ministry of Economic Affairs, Luxembourg.

Figure 21

Final Consumption of Electricity by Sector, 1973 to 2010

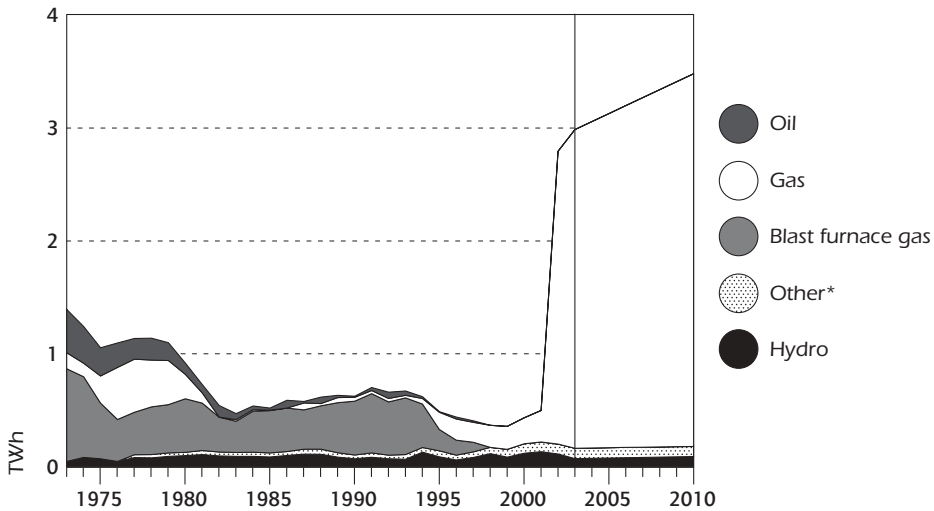


* includes commercial, public service and agricultural sectors.

Sources: *Energy Balances of OECD Countries*, IEA/OECD Paris, 2004; and country submission.

Figure 22

Electricity Generation by Source, 1973 to 2010



* includes solar, wind and combustible renewables.

Sources: *Energy Balances of OECD Countries*, IEA/OECD Paris, 2004; and country submission.

The first and most important feature is the growth of domestic electricity production with the commissioning of the TWINerg plant in 2002, which generated 2.3 TWh in the same year. This is the completion of a project for which the government launched a bid in 1998 for the building and management of a 350-MW CCGT situated in the south near Esch-sur-Alzette. The contract was awarded to Electrabel, a Belgian electricity company. The company TWINerg, owned 65% by Electrabel, 17.5% by CEGEDEL and 17.5% by ARCELOR, was created to build and manage the plant. A capacity of 100 MW has been dedicated to CEGEDEL, another 100 MW to SOTEL and the remaining 150 MW is dispatched on the Belgian grid. The CCGT is expected to increase production to around 3 TWh in the coming years and to eventually supply about 40% of Luxembourg's electricity consumption.

SOTEL and CEGEDEL signed a 15-year take-or-pay contract with TWINerg for the supply of electricity on baseload. TWINerg signed a backup contract with Electrabel. The CCGT is supplied with gas from Ruhrgas through the gas pipeline built from the German border under a contract which sets gas prices allowing the CCGT to sell electricity at a competitive price.

Although in the first two years the CCGT did not produce heat, it is expected to produce 190 MWth of heat, of which 150 MWth would be dedicated to industries' consumption and 40 MWth could supply a local district heating grid. However, the high costs of investment and functioning for this district heating system leads to a price well above that of natural gas. A task force was created to evaluate the feasibility of this project, including the possibility of attracting industrial clients. This task force concluded positively, giving birth to the AGORA project, a complex of offices and houses to be built in the vicinity of the power plant, with the first offices expected to be completed by 2006.

The second feature in domestic generation is that autoproduction remains a dynamic segment of electricity production, essentially through an increase in production from CHP plants. Autoproduction – which includes CHP – reached 358 GWh in 2002, against 184.3 GWh in 1998. At the end of 2003, there were 74 non-industrial co-generation facilities with a total capacity of 65.2 MW. Industrial electricity autoproduction decreased in the iron and steel industry since the restructuring of this sector in the 1990s, but increased in the chemical and petrochemical and transport equipment industry, along with heat production.

The third feature of electricity production is the change in the external electricity trade pattern of Luxembourg. Imports remain high, but the CCGT production is now enabling Luxembourg to export electricity (see Table 11).

According to the Energy and Communications Directorate within the Ministry of Economic Affairs, electricity consumption should continue to increase at a moderate rate of 1.4% per annum until 2010, mostly in industry. Growth in the residential sector is expected to slow down mainly because households are already equipped with a large number of electric appliances and there is not

much room for increased equipment and electricity consumption. Electricity consumption in the commercial sector should continue to increase in parallel with the development of this sector.

Electricity generation is expected to increase to 3.5 TWh by 2010 from 2.7 TWh in 2002, a significant growth of around 4% per annum. Net imports of electricity are projected to remain roughly the same by 2010, at around 3.5 TWh, but overall, exports and imports could decrease by 28% and 45% respectively in 2002-2010, indicating a reduction of external dependence and a reversal of the previous trend where imports grew to fill the gap between decreasing domestic generation and increasing demand.

RENEWABLES

Renewables accounted for 1.3% of TPES in 2002, up from 0.9% in 1990; 1.1% came from combustible renewables and waste, and 0.2% from hydro. This share is projected to remain stable by 2010.

In 2002, domestic hydroelectricity generation amounted to 97.4 GWh. This excludes electricity from the pumped storage plant of Vianden (see box).

The Vianden Pumped Storage Plant

In 2003, the 1100-MW Vianden pumped storage plant produced 831 GWh (and 880 GWh in 2002). Vianden imports electricity from RWE in Germany to pump water and exports electricity directly to Germany (RWE) for peak shaving. Vianden is not connected to Luxembourg's grid and its electricity generation does not appear in Luxembourg's balances.

Vianden is owned and operated by SEO (40%), the German utility RWE (40%), and private shareholders (20%). In 2003, Vianden imported 1133 GWh and exported 831 GWh.

Non-hydro renewable energy sources are mostly used in electricity generation. In 2002, energy from renewable sources was as follows:

- Municipal waste was used to generate 36.2 GWh of electricity, *i.e.* the majority of Luxembourg's non-hydro renewable electricity supply.
- Electricity generation from wind energy started in January 1997 with the connection of four 500-kW wind turbines to the grid. At the end of 2003, there were 27 windmills in Luxembourg for a total capacity of 22 MW. The production has been growing and in 2002 it reached 24.7 GWh.

- Electricity generation from biogas started in 1997 and quickly developed to reach 9.3 GWh in 2002.
- Two photovoltaic stations of 3 kW each were commissioned in September 1993. In 2002, photovoltaic produced 59 MWh.

In 2002, the share of renewables in electricity generation was 7.1%, out of which 2.2% was from combustible renewable and waste, 4.0% from hydroelectricity and 0.9% from solar, wind and others.

