INTERNATIONAL ENERGY AGENCY

Energy Policies of IEA Countries

LUXEMBOURG

2008 Review

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Luxembourg has reformed its energy policies across all sectors since the last IEA in-depth review in 2004. The country has fully liberalised its electricity and natural gas markets, and is actively participating in the development of the evolving Central West European regional electricity system. Luxembourg has also prepared a broad action plan on energy efficiency, improved the support system for renewable energy sources and revised taxes to mitigate climate change.

The country's energy policy in the coming decade will be shaped by the EU 2020 targets that call for substantial reductions in greenhouse gas emissions, and strong increases in renewable energy and energy efficiency. These targets will be hard to meet, given that roughly half of energy-related CO_2 emissions come from transport fuel use by foreign truckers and motorists, and that Luxembourg's potential for producing much more renewable energy is limited.

Luxembourg is heavily dependent on oil. Although oil sources are well diversified by country of origin, more than 85% of oil stocks are held in neighbouring countries and often based on short-term leasing contracts. This leaves the country vulnerable to potential oil supply disruptions. Luxembourg should swiftly implement a plan to improve the security of oil supply.

This review analyses the energy challenges facing Luxembourg and provides critiques and recommendations for further policy improvements. It is intended to help guide the country towards achieving its sustainability targets.

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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-eight of the OECD 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 promote international collaboration on energy technology.
- To assist in the integration of environmental and energy policies.

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

ORGANISATION FOR ECONOMIC CO-OPERATION AND DEVELOPMENT

The OECD is a unique forum where the governments of thirty democracies work together to address the economic, social and environmental challenges of globalisation. The OECD is also at the forefront of efforts to understand and to help governments respond to new developments and concerns, such as corporate governance, the information economy and the challenges of an ageing population. The Organisation provides a setting where governments can compare policy experiences, seek answers to common problems, identify good practice and work to co-ordinate domestic and international policies.

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

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EXECUTIVE SUMMARY AND KEY RECOMMENDATIONS

EXECUTIVE SUMMARY

Since the previous in-depth review in 2004, Luxembourg has reformed its energy policies across all sectors. It has also fully liberalised its electricity and natural gas markets, and is actively participating in the development of the evolving Central West European regional electricity system. It is in compliance with the IEA oil security requirements; it has prepared a broad action plan on energy efficiency and revised the requirements for energy efficiency in buildings. It has also changed car taxation to reflect CO_2 emissions and improved the support system for renewable energy sources. All these are significant improvements over the situation in 2004. The IEA congratulates Luxembourg for this clear progress.

Increasingly, the country's energy policy is and will be directed by decisions taken at the European Union (EU) level. This holds true for all EU member countries, but more so for Luxembourg because of the small size of its energy sector. EU law now sets requirements for electricity and natural gas markets, and for energy efficiency in appliances and buildings. It sets targets for total greenhouse gas (GHG) emissions and, through the EU Emissions Trading Scheme (EU-ETS), for CO_2 emissions from heavy industry and power and heat generation. It also sets minimum taxes the country must apply to energy products. The EU member states have non-binding targets for energy saving and for the share of renewable energy in total final consumption of energy (TFC), electricity supply and transport fuels. But this is not all.

The EU targets for 2020 on GHG mitigation, renewable energy and energy efficiency will shape energy policy in Luxembourg and the EU member countries in the coming decade. Under the target to reduce GHG emissions in the EU by 20% from 1990 to 2020, Luxembourg will have to cut emissions from the sectors outside of the EU-ETS by 20%. It will also have to increase the share of renewable energy sources in final energy consumption from 0.9% in 2005 to 11% in 2020, including providing 10% of transport fuels from renewable sources. And it will have to increase energy efficiency to contribute to the EU's target of reducing energy demand by 20% from the business-as-usual level in 2020.

In many ways, Luxembourg is a special case among IEA countries. It is the smallest member country, with the highest GDP per capita. Its economy employs the highest share of cross-border workers, around 40% of the workforce. It also has some of the lowest taxes on energy products, most

importantly on diesel. These characteristics all partly explain why the country has the highest total primary energy supply (TPES) level per head, the highest share of fossil fuels in its TPES and, consequently, the highest GHG emission per head among IEA countries. Oil accounts for more than 60% of TPES, and 90% of this oil is used for transport. Sales of diesel and gasoline to foreigners, in turn, account for roughly four-fifths of total transport fuel use. These significant diesel and gasoline sales to motorists and truckers who cross the border raise considerable tax revenues, but also lead to challenges in climate change policy and security of supply.

Climate change mitigation is a hard nut to crack for Luxembourg. The country must reduce its GHG emissions by 28% below their 1990 level in 2008-2012. More reductions will be needed after 2012, on the basis of a target of –21% from 2005 to 2020 for sectors covered by the EU-ETS, and –20% from 2005 to 2020 for all other sectors. Luxembourg's domestic efforts to limit CO_2 emissions have focused on promoting energy efficiency and renewable energy sources through various measures. Given the volume of transport fuel sales, however, these domestic measures will be insufficient.

Energy efficiency measures generally offer the least-cost options for domestic emissions reductions. In Luxembourg, the government has compiled a National Energy Efficiency Action Plan, with the aim of reducing energy use by 9% below the annual average of 2001-2005 by 2016, as required by EU law. The IEA urges Luxembourg to implement the plan without delay. Yet, even if fully implemented, the plan would only provide a partial solution to the emissions reduction challenge.

The economic viability for increasing renewable energy production is limited by the country's size, topography, nature protection policies and population density. Electricity from renewable sources contributes very little or nothing to meeting the country's target under the Kyoto Protocol, nor is it likely to for any future GHG target. This is because domestic renewable generation only replaces electricity imports, and these imports are not counted in Luxembourg's GHG balance, regardless of the energy source from which they are generated. Biofuels, in turn, contribute to reducing Luxembourg's GHG emissions, but they do little to improve the country's energy security, as they are all imported directly, or in the form of feedstocks. Domestic renewable energy sources are, therefore, not likely to significantly help in improving energy security and curbing GHG emissions at a reasonable cost. The country should consider all opportunities for green certificate trading and participating in international joint projects to be better able to reach the 2020 target.

In the short term, the largest contribution to meeting Luxembourg's GHG targets will come from the use of the Kyoto flexible mechanisms. The rules on their use after 2012, including any limits on the share of total emissions reductions they will bring, are yet to be adopted, but Luxembourg may find it will be necessary to reduce oil use. The government should prepare for

the post-Kyoto period by developing an integrated medium- to long-term energy and climate strategy, with a clear focus on measures in the transport sector.

Luxembourg is already increasing excise taxes on transport fuels to reduce the differences with its neighbouring countries, and earmarking these increased revenues for mitigating climate change. This policy deserves to be applauded, also on energy efficiency grounds, as higher prices encourage more efficient use. The government should consider continuing to gradually increase these excise taxes. It should also look further into the policies of the countries that have managed to successfully reduce oil use in space heating.

As Luxembourg depends almost completely on imports for its energy supply, securing these supplies is crucial for the country. Oil supplies are well diversified by country of origin, but more than 85% of the IEA minimum stockholding obligation is met by stocks held in neighbouring countries. Moreover, these stocks are often based on short-term leasing contracts, leaving the country vulnerable to potential oil supply disruptions. The government is intending to create a stockholding agency and to increase domestic storage capacity, but at the same time more than half of the current storage capacity may have to be closed in the next five years, requiring an even greater share of stocks to be held abroad. Without action, the country could face serious risks in its domestic oil supply chain, becoming more vulnerable to disruptions caused by events such as labour strikes or weather conditions which hinder fuel deliveries by road or rail. Large sales of transport fuels to foreign drivers are further putting at risk the availability of oil for domestic consumers in a supply disruption. The government should improve security of oil supply by urgently implementing a plan to maintain sufficient domestic storage capacity and swiftly revising the stockholding regime.

Supplies of natural gas are relatively well diversified by country of origin and by transportation route. The networks are well maintained, and interruptible contracts are further adding to security of supply. Network operators, suppliers and wholesale customers are also obliged to guarantee the security of supply to end consumers. As Luxembourg does not have natural gas storage or line pack, and the largest gas-fired power plant is not interruptible, raising the entry capacities would further improve supply security and provide greater flexibility for supply routes.

Luxembourg relies on imports for half of its electricity supply, and its electricity security largely depends on developments in neighbouring countries. Also for security of supply reasons, the country is actively pursuing the development of a regional electricity market in Central West Europe, and it is planning to increase its already ample interconnection capacity by new links with its neighbours. The IEA encourages the government to proceed with the implementation of these plans.

Since the last review in 2004, Luxembourg's electricity and natural gas market legislation has been fundamentally reformed on the basis of EU directives. The new laws entered into force on 1 August 2007. All customers are now free to choose their supplier, and third-party access to networks is guaranteed on an equal and transparent basis. The regulator has been strengthened, and *ex ante* regulation is now applied to network tariffs. Moreover, the electricity transmission system operators have been legally unbundled, and in the gas sector legal unbundling will take effect by July 2009.

Luxembourg's electricity and natural gas markets are both small and, as in many other countries, dominated by a few vertically integrated companies. The government continues to be the largest shareholder in the gas and electricity incumbents, and their merger is currently under review by the competition authorities. The government should continue to guarantee a level playing field for all participants, and ensure the regulator has sufficient powers and resources for doing this.

KEY RECOMMENDATIONS

The government of Luxembourg should:

- *Prepare for meeting future targets on greenhouse gas emissions by developing an integrated medium- to long-term energy and climate strategy, with a focus on transport.*
- *Consider all opportunities for certificate trading and participating in international joint projects to be better able to reach the 2020 targets for renewable energy sources and greenhouse gas emissions.*
- *Improve the security of oil supply by urgently implementing a plan to maintain sufficient domestic storage capacity and swiftly revising the stockholding regime.*

PART I

POLICY ANALYSIS

Figure 1

Map of Luxembourg

Note: The boundaries and names shown and the designations used on this map do not imply official endorsement or acceptance by the IEA.

Source: IEA.

COUNTRY OVERVIEW

The Grand Duchy of Luxembourg (hereafter Luxembourg) lies in the west of Europe, bordering on France, Belgium and Germany. With a population of 486 000 and a surface area of 2 586 km^2, it is the smallest IEA member country. Luxembourg's population has grown by more than a quarter over the past two decades, as a result of immigration. More than one in three residents is foreign-born, by far the highest share within the OECD.

Independent since 1867, the country has built up a reputation for prosperity and stability. Luxembourg is one of the six founding members of the European Economic Community (later the European Union), and it adopted the euro as its currency in 1999.[1]

Luxembourg's per-capita GDP (USD 82 000 at purchasing power parity in 2007) was the highest within the OECD, two-and-half times above the OECD average. Unemployment has decreased over the past several years, and now stands at less than 5%. GDP has grown very fast over the past two decades, at an annual average rate of 5.2%. Real GDP growth amounted to 6.1% in 2006, 4.5% in 2007 and an estimated 2.5% in 2008.

GDP figures are, however, somewhat misleading, because more than 40% of the workforce are cross-border commuters whose salaries contribute to GDP in Luxembourg, but are spent mostly outside the country. In the same vein, the profits of the many foreign-owned financial institutions based in Luxembourg are normally not spent in the country. Because of its small size, the country's economy is sometimes better understood in a regional context, as forming part of an economic area with the neighbouring regions in France, Germany, Belgium and even the Netherlands.

As in all developed economies, services are the biggest sector, but in Luxembourg they are even more dominant than in most countries. Led by the globally prominent financial sector, services provided 84% of GDP in 2007. The country's industry (9% of GDP) is traditionally based on the production of steel and related products. Construction accounted for 6% of GDP and the primary sector (agriculture and forestry) for 0.4%.

1. On average in 2007, EUR 1 = USD 1.3699.

Luxembourg is a constitutional monarchy, where the Grand Duke has a largely ceremonial role. The single-chamber parliament is elected by proportional representation. Since 2004, the country is ruled by a left-right coalition of the two largest parties. The next parliamentary elections will be held in June 2009.

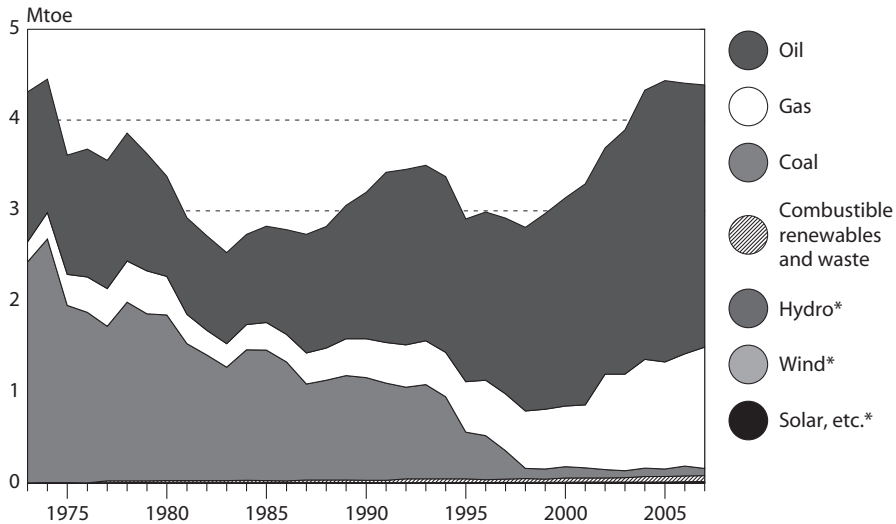
SUPPLY AND DEMAND

SUPPLY

Luxembourg's total primary energy supply (TPES) was 4.7 million tonnes of oil equivalent (Mtoe) in 2007 (see Annex B and Figure 2). From 1990 to 2007, TPES increased by a third, while GDP more than doubled, boosted by rapid growth in financial services. In 2007, oil accounted for 61% of TPES, natural gas for 28% and coal for 2%. Net imports of electricity supplied 7% of the country's energy needs, and the remaining 2% came from renewable sources, mostly biofuels for transport and other biomass-based fuels, but also small quantities of hydro and wind power. Close to 100% of TPES therefore comes from imports, including half of the country's electricity supply. If net imports of electricity are excluded from the comparison, Luxembourg's TPES has the highest share of fossil fuels within the IEA countries, around 97% in 2007 (see Figure 3).

Figure 2

Total Primary Energy Supply, 1973 to 2007

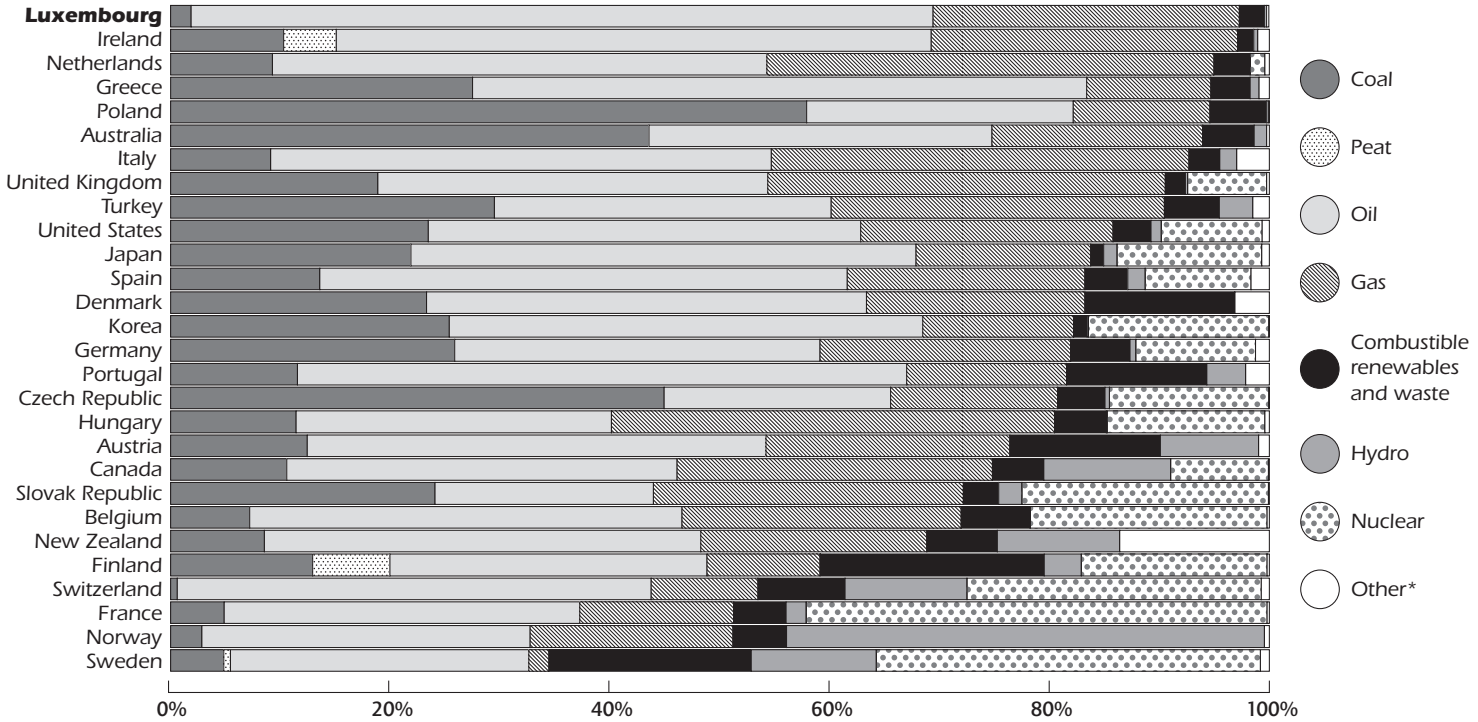


* negligible.

Source: *Energy Balances of OECD Countries*, IEA/OECD Paris, 2008.

Figure 3

Total Primary Energy Supply in IEA Member Countries, 2007



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

Source: E*nergy Balances of OECD Countries*, IEA/OECD Paris, 2008.

Oil's growing dominance in Luxembourg's energy supply since the late 1990s is explained by the large sales of diesel and gasoline to foreign drivers, *i.e.* sales of fuel that is used in Luxembourg only to a small extent. These buyers are normally truckers crossing Luxembourg and cross-border commuters that make up around 40% of the country's workforce. Transport fuels in Luxembourg are cheaper than in most neighbouring countries, because of low excise taxes. Domestic transport fuel use is estimated to account for around one-fifth of total sales volume in Luxembourg.

Reflecting this oil supply situation, but also the energy needs of the country's large steel industry, Luxembourg has the highest TPES per head among the IEA member countries. Together with the high share of fossil fuels in TPES, Luxembourg emits more CO_2 per capita than any other IEA member country (see Chapter 3, section on Climate Change). Energy intensity, however, is close to the IEA average, thanks to the service-intensive economy.

DEMAND

In 2007, Luxembourg's total final consumption of energy (TFC) was 4.4 Mtoe, up 50% from 1990. Transport was the largest user, accounting for 59% of the total. Industry's share was 25% and the other sectors (residential and services, and the primary sector) used 16% of the total. These shares have been fairly stable over the past five years. In comparison, the IEA averages in 2005 were 32% for industry, and 34% for both transport and other sectors. Oil was by far the largest source of Luxembourg's final energy use, accounting for 66% of the total in 2007 (see Figure 4). Reflecting natural gas use for electricity generation, mostly at the 350 MW Twinerg plant that was commissioned in 2002, gas provided 18% of TFC, as compared to 28% of TPES. Electricity accounted for 13% of TFC.