INDUSTRY STRUCTURE

SOCIÉTÉ ÉLECTRIQUE DE L'OUR (SEO)

Since it owns the Vianden pumped storage plant, SEO is the first electricity producer of Luxembourg. SEO has two subsidiaries managing some of its plants: CEFRALUX and CEDECEL.

SEO generated 106.2 GWh in 2002, in addition to the production of the 880 GWh from Vianden: 54.6 GWh from the hydro plants of Grevenmacher and Palzem; 16.2 GWh from the Schengen-Apch hydro plant (CEFRALUX) and 35.4 GWh from the CEDECEL hydro plants.

SEO's main shareholders are the State of Luxembourg and RWE (Germany). SEO owns three hydro plants in Luxembourg on the Moselle River with a total capacity of 16.8 MW, and in 1994 acquired four hydro plants in France on the Moselle with a total capacity of 10.4 MW. SEO created a subsidiary, CEDECEL, to own and manage these plants (at Koenigsmacker, Uckange, Liégeot and Pompey in France). SEO sells its domestic production to CEGEDEL and its production in France to EDF¹².

SEO is also developing renewables, in particular building jointly with CEGEDEL a wind farm in Heinerscheid with a total capacity of 5.4 MW (three units).

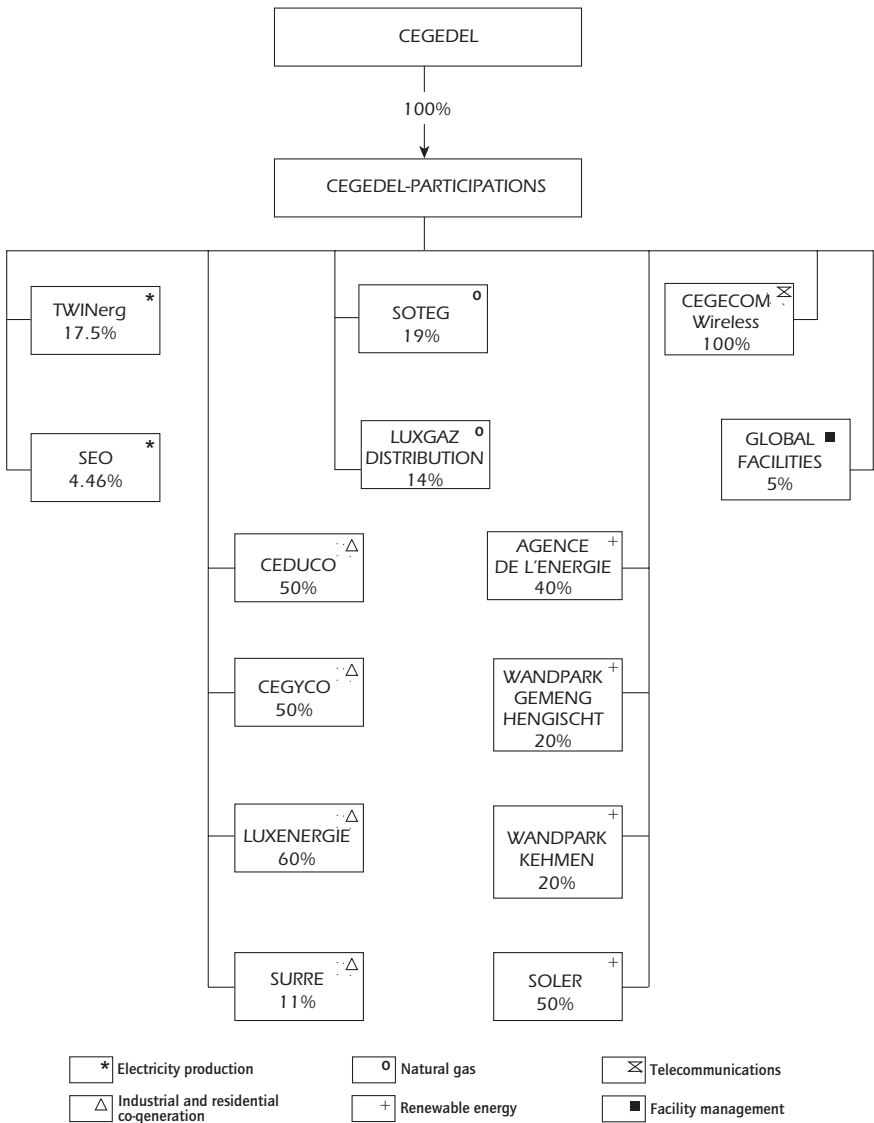
THE COMPAGNIE GRAND-DUCALE DE L'ÉLECTRICITÉ (CEGEDEL)

The Compagnie Grand-Ducale de l'Électricité (CEGEDEL) supplies and transports electricity and is involved in generation through joint ventures. In 2002, 42% of the CEGEDEL was owned by the Luxembourg State, 8% by the Belgian utility Electrabel, 26% by Luxempart Energie (a group of private investors, with a majority stake of RWE) and the rest was floated on the stock market. The company activities are defined through a concession contract extended in 1995 with the government. CEGEDEL has to ensure safe and competitive supplies to end-users. The 1995 contract covers the period up to

12. In addition SEO has shares in companies involved in wind energy and has a share in the Agence de l'Énergie.

2007 and defines CEGEDEL's public service missions (e.g. obligation to supply electricity), the actions to protect the environment, to adapt to the liberalisation of the electricity market, to diversify its activities and in particular to encourage co-generation. In 2002, the whole group employed 488 people.

Figure 23
CEGEDEL's Shareholding and Participations, 2002



Source: CEGEDEL, Annual Report 2002.

In 2002, 4.1 TWh were transported by CEGEDEL. Electricity supply is arranged as follows:

- CEGEDEL is supplied with electricity from SEO/RWE. SEO purchases electricity from RWE and resells it to CEGEDEL. A new contract between SEO and RWE came into force on 1 January 2001. The supply contract allows annual renegotiation of some contractual elements. Within a time period of three years, all contractual elements can be renegotiated. In 2002, imports from SEO/RWE amounted to 65.5% of total CEGEDEL's supply.
- CEGEDEL now gets 21.2% of its supplies from the TWINerg plant, with which it has a contract to purchase electricity from 100 MW_e of the plant's total capacity of 350 MW_e.
- Through CEGEDEL-PARTICIPATIONS, CEGEDEL has been increasingly involved in industrial co-generation. The electricity sold to CEGEDEL from co-generation facilities amounted to 6.9% in 2002. This electricity comes from co-generation plants developed in joint ventures with companies such as Dupont (CEDUCO in which CEGEDEL owns 50%), or Goodyear (CEGYCO in which CEGEDEL owns 50%), and from Luxenergie, a company in which CEGEDEL-PARTICIPATIONS owns 60% of the shares. Luxenergie's task is to build and manage co-generation systems for households and tertiary activities.
- CEGEDEL buys electricity from SEO's electricity plants (2.4% of its supplies), from three hydro plants¹³ owned by the State and from privately-owned micro power plants.
- Since February 2002, CEGEDEL is trading electricity on the Leipzig European Energy Exchange; 2.2% of its supplies are coming from trading in this exchange and from over-the-counter purchases.
- CEGEDEL buys 1% of its electricity from SIDOR (electricity from waste) and another 0.8% from wind farms, and other renewable energy generators. CEGEDEL is participating in the development of a 12.6-MW wind farm (7 units of 1.8 MW) in the municipality of Bourscheid.