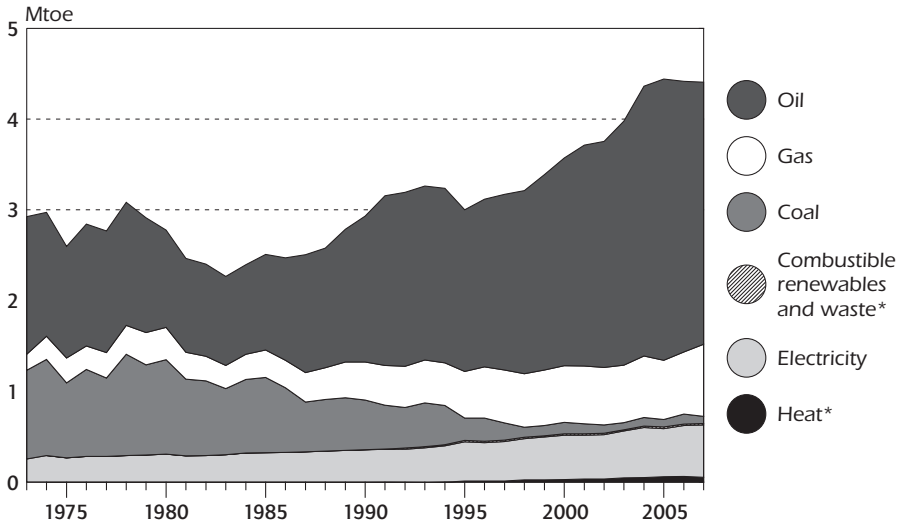
Luxembourg does not publish energy forecasts. Preparing accurate forecasts would be complicated, because of the transit-country position and the large number of cross-border consumers fuelling in Luxembourg. The impact of these consumers on national TFC largely depends on the differences in excise and value-added taxes on transport fuels between Luxembourg and its neighbours.

INSTITUTIONS

In Luxembourg, developing energy policy rests with the central government. The main government bodies active in energy policy are the following:

Figure 4

Total Final Consumption by Source, 1973 to 2007



* negligible.

Source: *Energy Balances of OECD Countries*, IEA/OECD Paris, 2008.

- *Ministry of Economic Affairs and Foreign Trade*

The ministry is in charge of general energy policy, electricity and gas markets, energy efficiency and renewable energy policies. It shares some of the responsibilities for energy efficiency and renewable energy policies with the Ministry of the Environment. Within the ministry, the Directorate for Energy, with a staff of eight people, has an overall co-ordination and planning role for energy policy.

- *Ministry of the Environment*

The ministry is in charge of climate policy. It has the responsibility for energy efficiency and renewable energy policies in the domestic sector which it shares with the Ministry of Economic Affairs and Foreign Trade. Within the ministry, these policies are the responsibility of the Administration for the Environment.

- *National Energy Agency (Agence de l'Energie)*

The National Energy Agency is responsible for implementing energy policy in the field of energy efficiency and renewable energy sources. It is a public-private partnership owned 50/50 by the State and the electricity industry (Cegedel 40%, SEO 10%). It has a staff of 10 people. The agency is undergoing a structural reform which was to be finalised in 2008.

- *Institut Luxembourgeois de Régulation*

The Institut Luxembourgeois de Régulation (ILR) regulates electricity since 2000 and natural gas since 2001. For both markets, its responsibilities include competition issues, network access and usage issues, and market supervision. The ILR also regulates postal services and telecommunications. For electricity and natural gas, it has a staff of three people.

KEY POLICIES

The current government programme for 2004–2009 sets the following goals for energy policy:

- Opening the electricity and natural gas markets to competition;
- Guaranteeing a high level of energy security by developing energy infrastructure, including cross-border interconnections, and through secure and competitive access to that infrastructure;
- Further increasing energy efficiency;
- Reconciling energy policy with social, environmental and economic considerations, both nationally and internationally.

Today, many of Luxembourg's energy policy goals are derived from the EU level, and the trend is for more commonly agreed targets and directives. For example, EU law now sets requirements for electricity and natural gas markets, and for energy efficiency in appliances and buildings. The EU member states have non-binding targets for energy saving and for the share of renewable energy in TFC, electricity supply and transport fuels. What is more, they have binding targets for total GHG emissions and, through the EU-ETS, for CO_2 emissions from heavy industry and large power and heat generation.

The EU targets for 2020 on GHG mitigation, renewable energy and energy efficiency will shape Luxembourg's energy policy in the coming decade. Under the target to reduce GHG emissions in the EU by 20% from 1990 level to 2020, Luxembourg will have to cut emissions from the sectors outside of the EU-ETS by 20% below 2005 levels. It will also have to increase the share of renewable energy sources in final energy consumption from 0.9% in 2005 to 11% in 2020. And it will have to increase energy efficiency to contribute to the EU target of reducing energy demand by 20% from the business-as-usual level by 2020.

SECURITY OF SUPPLY

As Luxembourg depends almost completely on imports for its energy supply, securing these supplies is crucial for the country. Oil supplies are well diversified by country of origin, but more than 85% of the IEA minimum

stockholding obligation is met by stocks held in neighbouring countries. Moreover, these stocks are often based on short-term leasing contracts, leaving the country vulnerable to oil supply disruptions. The government is intending to create a stockholding agency and to increase domestic storage capacity, but at the same time more than half of the current storage capacity may have to be closed in the next five years. Large sales of transport fuels to foreign drivers are further putting at risk the availability of oil for domestic consumers in a supply disruption.

Supplies of natural gas are relatively well diversified by country of origin and by transportation route. The networks are well maintained, and interruptible contracts are further adding to security of supply. Network operators, suppliers and wholesale customers are also obliged to guarantee the security of supply to end consumers. Raising the entry capacities would further improve supply security and provide greater flexibility for supply routes.

Luxembourg relies on imports for half of its electricity supply, and its electricity security largely depends on developments in the neighbouring countries. Also for security of supply reasons, the country is actively pursuing the development of a regional electricity market in Central West Europe, and it is planning to increase its already ample interconnection capacity by new links with its neighbours.

CLIMATE CHANGE MITIGATION

Climate change mitigation is a real challenge for Luxembourg. The country's target under the EU Burden-Sharing Agreement related to the Kyoto Protocol is to reduce its GHG emissions by 28% below their 1990 level in 2008-2012. More reductions will be needed after 2012: emissions from the sectors not covered by the EU-ETS must be 20% below the 2005 levels by 2020. For the ETS sector in the EU as a whole, the reduction target is 21% below the 2005 level by 2020.

Domestic efforts to limit CO_2 emissions have focused on promoting energy efficiency and renewable energy sources through various measures. The large sales of transport fuel to foreign motorists and truckers, however, make these domestic measures insufficient. Meeting the GHG targets will primarily be based on the use of the Kyoto flexible mechanisms: joint implementation (JI) and clean development mechanism (CDM).

MARKET REFORM

Since the last review in 2004, Luxembourg's electricity and natural gas market legislation was fundamentally reformed on the basis of EU directives. The new laws have been in force since 1 August 2007. All customers are now free to choose their supplier, and third-party access to the networks is guaranteed on

an equal and transparent basis. The regulator is strengthened, and *ex ante* regulation is applied to network tariffs. The electricity transmission system operators are legally unbundled, and in the gas sector legal unbundling will take effect by July 2009.

Both the electricity and natural gas markets are small and, as in many other countries, dominated by a few vertically integrated companies. The government continues to be the largest shareholder in the gas and electricity incumbents. Distribution companies are typically owned by municipalities. Cross-ownership is common. Competition in the electricity market is, however, increasing, as the number of wholesale suppliers to Luxembourg is growing. Also, supplier switching among the largest users is becoming more and more common. Sufficient interconnections and the evolving regional wholesale market in Central West Europe are set to increase these trends. In the gas market, the situation is different, as practically all gas is imported by SOTEG, the incumbent, and gas use is dominated by the 350 MW Twinerg power plant.

TAXATION

Taxes are generally low in Luxembourg, and energy products are no exception. Energy taxation levels are among the lowest within the IEA European countries in all product and consumer categories. In particular, excise taxes on gasoline and diesel remain significantly lower than in most neighbouring countries, even after several increases in recent years (see Chapter 4, section on Oil). These price differences have led to strong growth in fuel sales to motorists and truckers who cross the border, increasing Luxembourg's excise tax revenues but also CO_2 emissions. Taxes on heating oil for households are the second-lowest within IEA Europe. Taxes are generally used for fiscal purposes, but since January 2007, excise taxes on transport fuels have been gradually raised to finance measures to mitigate GHG emissions (see Chapter 3, section on Climate Change)

CRITIQUE

Since the previous in-depth review in 2004, Luxembourg has seen many positive developments in its energy sector. For the past two years, it has been in full compliance with the IEA stockholding requirements. Opening the electricity and gas markets to all customers was a milestone and increasing the regulator's powers was an essential element in developing these markets. In the field of energy efficiency, several commendable initiatives have been undertaken: much stricter requirements have been introduced for new buildings, which is particularly important over the long term, and vehicle taxation has been revised.

Luxembourg's energy policy is mostly guided by EU regulations and directives. Although yet to be confirmed, the coming obligations for 2020 on GHG reductions and renewable energy are likely to be very challenging for the

country. In preparing to meet them, the government should opt for the most cost-effective policies and measures. Many of these measures are listed in the National Energy Efficiency Action Plan (NEEAP). To facilitate the development of policies in this field, the government should also intensify its efforts to raise public awareness of the importance of climate policy and the need for action by energy users.

Another particularly challenging issue is the high dependence on oil. In 2007, oil accounted for 61% of TPES, the highest share within the IEA. All oil is imported, in the form of oil products, and because of its small size and geographical location, Luxembourg's oil market is greatly influenced by the energy policies and markets in surrounding countries. Oil consumption is heavily concentrated in the transport sector, which accounted for 90% of consumption in 2007. This is a significant increase from the 1990s, when its share was slightly less than two-thirds. The major reason for that increase are lower excise and value-added taxes on gasoline and diesel than in the neighbouring countries. Oil brings considerable tax revenue, but also creates problems for security of supply and, in particular, for reaching the national GHG target under the EU Burden-Sharing Agreement.