In 2002, CEGEDEL transported 67.4% of final electricity consumption. The rest was transported by SOTEL (see below), essentially for industrial consumption; 2 059 GWh were sold on the 65-kV lines to 32 industrial clients and distributors, 919 GWh were sold on the 20-kV lines to 2 201 clients and distributors, 834 GWh were sold to 142 111 clients on the low-voltage grid and 232 GWh were sold on the spot market.

13. Esch-sur-Sûre (10.7 MW), Rosport (6.2 MW), Ettelbruck (86 kW).

CEGEDEL's grid was 6 740 km at the end of 2002, of which 4 058 km were low-voltage and 2 150 km were 20 kV, 412 km were 65 kV and 120 km were 220 kV. The company has been making important investments to move lines underground. In 2002, 90.4% of low-voltage lines and 42.1% of medium-voltage lines were subterranean.

THE SOCIÉTÉ DE TRANSPORT DE L'ÉLECTRICITÉ (SOTEL)

The Société de Transport de l'Electricité (SOTEL) is a co-operative company created and owned by the following six members: ARCELOR (ex-ARBED, TradeARBED, MecanARBED and ProfilARBED), Paul Wurth, ARES, Laminoirs de Dudelange, EDF and Electrabel. Four of them are steel producers or equipment manufacturers for the steel industry. SOTEL imports and exports electricity from and to Belgium through a contract with Electrabel. SOTEL sells part of the electricity produced from the TWINerg power plant on to the Belgian grid.

In 2001, SOTEL created a subsidiary, SOTEL SC, to operate its electricity transmission grid and distribute electricity, thus implementing the law of July 2000 on electricity which called for unbundling transport activities from electricity purchases and sales.

SOTEL operates a network of 186 km: 220 kV – 31 km; 150 kV – 22 km; 65 kV – 113 km; 37 kV – 20 km. SOTEL is linked to the Belgian network operated by ELIA through two 220-kV lines and two 150-kV lines. This provides SOTEL with an indirect link to the French grid through the Belgian connection point of Aubange.

Electrabel supplies the bulk of power imported by SOTEL. As a private network for the steel industry, SOTEL is not under public service obligations and does not buy electricity from co-generators and renewable sources.

TWO DIFFERENT GRIDS

SOTEL is connected to ELIA's Belgian grid. CEGEDEL is connected to RWE-Net's German grid. The SOTEL and CEGEDEL 220-kV grids are not interconnected, but they share a double backup line of 220-kV each. This allows some power exchange for limited times and quantities. The two companies have a mutual agreement to interconnect the two lines in case of need (see box on the 2004 blackout).

An international interconnection between SOTEL and CEGEDEL's grid would mean connecting a 220-kV network between the RWE and ELIA grids which are already interconnected on the 380-kV level. Although studies have appraised the possibility of interconnecting the two grids positively for domestic purposes, the option of opening the Luxembourg grid to international interconnection was considered risky in the current configuration for the stability of the whole grid.

The September 2004 Blackout

In the late afternoon of 2 September 2004, a major failure occurred in the RWE network serving the western part of the Palatinate and the southern Eifel region in Germany and the whole of the public grid of Luxembourg. The blackout led to the loss of 890 MW of load, and affected almost one million people, about half of these in Luxembourg.

At the time of the interruption, the 400/220-kV transformer of the Niederstedem switching yard in Germany was out of service for a planned maintenance operation. Nevertheless the n-1 criterion (failure or absence of one essential element) was still fulfilled with three 220-kV power lines at the disposal of RWE TSO to supply the region with electricity. The reason for the blackout was a simultaneous occurrence of two independent events: *i)* A two-phase short-circuit appeared on the 220-kV line Saar-Nord. *ii)* Followed by a faulty protection unit switching off another 220-kV line so that the remaining 220-kV line could not cope with the charge and was also automatically switched off.

The Luxembourg grid operators managed to restore electricity to their customers much quicker than was the case in Germany, by connecting the two grids in Luxembourg, and procuring power for Luxembourg's public grid from the private grid and Belgium. The southern part of Luxembourg had power restored within 15 minutes, while the whole country was up again after 33 minutes. By comparison, the supply was not fully restored until over five hours later on the German side. Following the restoration of supply from the German side, the two Luxembourg grids were disconnected again.

The event shows that technically a connection of the two grids is feasible, and that the emergency strategy of relying on this connection appears to be sound. It also shows that the grid operators in Luxembourg have an efficacious emergency procedure. The government of Luxembourg in its report on the blackout states that there are some advantages that could be derived from a permanent connection of the two grids, especially in cases like this. On the other hand, it also foresees potential risks from integrating two grids at this low-voltage level, and points out that many blackouts over the past two years were in fact caused by faulty protection settings. Interconnecting grids on the 220-kV level is not normal practice, and the connection of two differently operated and phased networks in Luxembourg could, in the government's opinion, increase the risk of future blackouts.

Nevertheless, based on a recent governmental initiative, a working group composed of representatives of all the TSO's concerned by this matter has been established to analyse in detail the pros and cons of a permanent interconnection of the CEGEDEL and SOTEL grids and to further improve mutual emergency supply procedures.

DISTRIBUTION COMPANIES.

There are 11 independent distributors. Eight of them are owned by the municipalities and three of them are privately-owned. Distributors have a concession which gives them a monopoly in their area of distribution. The two major distribution companies, the town of Luxembourg and the town of Esch-sur-Alzette, distribute 670 GWh and 100 GWh per year respectively.

MEASURES TO PROMOTE ELECTRICITY FROM CO-GENERATION AND RENEWABLE SOURCES

In 1991 the government established the Agence de l'Energie (see Chapter 4), which is promoting renewable energies in Luxembourg. It acts as a consultant for the government on renewable energy issues. It completed a wind map in 1994 and estimated wind potential to be 1% of electricity consumption. It supports wind farm development projects and municipalities on renewable energy issues.

Still a reference for policy-making, the 1998 National Plan for a Sustainable Development sets the following targets:

- To increase the share of renewable energy in the public system (electricity distributed by CEGEDEL) from 2.5% in 1997 to 5% in 2010.
- To increase the share of co-generation in electricity consumption from 7% in 1997 to 15% in 2010.
- To double the share of wood in final energy consumption from 0.5% to 1% in 2010.

A ministerial regulation of 1994 provided for support for co-generation and renewable energy. A grant to non-industrial co-generators of LUF 6 000 (€149) per kW for the installation of the first 5 000 kW of capacity was provided. This came to an end in 1997 when this capacity ceiling was reached. Industrial co-generators are however eligible for special depreciation allowances for investments in new technologies, energy efficiency and renewable energies in the framework of the 1997 law. Wind turbines with a capacity of less than 50 kW have received a direct subsidy of 25% of the investment cost. There is a limitation of LUF 60 000 per turbine (€1 487). For wind turbines with a capacity above 50 kW, a subsidy of LUF 3 000 per kW (€74) with a maximum of LUF 6 million (€148 736) was granted to the first five projects. Projects involving solar energy, biomass, biogas and heat pumps in the residential sector have received a subsidy of 25% of the investment cost with a ceiling of LUF 60 000 per house (€1 487). In the non-residential

sector, projects have received 25% of the investment cost with a ceiling of LUF 1.5 million for each installation (€37 184).

Until the end of 1999, a Ministerial regulation of 1997 provided for a subsidy of 25% of the costs of connecting existing houses to the heat grid. The ceiling was LUF 25 000 per connection (€620).

In addition to these direct subsidies, the Grand Ducal regulation of 1994 sets the buy-back tariff for electricity from non-industrial co-generation and renewable sources. CEGEDEL only has a purchase obligation. The buy-back tariff for co-generators with a capacity of 1 to 150 kW averages LUF 2.95 per kWh (€0.073); from 151 to 1 500 kW, the tariff averages LUF 2.3 per kWh (€0.057) for day supplies and LUF 1.2 per kWh (€0.030) for night supplies. There is an annual subsidy of LUF 4 500 per kW installed (€ 111) used for peak power if electricity is supplied during peak demand. Electricity from renewable sources receives the same amount of subsidies as co-generators, but electricity from wind and solar PV receives an extra bonus of LUF 1 per kWh (€ 0.025). The government is currently revising this 1994 regulation with the aim of updating it. The 1994 Grand Ducal regulation introduced an obligation for distributors to dispatch renewable sources of electricity.

CEGEDEL purchases hydroelectricity from SEO at a price which allows SEO to cover its costs of production and to make a profit. Electricity from state and private micro power plants is purchased at a price set by the Grand Ducal regulation of 1994 which also allows the plants to recover their costs.

Articles 16 and 17 of the Grand Ducal regulation of 22 May 2001 on the organisation of the electricity market introduced a financial mechanism to compensate for the extra costs of purchasing renewable electricity under the obligation set by the 1994 Grand Ducal regulation mentioned above. All consumers below 65 kV are subject to a tax per kWh consumed. The income from this tax is gathered within a compensation fund allocated every year to the distribution companies under the obligation, according to the level of their declared additional costs for the purchase of renewable electricity. Total costs for this amounted to €13.9 million in 2003, and are estimated to reach €28 million by 2009, if the renewables support policy stays unchanged.

The law of 22 February 2004 (see also Chapter 4) provides subsidies to investments in renewable electricity projects and in CHP covering up to 40% of the initial eligible costs. Small and medium-sized enterprises (as defined in the European Community law) can receive a higher level of subsidy (an additional 10 percentage points). Eligible costs are all additional costs involved to reach the environmental objective, as the one set in the 1998 National Plan for a Sustainable Development.

MARKET LIBERALISATION

On 24 July 2000, Luxembourg's Parliament passed a law to implement the EU Directive on Electricity (96/92/EC). The law defines the consumers eligible to choose supplier, the electricity suppliers, the transmission system operators (TSO) and the energy regulator, expanding the responsibilities of the ILR.

The 2000 law defined initial thresholds of eligibility for consumers which were subsequently modified by Directive 2003/54/EC of 26 June 2003 as shown below. As of December 2003, 57% of the market (26 large-scale consumers above 20 GWh per annum) was opened for competition.

Final consumer (annual consumption per consumption site, including autoproduction):

- Before 1 January 2001 consumption > 100 GWh/year
- From 1 January 2001 consumption > 20 GWh/year
- From 1 January 2003 consumption > 9 GWh/year
- From 1 July 2004 all non-residential consumers
- From 1 July 2007 all consumers

Municipal or private distributor (annual consumption):

- Before 1 January 2003 consumption > 800 GWh/year
- From 1 January 2003 consumption > 90 GWh/year
- From 1 July 2004 all non-residential consumers
- From 1 July 2007 all consumers

Following the EU directive, electricity transport above 110 kV is considered transmission and below is distribution. TSOs are the owners of the transmission networks. The law states that the manager of the grid has to avoid any discrimination between the users of the grid and, in particular, should avoid favouring affiliate companies or shareholders.

The July 2000 law required CEGEDEL and SOTEL to unbundle their accounts for purchase/production, transport and distribution. As described above, SOTEL established a subsidiary and CEGEDEL recently separated its accounts.

A regulated third-party access was set up. The TSOs (CEGEDEL and SOTEL SC) publish the tariffs for access to the grid, use of the grid and ancillary services. The Minister approves the tariffs after consultation with the regulator, taking into account model load curves and costs for different categories of users. The Minister may impose maximum or minimum tariffs that have to be transparent and non-discriminatory.

Existing public service obligations, e.g. the equality of treatment for eligible customers of the same category, the obligation to purchase electricity produced from renewable sources and co-generation, have been maintained, as discussed above. A system was set up and is managed by the regulator to compensate for the extra costs of the public service obligations imposed on distributors. The extra costs of these obligations have also to be paid by eligible consumers (see below).

ELECTRICITY TARIFFS AND PRICES

Following the introduction of competition in the electricity market, a new tariff agreement (*accord tarifaire*) was signed on 10 January 2001 between the government and CEGEDEL. This agreement sets CEGEDEL's price formulas for non-eligible end-users. Large consumers connected to the high-voltage grid are eligible and CEGEDEL can negotiate the price at which it sells them electricity through individual contracts. Electricity prices to non-eligible consumers (medium and low tension) are defined according to a cost-plus calculation based on the price of wholesale electricity (purchased domestically or imported) and can evolve along with the retail price index.

Electricity prices are defined per category of consumers throughout the Luxembourg territory, except for the municipalities of Luxembourg, Esch-sur-Alzette, Echternach and Steinfeld, which set their own prices for final consumers.

The final price of electricity includes several taxes (as of 2004).