The growing importance of energy and climate issues has also increased the workload of energy policy experts. Commendably, Luxembourg has recognised this development and practically doubled the staff of the Directorate for Energy at the Ministry of Economic Affairs and Foreign Trade since the last review. Transposing EU directives into national law and preparing policies and measures to respond to future energy challenges are likely to increase the need for more energy policy experts. Increased staffing would also enable a wider participation in international energy co-operation, including at the IEA. Adequate staffing at the regulator, in turn, is critical for it to fulfil its extended role at the time of progressing market reform and growing market activity. Therefore, the government should continue its successful efforts to increase staffing in its energy sector.

RECOMMENDATIONS

The government of Luxembourg should:

- *Intensify efforts to raise public awareness of the need for stronger measures to improve energy efficiency and decrease GHG emissions.*
- *Address the high dependence on oil to reduce CO_2 emissions and the possible risk of supply problems.*
- *Continue to increase staffing at the Directorate for Energy and the regulator.*

CLIMATE CHANGE

OVERVIEW

Luxembourg is a party to the Kyoto Protocol. The related EU Burden-Sharing Agreement (2002/358/EC) limits its greenhouse gas (GHG) emissions to an average of 28% below their 1990 level in 2008-2012.

After marked decreases from 1993 to 1998, total emissions of the six GHGs have increased strongly since 1998 and are now back to their 1990 level. In 2006, the latest year for which data are available, total GHG emissions amounted to 13.3 million tonnes of CO_2 equivalent (Mt CO_2-eq), which is 0.1 Mt CO_2-eq more than in the 1990 base year (see Table 1). Emissions of CH_4 have remained fairly stable, whereas those of CO_2, N_2O and F-gases continue to increase. In 2006, CO_2 accounted for 91% of GHGs, N_2O for 5%, CH_4 for 3% and the F-gases (HFCs, PFCs and SF_6) for 1%.

Energy use in Luxembourg produces the highest CO_2 emissions per capita of all OECD countries (23.6 tonnes in 2006). This is linked to its highest carbon intensity of energy supply among IEA member countries, and, in particular, to a high share of transport fuel sales to foreign customers. Emissions per unit of GDP, in turn, are slightly below the OECD average (see Figure 5). In 2006, Luxembourg emitted 0.38 kg of CO_2 per US dollar of GDP (in 2000 prices and purchasing power parities). The dominance of high value-added services, such as banking and insurance, in the economy compensates for the high carbon intensity of energy supply. This is also the case with some other high carbon-intensive countries, such as Ireland and the Netherlands.

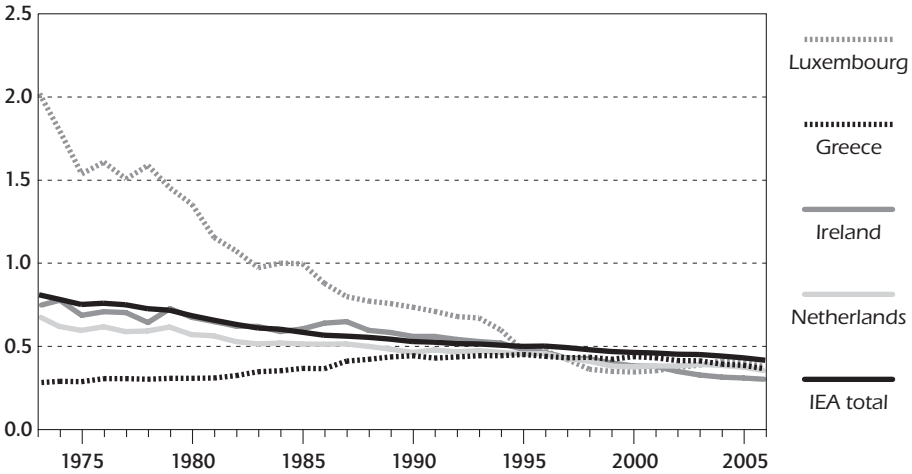
CO_2 EMISSIONS FROM FUEL COMBUSTION

The structure of energy-related CO_2 emissions has changed radically since 1990. The steel industry's conversion to electric-arc furnaces had practically eliminated its coal use and related emissions already from 1993 to 1998. Since the late 1990s, however, emissions from road transport have surged, largely because of lower fuel prices that have led to an increase in foreign drivers refuelling in Luxembourg. Emissions from power generation in turn increased markedly with the start of the Twinerg plant in 2002.

Figure 5

Energy-Related CO_2 Emissions per GDP in Luxembourg and in Other Selected IEA Member Countries, 1973 to 2006

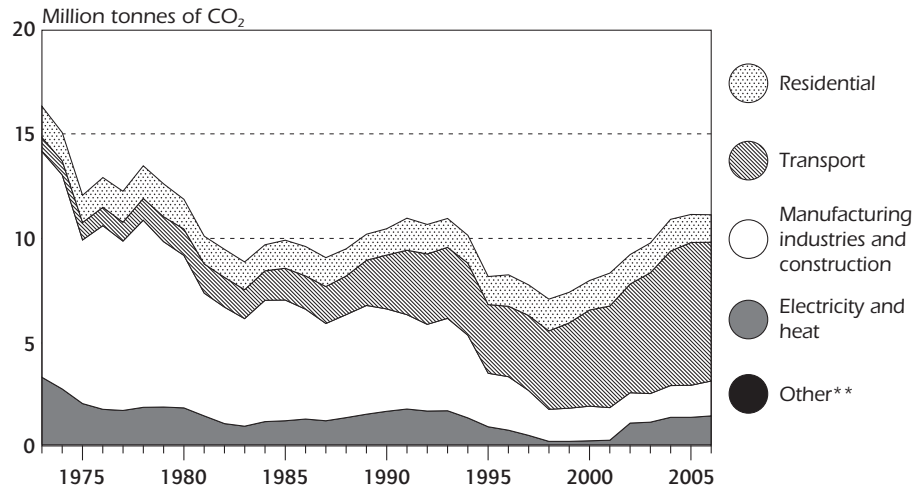
(tonnes of CO_2 emissions per thousand USD GDP using 2000 prices and purchasing power parities)



Sources: *Energy Balances of OECD Countries, IEA/OECD Paris*, 2008 and *National Accounts of OECD Countries*, OECD Paris, 2008.

Figure 6

CO_2 Emissions by Sector*, 1973 to 2006



* estimated using the IPCC Sectoral Approach.

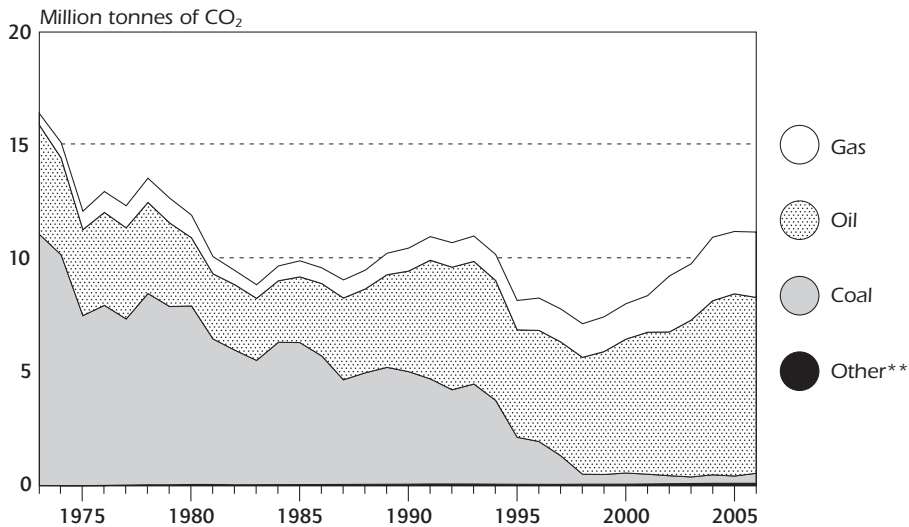
** includes emissions from commercial and public services, agriculture/forestry and fishing (negligible)

Source: *CO_2 Emissions from Fuel Combustion*, IEA/OECD Paris, 2008.

In 2006, transport was the largest emitter of energy-related CO_2 emissions, with a 60% share of the total. Manufacturing accounted for 15% of all emissions, and both the residential sector and power and heat each accounted for 12% (see Figure 6). Following on from the high share of transport, most emissions resulted from the use of oil. This accounted for 69% of all emissions, while the share of natural gas was 26%, that of coal 4% and that of waste 1% (see Figure 7).

Figure 7

CO_2 Emissions by Fuel*, 1973 to 2006



* estimated using the IPCC Sectoral Approach.

** includes industrial waste and non-renewable municipal waste. (negligible)

Source: *CO_2 Emissions from Fuel Combustion*, IEA/OECD Paris, 2008.

POLICIES AND MEASURES

Luxembourg's current climate policy is outlined in the 2006 National Action Plan to reduce GHG emissions (*Changement climatique : Agir pour un défi majeur ! - 1er Plan d'action en vue de la réduction des émissions de CO_2*). The plan includes measures on all sectors, including energy efficiency and renewable energy, and also purchasing emission credits from abroad. More details of these measures are given below and in the relevant chapters of this book. Progress is evaluated annually, and for that purpose the government has set up a taskforce that is chaired by the Minister for the Environment and that includes the Ministers for Agriculture, Economic Affairs, Finance, Interior, Housing, Transport and Public Works.

According to Luxembourg's projections, with the existing policies and measures, emissions will be on average 3% above the base-year level in 2008-2012 (see Table 1). Luxembourg expects to reach its –28% target primarily through the use of Kyoto mechanisms, but also through implementing additional measures. Transport would remain the largest emitter, and the emissions arising from fuel sales to foreign drivers, which are added on to Luxembourg's Kyoto balance, would remain high. In the National Allocation Plan II, the government expects these fuel exports to account for 44% of all emissions in 2010.