A tax on electricity consumption replaces the old concession fee paid by CEGEDEL. This tax applies to every consumer, including autoproducers. Funds gathered are used for financing the social security system. The tax level depends on consumption levels:

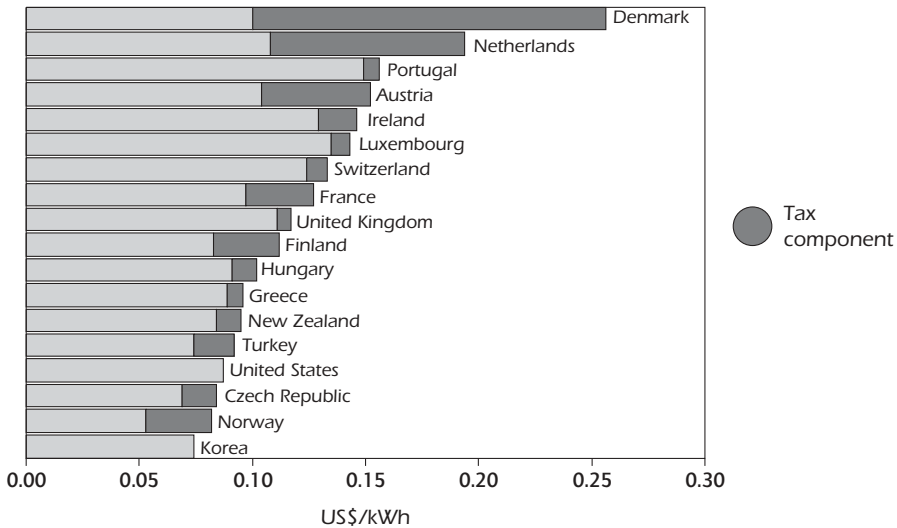
- Consumption < 1 GWh € 2.36 per MWh
- Consumption of 1 to 100 GWh € 1.66 per MWh
- Consumption < 100 GWh € 0.25 per MWh

A charge for the compensation fund for consumers connected to the grid at less than 65 kV equivalent to € 2.73 per MWh.

A tax to contribute towards the funding of the ILR was set at €0.085 per MWh for distributors and at €50 000 per annum for transmission operators.

Figure 24

Electricity Prices and Taxes in the Household Sector in IEA Countries, 2003



Note: Price excluding tax for the United States. Data not available for Australia, Belgium, Canada, Germany, Italy, Japan, Spain and Sweden.

Source: *Energy Prices and Taxes*, IEA/OECD Paris, 2004.

CRITIQUE

ELECTRICITY

The electricity sector of Luxembourg has changed considerably with the gradual introduction of competition since 2000 and the commissioning of TWINerg’s CCGT plant in 2002, which currently produces close to a quarter of the total electricity used in the country.

Building TWINerg’s plant provides numerous benefits and the government should be commended for the role it played in the achievement of this project. This electricity plant is a solution to the needs of large consumers for a stable electricity supply at predictable prices. It reduces the import dependence of Luxembourg’s public grid on a single supplier of electricity and diversifies its natural gas supply sources. With the growth of domestic production, the share of imports in final electricity consumption decreases significantly, to two-thirds. In addition to security of supply benefits, this also offers a means for Luxembourg’s energy sector to become an active player in the European internal electricity and gas markets, because it has now begun to export

electricity. The TWINerg plant allows its clients to foster competition between potential suppliers of CEGEDEL and SOTEL and puts further pressure on electricity purchase prices.

Luxembourg does not intend to build a further CCGT plant, mainly because of the need to mitigate GHG emissions. When the existing CCGT project was planned in 1995, the government's assumption was that this would contribute towards reducing GHG emissions by substituting imported coal-fired electricity. The final rules of the Kyoto Protocol have however led to the opposite effect, and the CCGT is contributing to Luxembourg's rise in CO₂ emissions, because the CO₂ emissions of the imported electricity that it replaces were counted in the exporting country, not in Luxembourg. However, increasing the efficiency of the CCGT through heat production will be of particular importance from a climate change mitigation point of view, reducing the emissions intensity of energy production.

The opening of the electricity market to competition began in 2000, when the Parliament adopted a new electricity law to implement the EU directive on the European single electricity market. The transposition of the second 2003 directive is in process at the time of writing. The total opening of the market is foreseen for 1 July 2007. Few eligible consumers have switched suppliers but many of them have renegotiated their existing contracts. As far as tariffs are concerned, the price for captive consumers has increased slightly and the price for industrial clients has marginally decreased.

The review team recognises the specificity of the Luxembourg market: a limited domestic size and demand led by a few large energy-intensive industries. This has already led to the development of arrangements, including the TWINerg plant, to the benefit of Luxembourg industrial consumers. Despite these factors, the government should explore the ways and means to further maximise the benefit of competition and market liberalisation in Luxembourg.

Noting that state ownership remains high in Luxembourg's electricity sector, the team suggests that the government should continue to refrain from interfering in the daily management and strategic decisions of companies. This is essential to ensure that electricity companies can compete on a level playing field.

In the near future, the distributors, now largely operated by municipalities, will have to adapt to competition rules and unbundle their accounts. Given the limited size of these companies, it will not be easy to implement a complete unbundling (for reasons of staffing, status of employees/civil servants, operating and administrative costs, etc.). This question is still under discussion and will need further investigation to explore the full range of options to introduce more transparency.

Because of the small size of Luxembourg and its geographical location, the proper functioning of competition will depend on regulations and practices in

the neighbouring countries. These include the tariffs and conditions for the use of the grid and the prevention of anti-competitive practices such as cross-subsidies in favour of eligible consumers. Therefore, the energy regulator needs to ensure close communication and co-operation with its counterparts in the neighbouring countries. It should be ensured that staffing will not be a bottleneck for this. Similarly, transmission system operators will also need to ensure a high level of communication and co-operation with their neighbouring counterparts.

In order to allow Luxembourg's consumers greater access to the larger European market, developing a high-tension grid in Luxembourg interconnected to the three neighbouring networks is an option worth considering because it would expand the size of the market. Interconnection of the two Luxembourg grids would be the first step in this direction. For technical and economic reasons, the interconnection of the two grids (CEGEDEL and SOTEL) may translate into a rise in transit flows with the risk of threatening the stability of the grids. The potential benefit of linking the two domestic networks needs further examination, which the regulator could accelerate.

Co-generation is essential to achieve energy efficiency goals. However, some co-generation technology is mature and no longer requires direct or indirect subsidy, while other technologies may need support. The government will need to investigate the cost-effectiveness of its current support mechanism for co-generation and modify it, if necessary. Possibilities to link the financial support mechanisms to improved efficiency and environmental performances (for example, in terms of CO₂ reductions) should be considered.

Additionally, it is important that district heating infrastructure is built under an economic rationale. Therefore, it should be ensured that the envisaged district heating grid from the new TWINerg plant will be built only if it provides heat to customers at a lower cost than would have been possible with other fuels.

RENEWABLES

Renewables are the only indigenous energy source in Luxembourg and, until the construction of the TWINerg plant, contributed a significant share to domestic electricity production.

Electricity generating capacity from renewable sources of energy (and co-generation) has expanded rapidly thanks to generous buy-back tariffs and direct subsidies, particularly for wind. Today 22 MW_e of wind power are installed and it is possible to expand this to 50 MW, according to the Ministry of Economic Affairs. The government also sees some potential in power generation from biomass.

However, the current feed-in tariff scheme does not have any time limit or degression element to lower the tariff over time. This lack of an incentive for investors to increase the productivity of their assets could eventually become very costly to the economy. A fund to compensate for the extra costs of feed-in tariffs has been established and is supported by all consumers linked to the low and medium (20 kV) voltage grids. The exemption for consumers linked to the high-voltage grid (industry) has been questioned on state-aid grounds by the European Commission. The government should accelerate the process of broadening the base of financial support for renewables.