Table 1

GHG Emissions Projections in Luxembourg

GHG emissions	*Emissions (Mt CO_2-eq)*	*Relative to base year*
Base-year emissions (1990)	13.2	0.0%
Kyoto target	9.5	–28.0%
2006 emissions	13.3	1.2%
Average emissions in 2002-2006	12.6	–4.3%
Projected emissions in 2010 (existing measures)	13.6	3.1%
Projected effect of planned new measures	*–0.1*	*–1.1%*
Projected effect of carbon sink activities	*0.0*	*0.0%*
Projected use of Kyoto Mechanisms	*–4.0*	*–30.1%*
Projected total emissions in 2010	**9.5**	**–28.1%**

Source: European Environment Agency, 2008

As for post-2012 plans, the EU Commission proposed in January 2008 how to divide the EU overall GHG target of –20% from 1990 to 2020 between the ETS and non-ETS sectors on the one hand, and across member states on the other. An agreement on the proposal between the Council (the member states) and the European Parliament in December 2008 implies that Luxembourg will have to reduce emissions from the non-ETS sectors by 20% below the 2005 levels by 2020. The ETS sector in the EU as a whole will have to cut emission by 21% in the same period.

EU Emissions Trading Scheme (EU-ETS)

The EU-ETS limits the amount of CO_2 emissions from installations in six energy-intensive industries: power and heat; iron and steel; cement; glass and ceramic construction materials; pulp and paper; and oil refining. Each

installation is allocated emission allowances and must hold allowances to cover its total CO_2 emissions. If its emissions are higher than expected, it can purchase more allowances on the allowance market to avoid a penalty. If, in turn, it needs fewer allowances than it holds, it can sell them. Allocation in the first two phases of the EU ETS is based on a National Allocation Plan that is prepared by the national government and approved by the EU Commission. Allocation criteria are laid out in Annex III to the EU Emissions-Trading Directive (2003/87/EC).

The EU-ETS was launched in 2005 and its first commitment period ran until the end of 2007. For 2008-2012, the second commitment period, Luxembourg can allocate 2.5 Mt of CO_2 allowances per year. This is 24% less than in the first commitment period and 37% less than what it had proposed in its submission to the European Commission. All allowances are allocated free. The installations in Luxembourg can use JI and CDM credits for up to 10% of their total emissions obligation.

Luxembourg has 15 installations in the emissions trading sector. In 2005, they accounted for 23% of the country's energy-related CO_2 emissions. In comparison with the EU as a whole, the EU-ETS sets a higher burden on process industries in Luxembourg, as opposed to the electricity and heating sector. In 2005, process industries' share of the emissions in the trading sector was 40% in the EU as a whole, but 52% in Luxembourg.

Domestic measures outside the EU-ETS sector

Domestic measures outside the EU-ETS sector focus on improving energy efficiency, promoting renewable energy and reducing CO_2 emissions from car use. They also include tax measures to reduce transport fuels sales to foreign drivers. The measures on energy efficiency and renewable energy are detailed in the respective chapters of this book. The measures on transport are outlined below.

In the transport sector, Luxembourg is using mostly taxation to reduce CO_2 emissions. It has completely overhauled car taxation, which was previously based on engine size. Since the beginning of 2007, cars are taxed on their CO_2 emission intensity. The new system applies to cars registered after 1 January 2001. Older cars continue to be taxed on the basis of the engine size.

The minimum rate (EUR 0.6 per g CO_2 per km) applies to cars with emissions of less than 100 g CO_2 per km. The tax rate then increases by EUR 0.1 for every ten grams of emissions (for example, EUR 1 for emissions from 130 to 140 g CO_2 per km). Because of higher air pollution levels, diesel cars pay 50% more tax than cars running on gasoline, and have a multiplier of 0.9 as opposed to 0.6 for gasoline cars. The tax also includes rebates for diesel cars with very low particles emissions.

For example, a diesel car emitting 145 g CO_2 per km faces an annual tax of EUR 144, whereas a gasoline car is taxed EUR 96.[2]

The government is also subsidising purchases of low-emitting passenger cars with a grant of EUR 750. Eligible cars can emit up to 120 g CO_2 per km (equivalent to 5 litres of gasoline per 100 km or 4.5 litres of diesel per 100 km). For hybrid or LNG-fuelled cars, the limit is 160 g CO_2 per km. The eligible cars will have to be registered between 1 June 2007 and 31 December 2009. According to the European Commission, average emissions for passenger cars registered in Luxembourg in 2006 were 167 g CO_2 per km.

Luxembourg has also increased excise taxes on transport fuels from 1 January 2007. The revenue from these increases is earmarked for purchases of emission credits from Kyoto mechanisms (see International measures below). To contribute further towards reducing CO_2 emissions from transport, since 2007 at least 2% of motor-vehicle fuel has to be biofuels.

International measures

To fill the significant gap between emissions reductions from domestic measures and the required total reductions, Luxembourg will be using the Kyoto flexible mechanisms (emission allowance trading/clean development mechanism/joint implementation).

The government has committed itself to signing bilateral agreements with host countries, participating in bilateral projects and buying emission credits. Also, it is already participating in the following multilateral funds:

- The World Bank's Biocarbon Fund with an outlay of USD 5 million.
- The World Bank's Community Development Carbon Fund with an outlay of USD 10 million.
- The Multilateral Carbon Credit Fund of the European Bank for Reconstruction and Development with an outlay of EUR 10 million.
- The Asian-Pacific Carbon Fund of the Asian Development Bank with an outlay of USD 15 million.
- The Carbon Fund for Europe of the European Investment Bank with an outlay of EUR 10 million.

The credits are purchased by the government's Kyoto Fund which is financed from three sources. The first source is an earmarked excise duty on motor-vehicle fuel (in 2007, the excise duty was EUR 0.02 per litre of gasoline and EUR 0.0125 per litre of diesel; the excise duty on diesel was further increased to EUR 0.025 per litre from 1 January 2008). The second source is a 40%

2. Diesel car: 145 g CO_2 per km × EUR 1.1 per g CO_2 per km × 0.9 = EUR 144. Gasoline car: 145 g CO_2 per km × EUR 1.1 per g CO_2 per km × 0.6 = EUR 96.

share of the revenue from the reformed car taxes. The third source is the state general budget, covering 15% of the total funding.

In 2007, total spending by the Kyoto Fund was expected to amount to EUR 73.8 million (0.2% of GDP). Roughly three-quarters of the total is spent on purchasing JI and CDM credits and the rest is spent on measures to improve energy efficiency in Luxembourg. The government expects total annual spending by the Kyoto Fund to gradually increase to EUR 120 million (> 0.3% of GDP) in the 2008-2012 period. It also estimates that earmarked excise duties and revenues from car taxes alone will amount to nearly EUR 400 million in the period 2007-2012, taking into account a decrease in fuel sales.

ENERGY EFFICIENCY

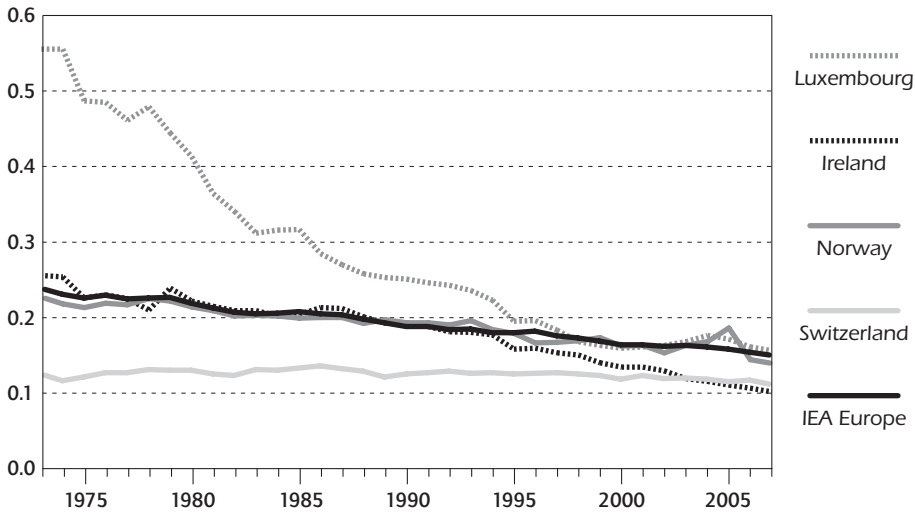
OVERVIEW

Luxembourg's energy intensity has improved since the previous review in 2004, and is now similar to the IEA Europe average (see Figure 8). Intensity has decreased by an impressive 39% since 1990, mainly owing to structural changes in industry and the overall economy, but there are also improvements in energy efficiency. In 2007, for each US dollar of gross domestic product (GDP), the country needed 0.15 toe of primary energy.

Figure 8

Energy Intensity in Luxembourg and in Other Selected IEA Member Countries, 1973 to 2007

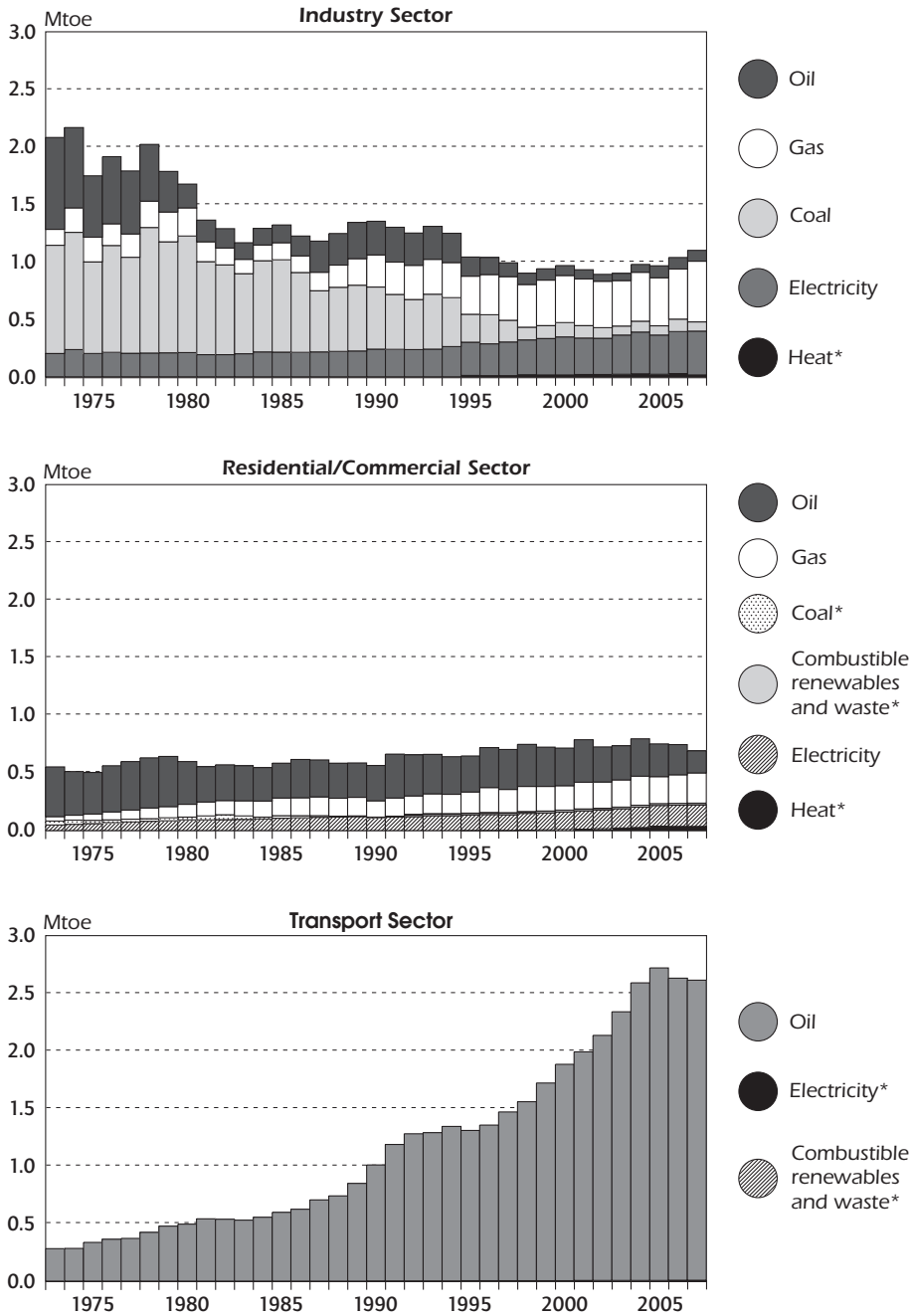
(toe per thousand USD at 2000 prices and purchasing power parities)



Sources: *Energy Balances of OECD Countries, IEA/OECD Paris*, 2008 and *National Accounts of OECD Countries*, OECD Paris, 2008.

Figure 9

Total Final Consumption by Sector and by Source, 1973 to 2007



* negligible.

Source: *Energy Balances of OECD Countries*, IEA/OECD Paris, 2008.

Although Luxembourg's economy is characterised by high value-added financial services, unlike some other small and wealthy IEA members, it also has substantial heavy industry in relation to the size of its economy. Comparing Luxembourg with other countries is complicated by the large amounts of transport fuels sold to foreigners and used outside of the country. If this transit traffic is excluded from the country's total final consumption of energy (TFC), Luxembourg's energy intensity falls to become one of the lowest within the IEA. But to be consistent, the GDP contribution of foreign workers should also then be excluded. For a clearer picture of energy efficiency in the country, sectoral benchmarking and structural comparisons should be used.

Luxembourg's TFC was 4.4 Mtoe in 2007, up 50% from 1990. Transport was the largest user, accounting for 59% of the total. Industry's share was 25% and the other sectors (residential and services, and the primary sector) used 16% of the total. These shares have been fairly stable over the past five years. In comparison, the IEA averages in 2005 were 32% for industry, and 34% for both transport and other sectors.

Energy use in industry and the residential/commercial sector has remained relatively flat since the mid-1990s (see Figure 9). Industry has modernised and restructured itself, and, counterbalancing the impact of rapid population growth, energy use in buildings has become more efficient. The transport sector, in turn, has seen a dramatic increase in energy use over the past decade. This can be largely attributed to transit traffic, *i.e.* fuel sales to foreign lorries crossing Luxembourg and to daily commuters from across Luxembourg's borders. The government estimates that these sales account for around 80% of TFC in transport.

POLICIES AND MEASURES

Energy efficiency policy is increasingly guided by EU directives and non-binding goals which, however, leave room for Luxembourg to decide how to implement them. The most important directives are described below. Luxembourg's main energy efficiency policy document is the National Energy Efficiency Action Plan (NEEAP), published on 29 February 2008.

Preparing the NEEAP is an obligation under the Directive on Energy End-Use Efficiency and Energy Services (2006/32/EC). The directive contains an indicative national energy savings target of 9% to 2016, to be reached by way of energy services and other energy efficiency improvement measures in the sectors that are not part of the EU-ETS. The reduction is calculated against the annual average TFC in the non-ETS sectors over the most recent five-year period previous to 2008 for which official data are available. For Luxembourg, this period is 2001-2005.

The Directive on the Energy Performance of Buildings (2002/91/EC) sets requirements for a more energy-efficient building code, including minimum performance standards and energy certificates. Requirements for energy labelling of household appliances, in turn, are based on several directives adopted over the past 15 years. They also include compulsory minimum efficiency requirements. Over the longer term, the Directive Establishing a Framework for Setting Ecodesign Requirements for Energy-Using Products (2005/32/EC) will improve the energy efficiency of all new products outside the transport sector. The directive was to be transposed into national law in the spring of 2008. Furthermore, the EU-ETS has an indirect, but strong effect on energy efficiency in heavy industry and the heat and power sector.

Under the NEEAP, the energy saving target of 9% equals 1 582 GWh. The interim target for Luxembourg by the end of 2010 is 3%, equivalent to a saving of 527 GWh. The NEEAP goes beyond this and identifies measures that would save 10.4% of TFC, equalling 1 825 GWh (see Table 2). The savings are expected to come from three categories: first, measures introduced from 1995 to 2007 (early action) that will still be taking effect in 2016 would save 4% of TFC; second, new measures would save 4.1% of TFC; and third, planned and potential measures would save up to 2.3% of TFC by 2016.

In addition to the –9% target by 2016, Luxembourg and other EU member states have also agreed to a non-binding –20% target for 2020. This 2020 target is calculated as savings in TPES from the business-as-usual scenario. As explained in more detail in Chapter 5, Luxembourg will also have to meet a binding EU target for renewable energy in 2020. This target is for a share of renewable energy in TFC, and the proposed target for Luxembourg is 11% in 2020, whereas the share in 2005 was 0.9% of TFC. Success in improving energy efficiency will, therefore, be essential for reducing GHG emissions and increasing the share of renewable energy in TFC.

Buildings

Luxembourg expects measures in the building sector to deliver three-fifths of all energy savings by 2016 (see Table 2). Most emphasis is placed on minimum requirements for thermal insulation, but the government is also subsidising energy efficiency investments.

In a move to comply with the Directive on the Energy Performance of Buildings, the building code was revised as of 1 January 2008 to include more ambitious requirements for thermal insulation in new buildings. The new building code limits the maximum energy use in residential buildings, both per floor area and specifically for heating. It also sets minimum efficiency requirements for selected individual components in both residential and non-residential buildings.

Table 2

Anticipated Effects of Energy-Saving Measures in 2016

Current and planned measures	*Expected annual energy savings by end 2016 (GWh)*
RESIDENTIAL BUILDINGS	
Early action	
1996 Thermal Insulation Ordinance	295
Promotion of efficient new buildings and efficient heating systems (2001-2007)	76
New measures (advanced planning)	
Improvement in overall energy efficiency in dwellings (WD2008)	372
Upgrading programme for old buildings	25
Promotion of energy-efficient new buildings	12
Planned/proposed measures	
Increase in old building upgrading programmes	32
Heating renewal regulations	53
Increase in promotion of energy-efficient new buildings	25
Electricity savings through labelling of appliances	8
TERTIARY SECTOR	
Early action	
1996 Thermal Insulation Ordinance	118
New measures (advanced planning)	
Improvement in U-values for non-domestic buildings	40
Planned/proposed measures	
Improvement in overall energy efficiency of non-domestic buildings	76
Realising electricity savings potential	65
INDUSTRY	
Planned/proposed measures	
Realising electricity savings potential for industrial cross-cutting technologies	99
TRANSPORT	
New measures (advanced planning)	
Reduction in fuel consumption by raising fuel prices (national transport)	61
CO_2 car tax	86
Promotion of least-polluting cars	75
CROSS-CUTTING MEASURES	
Early action	
Promotion of decentralised renewables by 2007 (electricity/heat without biomass use)	26
Promotion of decentralised renewables by 2007 (heat, biomass use)	22
Promotion of small CHP (savings in primary energy)	167
New measures (advanced planning)	
Further promotion of decentralised renewables (electricity/heat without biomass use)	12
Further promotion of decentralised renewables (heat, biomass use)	45
Planned/proposed measures	
Increased promotion of decentralised renewables (electricity/heat without biomass use)	23
Increased promotion of decentralised renewables (heat, biomass use)	11
Total expected final energy savings by 2016 from 2001-2005	**1 825**

Source: Luxembourg's *National Energy Efficiency Action Plan*. February 2008

The limit set for the total maximum annual energy use depends on the design and location of the building. For multi-family houses, the limit for primary energy, calculated on the basis of the heated living area, ranges from 79 to 159 kWh per m^2 and year, depending on the surface/volume ratio of the building. For single-family houses, the range is 91 to 153 kWh per m^2 and year. Specific maximum energy use for heating is limited to the range of 40 to 95 kWh per m^2 of heated living area and year for multi-family houses, and of 54 to 97 kWh per m^2 of heated living area and year for single-family houses, depending on the surface/volume ratio of the building. The effective maximum U-values[3] for individual building components in turn are 0.23 for roofs, 0.26 for exterior walls, 1.0 for windows and 1.0 for exterior doors. These U-values apply to both residential and non-residential buildings. The government is working on new limit values for annual maximum energy use in new non-residential and modified/extended buildings, and is planning to introduce them by the beginning of 2010.