Generous subsidies and feed-in tariffs for photovoltaics (PV) have made Luxembourg the world leader in solar PV power generation, on a per capita basis. Today 20 MW_p are installed. However, its contribution to electricity production is minimal, and considering Luxembourg's overall natural resource endowments, this policy may not be the most cost-effective option to achieve energy policy objectives.

The responsibility for promoting renewable energy was changed from the Ministry of Economic Affairs to the Ministry of Environment. A renewable energy promotion policy should be regarded not as an objective in itself, but as a tool in a broader policy portfolio to achieve energy security, environmental protection and economic efficiency. Splitting renewable energy promotion policy from overall energy policy could make it more difficult to compare the cost-effectiveness of renewable energy policy with other policy options. Luxembourg is planning to change the renewable promotion system in 2010 at the latest. This policy review should be accelerated and it should be ensured that the cost-effectiveness of renewable energy policy is assessed as part of the overall energy policy, ensuring close co-ordination of actions between the Ministry of Environment and the Ministry of Economic Affairs.

RECOMMENDATIONS

The government of Luxembourg should:

Electricity

- ▶ *Maintain an arm's length relationship with companies having state-ownership in the electricity sector.*
- ▶ *Keep under technical review the possibility of interconnecting the SOTEL and CEGEDEL networks in view of integrating further the Luxembourg market into the European electricity market.*
- ▶ *Ensure close co-operation between the regulator and its counterparts in neighbouring countries.*

- ▶ *Further consider cost-effective ways of supporting highly efficient co-generation, including linking financial support to efficiency criteria and environmental benefits or phasing out subsidies to co-generation.*

Renewables

- ▶ *Review the cost-effectiveness of the current scheme for PV.*
- ▶ *Review the tariff scheme and consider introducing degressivity over time. Try to find a more cost-effective system for renewables.*
- ▶ *Explore the possibilities of broadening the base of financial support for renewables promotion in Luxembourg.*
- ▶ *Assess renewable energy policies in the broader portfolio of energy policy.*

ENERGY BALANCES AND KEY STATISTICAL DATA

Unit: Mtoe

SUPPLY		1973	1990	2001	2002	2010	2020	2030
TOTAL PRODUCTION		0.00	0.03	0.06	0.06	0.05	..	..
Coal ¹		-	-	-	-	-	..	..
Oil		-	-	-	-	-	..	..
Gas		-	-	-	-	-	..	..
Comb. Renewables & Waste ²		-	0.03	0.05	0.04	0.04	..	..
Nuclear		-	-	-	-	-	..	..
Hydro		0.00	0.01	0.01	0.01	0.01	..	..
Geothermal		-	-	-	-	-	..	..
Solar/Wind/Other		-	-	0.00	0.00	0.00	..	..
TOTAL NET IMPORTS³		4.51	3.55	3.75	4.00	3.67	..	..
Coal ¹	Exports	-	-	-	-	-	..	..
	Imports	2.44	1.13	0.11	0.09	0.10	..	..
	Net Imports	2.44	1.13	0.11	0.09	0.10	..	..
Oil	Exports	0.01	0.01	0.03	0.02	-	..	..
	Imports	1.69	1.67	2.49	2.58	1.80	..	..
	Bunkers	-	-	-	-	-	..	..
	Net Imports	1.67	1.65	2.46	2.56	1.80	..	..
Gas	Exports	-	-	-	-	-	..	..
	Imports	0.22	0.43	0.69	1.05	1.47	..	..
	Net Imports	0.22	0.43	0.69	1.05	1.47	..	..
Electricity	Exports	0.07	0.06	0.06	0.25	0.18	..	..
	Imports	0.24	0.40	0.55	0.55	0.48	..	..
	Net Imports	0.18	0.34	0.49	0.30	0.30	..	..
TOTAL STOCK CHANGES		-0.01	-0.01	0.03	-0.02	-	..	..
TOTAL SUPPLY (TPES)		4.51	3.57	3.83	4.04	3.72	..	..
Coal ¹		2.44	1.13	0.11	0.09	0.10	..	..
Oil		1.67	1.64	2.48	2.54	1.80	..	..
Gas		0.22	0.43	0.69	1.05	1.47	..	..
Comb. Renewables & Waste ²		-	0.03	0.05	0.04	0.04	..	..
Nuclear		-	-	-	-	-	..	..
Hydro		0.00	0.01	0.01	0.01	0.01	..	..
Geothermal		-	-	-	-	-	..	..
Solar/Wind/Other		-	-	0.00	0.00	0.00	..	..
Electricity Trade ⁴		0.18	0.34	0.49	0.30	0.30	..	..
Shares (%)								
Coal		54.1	31.7	2.9	2.3	2.7	..	..
Oil		37.1	46.0	64.8	62.9	48.4	..	..
Gas		4.9	12.0	18.1	26.1	39.5	..	..
Comb. Renewables & Waste		-	0.7	1.2	1.1	1.1	..	..
Nuclear		-	-	-	-	-	..	..
Hydro		0.1	0.2	0.3	0.2	0.2	..	..
Geothermal		-	-	-	-	-	..	..
Solar/Wind/Other		-	-	0.1	-	0.1	..	..
Electricity Trade		3.9	9.5	12.7	7.3	8.0	..	..

0 is negligible, - is nil, .. is not available.

Please note: All forecast data are based on the 1999 submission.