As required by the Directive on the Energy Performance of Buildings, the revised building code also includes an obligation to present an energy performance certificate for residential buildings since 1 January 2008. Overall, the government estimates that the efficiency requirements in the new building code are around 40% stricter than in the previous requirements dating from 1996.

Investment subsidies for energy efficiency improvements in new and old buildings were revised as of 1 January 2008. For new houses, grants range from EUR 21 to 45 per m^2 for low-energy houses and from EUR 57 to 160 per m^2 for passive houses, depending on the surface area. Maximum surface area is 200 m^2 for an eligible single-family house and 120 m^2 for an eligible flat. An energy performance evaluation is required for all new and old buildings before any investment subsidy can be granted. Consultation services for this evaluation are subsidised up to EUR 50 per hour.

In May 2008, the Ministry of Economic Affairs and Foreign Trade launched a partnership agreement to include the financial sector in supporting improved energy efficiency in the building sector. Under the agreement, participating banks will offer reduced interest rates on loans financing the construction of passive houses or low-energy houses. The reduction must be at least 0.125% on the interest rate, granted for the full duration of the loan. Participating banks are awarded the status of Energy Efficient Partner, and can use the Energy Efficient Partner logo on all their communication supports. The agreement has been signed by four banks, Dexia, Fortis, ING and Raiffeisen.

The government has also decided that new public buildings will be designed for the greatest possible energy efficiency. This process includes developing an

3. The U-value represents the rate of heat loss, *i.e.* how much energy passes through one square metre of a material by a difference of one degree in temperature. It is measured in watt (W) per degree Kelvin (K) per m^2.

energy concept and evaluating the feasibility of connecting to combined heat and power (CHP) plants and/or using renewables in the building.

For housing more than 10 years old, grants are provided for the replacement of various components, such as thermal insulation of walls, floors and roofs (EUR 8 to 15 per m^2) and high efficiency windows (EUR 12 to 30 per m^2). Installation of improved ventilation systems is subsidised up to 50%. For a complete refurbishment, subsidies would be 20% higher. The total amount of subsidy would be capped, and this cap would depend on the type and size of housing. The government has also allocated EUR 30 million from 2007 to 2012 for improving the energy performance of existing public buildings.

The government is further planning to introduce more measures to promote energy efficiency in old and new buildings as from 2010. The measures would likely include subsidies for replacing the oldest heating systems with heat pumps, biomass boilers as well as solar heating systems. The government is also subsidising investments in renewable energy technologies in dwellings (see Chapter 5 for the details).

Appliances

Mandatory energy labelling of domestic appliances is based on the EU directives. It covers lamps, ovens, refrigerators, freezers, washing machines, tumble-dryers and dishwashers. Appliances are classified from A to G, where class A is for the most energy-efficient appliances. In 2004, two new classes were introduced: compared to class A: electricity use in class A+ is 25% lower and in class A++ 40% lower.

In the coming years, minimum energy efficiency standards for appliances will be introduced in Luxembourg and other EU member states. These standards will be set by EU regulations that are to be based on the Ecodesign Directive (2005/32/EC). At this stage, the EU Commission has plans for proposing such standards for 19 product groups.

Industry and commerce

Since 2004, Luxembourg has offered subsidies for industry and services sectors to invest in improving energy efficiency. These subsidies can cover up to 40% of the eligible investment cost, and up to 50% for small and medium-sized enterprises (SMEs). All projects that reduce final energy consumption are eligible, provided the reductions go beyond those reached by complying with EU requirements. If EU requirements do not apply to the projects, they are eligible for subsidies if it can be proved that the projects would not have been carried out without the subsidies.

A voluntary energy saving agreement with the manufacturing industries was concluded in 1990 and it has been subsequently extended several times. The

agreement covers around 90% of energy use in manufacturing industries. According to FEDIL, the industry organisation, from 1990 to 2008, energy efficiency in the participating industries improved by 28%, clearly more than the stated goal of 1% per year. Companies meeting the annual 1% efficiency improvement target are partially exempt from energy taxes.

The government is also planning measures to promote efficient use of electricity in industry (non-ETS facilities). The focus would be on industrial cross-cutting technologies, such as pumps, fans, compressed air systems, cooling, lighting and space heating. The measures may include subsidies, energy audits, voluntary agreements and information campaigns. The measures are planned to become effective in 2010.

Transport

Luxembourg's energy use in transport is growing, reflecting a global trend. The country's efforts to limit the resulting challenges for security of supply and climate change mitigation are strongly focused on fiscal incentives for low-emission cars, but also on promoting alternative fuels (see Chapter 5).

Table 3

Breakdown of Passenger Travel by Mode, 2006

Mode	*Car*	*Bus*	*Train*
Share, %	85.3	10.8	3.9

Source: *EU Energy and Transport in Figures – Statistical Pocketbook 2007/2008*.

Private cars remain the dominant form of passenger travel in Luxembourg (see Table 3). Traffic volume by passenger cars increased by 63% from 1990 to 2006, roughly at the same pace as bus use, whereas railway use for passenger transport remained flat. Luxembourg has the highest passenger car density in IEA Europe, 661 cars per 1 000 inhabitants in 2006, as compared to the EU15 average of 508. Also, the average annual distance travelled by car is relatively high, despite the country's small size.

Freight is mostly transported by lorries. These accounted for 91% of the total of tonne-kilometres in 2006. Freight volumes in Luxembourg are closely linked to developments in the overall economy, including that of the neighbouring countries. In 2006, international haulage accounted for 94% of all haulage by heavy-duty vehicles registered in Luxembourg.

In the NEEAP, Luxembourg lists the following three measures that it is taking to increase energy efficiency in transport:

- Reducing fuel consumption by raising taxes on transport fuels.
- Introducing a CO_2 car tax.
- Promoting least-polluting cars.

These measures are explained in more detail in the section on Climate Change above. In addition, the government is taking measures to reach a 25% share for public transport in 2020.

The government sees increasing passenger transport as part of a wider phenomenon of urban sprawl that extends beyond the country's borders. The government is addressing this concern in the context of territorial planning, which also intends to manage spatial development. Measures to promote public transport include a EUR 3 billion programme for investing in rail infrastructure; investments in rail will for a long time exceed those in road infrastructure. The government is also active in regional cross-border initiatives to promote public transport options for commuters. Cross-border commuters account for around 40% of Luxembourg's workforce and more than half of all commuter traffic.

CRITIQUE

CLIMATE CHANGE

Under the EU Burden-Sharing Agreement related to the Kyoto Protocol, Luxembourg has the enormous challenge of reducing its GHG emissions by 28% below 1990 levels to 2008-2012. From 1990 to 1998 emissions decreased dramatically owing to restructuring in the iron and steel industry. Since 1998, however, the emissions have grown strongly, and in 2006, they were roughly at their 1990 levels. Therefore, the government should accelerate efforts to meet the Kyoto target. It should build on its 2006 national climate strategy and prepare for the challenges after 2012 by developing integrated energy and GHG scenarios.

As an EU country, Luxembourg will have to focus its efforts on the sectors outside of the EU-ETS. Transport is by far the most important of these sectors and also the one with the fastest growing emissions in previous years. The government has taken several commendable steps to decrease emissions from transport, as was recommended also in the previous in-depth review.

Since 2007, vehicle taxes are based on environmental criteria, giving consumers strong incentives to favour low-emission cars. These emissions include CO_2, but also nitrous oxides (NO_x) and fine particles. Therefore, the reform also helps to limit local air pollution and the resulting adverse effects on human health and the environment. Also in 2007, the government increased excise duties on transport fuels to finance emissions reductions at

home and abroad. Revenues from 40% of the vehicle taxes and all of the increased excise taxes are earmarked for the Kyoto Fund. This makes the polluters pay, at least partly, for their actions. This is sound policy and Luxembourg deserves to be commended for it.

The government has also introduced a subsidy for purchasing low-emission cars. Again, this is sound policy and will contribute to mitigating climate change, but the incentive, now at EUR 750 per purchase, could be much stronger. Subsidies for purchasing low-emission cars can be increased in a revenue-neutral way. Thus, the government should consider setting a relatively high purchase tax on high-emission cars and then use these tax revenues to pay for an increased subsidy on the purchase of low-emission cars.

In the same vein, to make polluters pay, the Kyoto Fund could be entirely financed by tax revenue from fuel use, if these taxes were higher. As the government has already planned to provide 15% of the Kyoto Fund's financing from its core budget, these increases of the vehicle and excise taxes could be made revenue-neutral. Considering the relatively large differences in excise taxes with France, Germany and the Netherlands, moderately higher taxes would not have to lead to a mass flight of foreign gasoline and diesel buyers, always a concern in countries profiting from these differences.

Using the Kyoto flexible mechanisms is a cost-effective way to reduce emissions. Commendably, Luxembourg is already engaged in purchasing emission credits through the Kyoto Fund and it has also earmarked financing for the fund. However, the need for these credits depends on the success of policies in other sectors, and, more than that, on excise tax levels in the neighbouring countries. Therefore, it is difficult to quantify the exact level of needed credits. Also, the exact budget needed depends on the availability of credits and subsequent market price. The government should therefore maintain sufficient institutional flexibility and be ready to act quickly to balance any possible funding gaps.

More importantly, in the Kyoto Protocol these flexible mechanisms are referred to as supplementary to the measures taken at home. It is, therefore, controversial that Luxembourg is planning to use them for covering an important part of the required emissions reductions. The government should clarify the internationally agreed level up to which it can resort to these mechanisms and investigate more measures in a domestic abatement strategy.

Energy efficiency

Luxembourg has recently taken several commendable steps to improve energy efficiency. Ambitious energy efficiency requirements for new,

modified and extended buildings have been in place since the beginning of 2008 and support for energy efficiency refurbishments has been increased. A certificate system for the energy performance of residential buildings in Luxembourg has also been introduced. Vehicle taxes have been revised to encourage purchases of low-emission cars.