DEMAND**FINAL CONSUMPTION BY SECTOR**

	1973	1990	2001	2002	2010	2020	2030
TFC	2.94	2.96	3.76	3.81	3.24	..	..
Blast Furnace Gas	0.74	0.20	-	-	-	..	..
Other Coal ¹	0.24	0.35	0.11	0.09	0.10	..	..
Oil	1.54	1.64	2.48	2.54	1.80	..	..
Gas	0.18	0.42	0.64	0.63	0.72	..	..
Comb. Renewables & Waste ²	-	-	0.02	0.02	0.01	..	..
Geothermal	-	-	-	-	-	..	..
Solar/Wind/Other	-	-	-	-	-	..	..
Electricity	0.26	0.36	0.48	0.49	0.55	..	..
Heat	-	-	0.03	0.04	0.06	..	..
Shares (%)							
Blast Furnace Gas	25.1	6.8	-	-	-	..	..
Other Coal	8.1	11.7	2.9	2.4	3.1	..	..
Oil	52.1	55.3	65.9	66.8	55.6	..	..
Gas	6.0	14.2	16.9	16.6	22.2	..	..
Comb. Renewables & Waste	-	-	0.4	0.4	0.4	..	..
Geothermal	-	-	-	-	-	..	..
Solar/Wind/Other	-	-	-	-	-	..	..
Electricity	8.7	12.0	12.9	12.8	16.9	..	..
Heat	-	-	0.9	0.9	1.8	..	..
TOTAL INDUSTRY⁵	2.09	1.34	0.94	0.90	1.04	..	..
Blast Furnace Gas	0.74	0.20	-	-	-	..	..
Other Coal ¹	0.20	0.34	0.11	0.09	0.10	..	..
Oil	0.81	0.30	0.08	0.06	0.09	..	..
Gas	0.14	0.28	0.41	0.41	0.45	..	..
Comb. Renewables & Waste ²	-	-	-	-	-	..	..
Geothermal	-	-	-	-	-	..	..
Solar/Wind/Other	-	-	-	-	-	..	..
Electricity	0.20	0.23	0.32	0.32	0.37	..	..
Heat	-	-	0.02	0.02	0.04	..	..
Shares (%)							
Blast Furnace Gas	35.4	15.1	-	-	-	..	..
Other Coal	9.7	25.3	11.7	10.3	9.2	..	..
Oil	38.6	22.0	8.7	6.8	8.7	..	..
Gas	6.6	20.8	43.4	45.2	42.8	..	..
Comb. Renewables & Waste	-	-	-	-	-	..	..
Geothermal	-	-	-	-	-	..	..
Solar/Wind/Other	-	-	-	-	-	..	..
Electricity	9.7	16.8	34.0	35.5	35.1	..	..
Heat	-	-	2.2	2.2	4.2	..	..
TRANSPORT⁶	0.29	1.03	2.03	2.18	1.41	..	..
TOTAL OTHER SECTORS⁷	0.56	0.59	0.80	0.73	0.79	..	..
Coal ¹	0.03	0.01	0.00	0.00	0.00	..	..
Oil	0.44	0.31	0.38	0.31	0.31	..	..
Gas	0.04	0.14	0.23	0.23	0.27	..	..
Comb. Renewables & Waste ²	-	-	0.02	0.02	0.01	..	..
Geothermal	-	-	-	-	-	..	..
Solar/Wind/Other	-	-	-	-	-	..	..
Electricity	0.05	0.13	0.16	0.16	0.17	..	..
Heat	-	-	0.01	0.02	0.02	..	..
Shares (%)							
Coal	6.1	1.0	0.1	0.1	0.5	..	..
Oil	78.4	53.6	47.3	42.3	39.3	..	..
Gas	6.8	24.1	29.1	31.1	34.6	..	..
Comb. Renewables & Waste	-	-	2.0	2.0	1.8	..	..
Geothermal	-	-	-	-	-	..	..
Solar/Wind/Other	-	-	-	-	-	..	..
Electricity	8.8	21.3	19.9	22.0	21.9	..	..
Heat	-	-	1.6	2.2	1.9	..	..

DEMAND							
ENERGY TRANSFORMATION AND LOSSES							
	1973	1990	2001	2002	2010	2020	2030
ELECTRICITY GENERATION⁸							
INPUT (Mtoe)	0.44	0.20	0.10	0.46	0.58	..	..
OUTPUT (Mtoe)	0.12	0.05	0.04	0.24	0.30	..	..
(TWh gross)	1.39	0.62	0.50	2.79	3.48	..	..
Output Shares (%)							
Blast Furnace Gas	58.8	76.4	-	-	-	..	..
Other Coal	-	-	-	-	-	..	..
Oil	27.6	1.4	-	-	-	..	..
Gas	10.2	5.4	56.0	92.8	94.8	..	..
Comb. Renewables & Waste	-	5.4	11.8	2.2	1.4	..	..
Nuclear	-	-	-	-	-	..	..
Hydro	3.4	11.2	26.7	4.0	2.6	..	..
Geothermal	-	-	-	-	-	..	..
Solar/Wind/Other	-	-	5.4	0.9	1.1	..	..
TOTAL LOSSES	1.54	0.61	0.07	0.23	0.48	..	..
of which:							
Electricity and Heat Generation ⁹	0.32	0.14	0.02	0.18	0.23	..	..
Other Transformation	1.08	0.41	-	-	-	..	..
Own Use and Losses ¹⁰	0.14	0.06	0.04	0.05	0.25	..	..
Statistical Differences	0.02	0.00	0.00	0.00	-	..	..
INDICATORS							
	1973	1990	2001	2002	2010	2020	2030
GDP (billion 1990 US\$)	8.44	14.90	25.77	26.10	31.31	..	..
Population (millions)	0.35	0.38	0.44	0.45	0.49	..	..
TPES/GDP ¹¹	0.53	0.24	0.15	0.15	0.12	..	..
Energy Production/TPES	0.00	0.01	0.02	0.01	0.01	..	..
Per Capita TPES ¹²	12.83	9.35	8.67	9.06	7.65	..	..
Oil Supply/GDP ¹¹	0.20	0.11	0.10	0.10	0.06	..	..
TFC/GDP ¹¹	0.35	0.20	0.15	0.15	0.10	..	..
Per Capita TFC ¹²	8.39	7.74	8.52	8.53	6.66	..	..
Energy-related CO ₂ Emissions (Mt CO ₂) ¹³	16.5	10.5	8.4	9.3	8.1	..	..
CO ₂ Emissions from Bunkers (Mt CO ₂)	0.2	0.4	1.1	1.2	1.2	..	..
GROWTH RATES (% per year)							
	1973	1990	2001	2002	2010	2020	2030
TPES	-2.5	-0.8	0.6	5.4	-1.0	..	..
Coal	-4.6	-4.3	-19.1	-15.5	0.9	..	..
Oil	-4.0	2.1	3.8	2.4	-4.2	..	..
Gas	13.6	-0.8	4.5	51.7	4.2	..	..
Comb. Renewables & Waste	-	3.0	5.7	-4.3	-0.6	..	..
Nuclear	-	-	-	-	-	..	..
Hydro	12.2	-2.6	5.7	-9.1	-2.8	..	..
Geothermal	-	-	-	-	-	..	..
Solar/Wind/Other	-	-	-	-	9.1	..	..
TFC	-0.1	0.1	2.2	1.1	-2.0	..	..
Electricity Consumption	2.7	1.6	2.9	0.8	1.4	..	..
Energy Production	36.6	1.6	6.2	-6.7	-0.5	..	..
Net Oil Imports	-3.5	1.8	3.7	4.3	-4.3	..	..
GDP	1.3	4.6	5.1	1.3	2.3	..	..
Growth in the TPES/GDP Ratio	-3.7	-5.1	-4.2	4.1	-3.3	..	..
Growth in the TFC/GDP Ratio	-1.3	-4.3	-2.8	-0.2	-4.2	..	..

Please note: Rounding may cause totals to differ from the sum of the elements.

FOOTNOTES TO ENERGY BALANCES AND KEY STATISTICAL DATA

1. Includes lignite.
2. Comprises solid biomass, biogas and municipal waste. Data are often based on partial surveys and may not be comparable between countries.
3. Total net imports include combustible renewables and waste.
4. Total supply of electricity represents net trade.
5. Includes non-energy use.
6. Includes less than 1% non-oil fuels.
7. Includes residential, commercial, public service and agricultural sectors.
8. Inputs to electricity generation include inputs to electricity and CHP. Output refers only to electricity generation.
9. Losses arising in the production of electricity and heat at public utilities and autoproducers. For non-fossil-fuel electricity generation, theoretical losses are shown based on plant efficiencies of 100% for hydro.
10. Data on "losses" for forecast years often include large statistical differences covering differences between expected supply and demand and mostly do not reflect real expectations on transformation gains and losses.
11. Toe per thousand US dollars at 1995 prices and exchange rates.
12. Toe per person.
13. "Energy-related CO₂ emissions" specifically means CO₂ from the combustion of the fossil fuel components of TPES (*i.e.* coal and coal products, peat, crude oil and derived products and natural gas), while CO₂ emissions from the remaining components of TPES (*i.e.* electricity from hydro, other renewables and nuclear) are zero. Emissions from the combustion of biomass-derived fuels are not included, in accordance with the IPCC greenhouse gas inventory methodology. Also in accordance with the IPCC methodology, emissions from international marine and aviation bunkers are not included in national totals. Projected emissions for oil and gas are derived by calculating the ratio of emissions to energy use for 2002 and applying this factor to forecast energy supply. Future coal emissions are based on product-specific supply projections and are calculated using the IPCC/OECD emission factors and methodology.

INTERNATIONAL ENERGY AGENCY “SHARED GOALS”

Member countries* of the IEA seek to create the conditions in which the energy sectors of their economies can make the fullest possible contribution to sustainable economic development and the well-being of their people and of the environment. In formulating energy policies, the establishment of free and open markets is a fundamental point of departure, though energy security and environmental protection need to be given particular emphasis by governments. IEA countries recognise the significance of increasing global interdependence in energy. They therefore seek to promote the effective operation of international energy markets and encourage dialogue with all participants.

In order to secure their objectives they therefore aim to create a policy framework consistent with the following goals:

- 1. Diversity, efficiency and flexibility within the energy sector** are basic conditions for longer-term energy security: the fuels used within and across sectors and the sources of those fuels should be as diverse as practicable. Non-fossil fuels, particularly nuclear and hydro power, make a substantial contribution to the energy supply diversity of IEA countries as a group.
- 2. Energy systems should have the ability to respond promptly and flexibly to energy emergencies.** In some cases this requires collective mechanisms and action: IEA countries co-operate through the Agency in responding jointly to oil supply emergencies.
- 3. The environmentally sustainable provision and use of energy** is central to the achievement of these shared goals. Decision-makers should seek to minimise the adverse environmental impacts of energy activities, just as environmental decisions should take account of the energy consequences. Government interventions should where practicable have regard to the Polluter Pays Principle.
- 4. More environmentally acceptable energy sources** need to be encouraged and developed. Clean and efficient use of fossil fuels is essential. The development of economic non-fossil sources is also a priority. A number of IEA members wish to retain and improve the nuclear

* Australia, Austria, Belgium, Canada, the Czech Republic, Denmark, Finland, France, Germany, Greece, Hungary, Ireland, Italy, Japan, Korea, Luxembourg, the Netherlands, New Zealand, Norway, Portugal, Spain, Sweden, Switzerland, Turkey, the United Kingdom, the United States.

option for the future, at the highest available safety standards, because nuclear energy does not emit carbon dioxide. Renewable sources will also have an increasingly important contribution to make.

5. Improved energy efficiency can promote both environmental protection and energy security in a cost-effective manner. There are significant opportunities for greater energy efficiency at all stages of the energy cycle from production to consumption. Strong efforts by governments and all energy users are needed to realise these opportunities.

6. Continued research, development and market deployment of new and improved energy technologies make a critical contribution to achieving the objectives outlined above. Energy technology policies should complement broader energy policies. International co-operation in the development and dissemination of energy technologies, including industry participation and co-operation with non-member countries, should be encouraged.

7. Undistorted energy prices enable markets to work efficiently. Energy prices should not be held artificially below the costs of supply to promote social or industrial goals. To the extent necessary and practicable, the environmental costs of energy production and use should be reflected in prices.

8. Free and open trade and a secure framework for investment contribute to efficient energy markets and energy security. Distortions to energy trade and investment should be avoided.

9. Co-operation among all energy market participants helps to improve information and understanding, and encourage the development of efficient, environmentally acceptable and flexible energy systems and markets worldwide. These are needed to help promote the investment, trade and confidence necessary to achieve global energy security and environmental objectives.

(The Shared Goals were adopted by IEA Ministers at their 4 June 1993 meeting in Paris.)

GLOSSARY AND LIST OF ABBREVIATIONS

In this report, abbreviations are substituted for a number of terms used within the International Energy Agency. While these terms generally have been written out on first mention and abbreviated subsequently, this glossary provides a quick and central reference for many of the abbreviations used.

CEGEDEL	Compagnie Grand-Ducale de l'Électricité.
CCGT	Combined-cycle gas turbine.
CEFRALUX	Centrale Electrique Franco-Luxembourgeoise SARL.
CHP	combined production of heat and power; sometimes, when referring to industrial CHP, the term "co-generation" is used.
EU	The European Union, whose members are Austria, Belgium, Denmark, Finland, France, Germany, Greece, Ireland, Italy, Luxembourg, the Netherlands, Portugal, Spain, Sweden and the United Kingdom. Since May 2004, ten new countries became members: Cyprus, the Czech Republic, Estonia, Hungary, Latvia, Lithuania, Malta, Poland, Slovakia, Slovenia.
FCCC	Framework Convention on Climate Change.
FEDIL	Fédération des Industriels Luxembourgeois.
GDP	gross domestic product.
GHG	greenhouse gas.
GW	gigawatt, or one watt $\times 10^9$.
IEP	International Energy Program.
ILR	Institut Luxembourgeois de Régulation.
LPG	liquefied petroleum gas; refers to propane, butane and their isomers, which are gases at atmospheric pressure and normal temperature.

LUF	Luxembourg francs.
mcm	million cubic metres.
Mt	million tonnes.
Mtoe	million tonnes of oil equivalent; see toe.
MW	megawatt of electricity, or one watt $\times 10^6$.
MWh	megawatt-hour = one megawatt \times one hour, or one watt \times one hour $\times 10^6$.
NESO	National Oil Emergency Organisation.
OECD	Organisation for Economic Co-operation and Development.
Pb	lead.
PPP	purchasing power parity: the rate of currency conversion that equalises the purchasing power of different currencies, <i>i.e.</i> estimates the differences in price levels between different countries.
R&D	research and development, especially in energy technology; may include the demonstration and dissemination phases as well.
RWE	Rheinisch-Westfaelische Elektrizitaetswerke.
SEO	Société Electrique de l'Our.
SOTEG	Société de transport de gaz.
SOTEL	Société de transport de l'électricité.
toe	tonne of oil equivalent.
TFC	total final consumption of energy; the difference between TPES and TFC consists of net energy losses in the production of electricity and synthetic gas, refinery use and other energy sector uses and losses.
TPES	total primary energy supply.
TSO	transmission system operator.
TW	terawatt, or one watt $\times 10^{12}$.
TWh	terawatt \times one hour, or one watt \times one hour $\times 10^{12}$.
VOC	Volatile organic compound.

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