The government compiled its first National Energy Efficiency Action Plan, in accordance with the EU Directive on Energy End-Use Efficiency and Energy Services, and submitted it to the European Commission in March 2008. The plan outlines the measures with which to reduce energy use by 9% from 2001-2005 to 2016. The government is encouraged to move on to implement these measures without delay.

Luxembourg deserves to be applauded for the new energy efficiency requirements in the revised building code. The country also shows commendable determination in its readiness to subsidise energy efficiency improvements in old buildings. The new requirements improve efficiency by some 40% from the previous legislation and are expected to deliver the largest energy savings by 2016 of all national policy measures. More efficient energy use in buildings also directly helps to reduce CO_2 emissions in Luxembourg. As the revised building code includes limit values for total annual energy use for residential buildings only, the IEA urges the government to proceed to introducing ambitious limit values for non-residential buildings without delay. As energy efficiency requirements for buildings need to be updated in all countries, the Grand Duchy should strive to increase its already much improved requirements.

In the industry sector, Luxembourg's heavy industry and most utilities are covered by the EU-ETS which should also give them strong direct and indirect incentives to use energy more efficiently. The government is offering subsidies for investing in energy efficiency improvements and it has also concluded voluntary agreements to save energy. These agreements cover 90% of energy use in manufacturing and have met their overall objectives by a wide margin. The IEA encourages the government to continue the voluntary programme and consider expanding it to other sectors as well.

Measures in the transport sector are primarily motivated by the need to reduce CO_2 emissions. Energy efficiency is one way to do this, as can be the use of biofuels. The government is to be commended for the new fiscal incentives in favour of low-emission cars and reduced fuel use. It should monitor the effectiveness of these measures and consider new ones to further stimulate efficient use of energy. These new measures could include ones on road pricing, parking fees and parking space. Apart from these three new measures, however, the government should vigorously continue to pursue a modal shift in favour of more public transport. A major part of the challenge of increasing public transport is the volume of cross-border commuting. Responding to this challenge, therefore, requires regional cross-border co-operation, and

Luxembourg should be congratulated for its active role in initiating this co-operation.

Detailed data on end-use of energy by sector and sub-sector are often hard to find. Estimates of future use in the current NEEAP are often derived from specific figures used for Germany. Collecting local data and using them would also help prepare more detailed policies and measures to improve end-use, especially in the services sector. In particular, data on electricity use should be relatively easy to find in co-operation with the utilities.

To improve energy efficiency, the IEA also urges the government to continue its work in making the national and EU policies fully consistent with the energy efficiency policy recommendations the IEA presented to the Group of Eight (G8). The IEA energy ministers endorsed the initial 16 measures in 2007. Since then, nine new recommendations have been added (see Box 1).

Box 1

IEA G8 Energy Efficiency Recommendations

At the Group of Eight* (G8) Summit in 2005 in Gleneagles, Scotland, the G8 countries asked the IEA to assist in developing and implementing energy efficiency policies. Responding to this request, the IEA subsequently prepared a set of energy efficiency policy recommendations covering 25 fields of action across seven priority areas: cross-sectoral activities, buildings, appliances, lighting, transport, industry and power utilities. These 25 recommendations were presented to the summit of the G8 in Hokkaido, Japan in July 2008. The fields of action are outlined below.

1. The IEA recommends action on energy efficiency *across sectors*. In particular, the IEA calls for action on:

- Measures for increasing investment in energy efficiency.
- National energy efficiency strategies and goals.
- Compliance, monitoring, enforcement and evaluation of energy efficiency measures.
- Energy efficiency indicators.
- Monitoring and reporting progress with implementing the IEA energy efficiency recommendations themselves.

2. *Buildings* account for about 40% of energy used in most countries. To save a significant portion of this energy, the IEA recommends action on:

- Building codes for new buildings.
- "Passive energy houses" and zero-energy buildings.
- Policy packages to promote energy efficiency in existing buildings.
- Building certification schemes.
- Energy efficiency improvements in glazed areas.

3. *Appliances and equipment* represent one of the fastest growing energy loads in most countries. The IEA recommends action on:

- Mandatory energy performance requirements or labels.
- Low-power modes, including stand-by power, for electronic and networked equipment.
- Televisions and set-top boxes.
- Energy performance test standards and measurement protocols.

4. Saving energy by adopting efficient *lighting* technology is very cost-effective. The IEA recommends action on:

- Best-practice lighting and the phase-out of incandescent bulbs.
- Ensuring least-cost lighting in non-residential buildings and the phase-out of inefficient fuel-based lighting.

5. About 60% of world oil is consumed in the *transport* sector. To achieve significant savings in this sector, the IEA recommends action on:

- Fuel-efficient tyres.
- Mandatory fuel efficiency standards for light-duty vehicles.
- Fuel economy of heavy-duty vehicles.
- Eco-driving.

6. In order to improve energy efficiency in *industry*, action is needed on:

- Collection of high-quality energy efficiency data for industry.
- Energy performance of electric motors.
- Assistance in developing energy management capability.
- Policy packages to promote energy efficiency in small and medium-sized enterprises.

7. *Energy utilities* can play an important role in promoting energy efficiency. Action is needed to promote:

- Utility end-use energy efficiency schemes.

Implementation of IEA energy efficiency recommendations can lead to huge cost-effective energy and CO_2 savings. The IEA estimates that, if implemented globally without delay, the proposed actions could save around 8.2 Gt CO_2/year by 2030. This is equivalent to one-fifth of global energy-related CO_2 emissions in 2030 under the IEA Reference Scenario, in which no new policies are adopted or implemented. Taken together, these measures set out an ambitious road-map for improving energy efficiency on a global scale.

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* The Group of Eight is an international forum for the governments of Canada, France, Germany, Italy, Japan, Russia, the United Kingdom and the United States.

RECOMMENDATIONS

The government of Luxembourg should:

Climate change

- *Accelerate efforts to meet the Kyoto target and prepare for the post-Kyoto challenges by developing integrated energy and GHG scenarios.*
- *Address the main cause of national GHG emissions by considering stronger fiscal incentives to reduce CO_2 emissions from transport.*
- *Continue to ensure institutional flexibility and adequate funds to purchase emission credits through JI/CDM.*
- *Clarify, in this context, the contribution of JI/CDM credits to reaching the Kyoto target.*

Energy efficiency

- *Implement the measures listed in the National Energy Efficiency Action Plan.*
- *Improve further the requirements for energy efficiency in the building sector.*
- *Continue the voluntary agreements with industry and consider expanding them to other sectors.*
- *Monitor the effectiveness of the measures in the transport sector, and vigourously pursue modal shift in favour of public transport.*
- *Strive to improve the coverage and the level of detail of statistics on the end-use of energy.*

PART II

SECTOR ANALYSIS

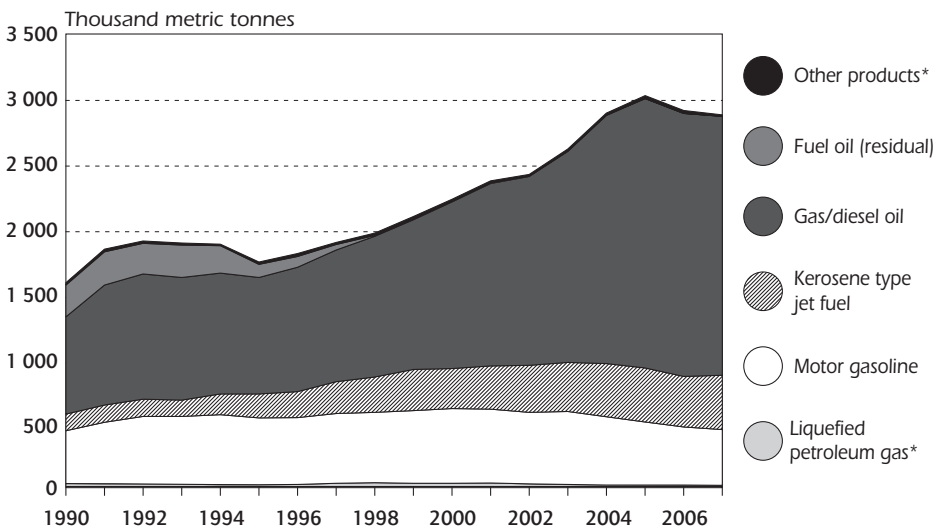
OIL

SUPPLY AND DEMAND

Oil demand in 2007 was just over 2.89 million tonnes (Mt), or an average of nearly 61 thousand barrels per day (b/d) (see Figure 10). This is a decrease of 2.5% per year from 2005, a year when oil demand peaked after a period of strong growth. In the period from 1990 to 2005, oil demand grew by an average annual rate of 4.5%, primarily the result of increasing diesel demand. Oil consumption has grown ever more concentrated in the transport sector, which now represents nearly 88% of total oil demand compared to 62% in 1990. The use of transport diesel is the single largest component of the country's oil demand, equating to 1.7 Mt or 36 kb/d in 2007.

Figure 10

Oil Demand by Type of Product, 1990 to 2007



* negligible.

Source: *Monthly Oil Statistics*, IEA

The oil sector in Luxembourg is unique among IEA countries in that it neither produces nor refines any oil. All oil products are imported. They essentially come from refineries located in Antwerp in Belgium (roughly

72% of oil products imported in 2007), 255 km from the city of Luxembourg. The rest comes from Germany (16%), France (8%) and the Netherlands (4%). Although the most commonly used method of transport is by road (39% of the total in 2007), a significant proportion of oil products reaches Luxembourg by rail and barge. The only pipeline in the country, the Central Europe Pipeline System (CEPS), is used exclusively for supplying aviation kerosene to the country's airport at Findel. In 2008, 15 companies operated in Luxembourg's oil market, and they had close to 240 filling stations.

A large majority of Luxembourg's demand for oil is for cars and trucks coming from across its borders. The outlook for oil demand in the Grand Duchy, therefore, depends on regional demand and price differentials with neighbouring countries that are due to varying levels of value-added taxes (VAT) and excise duties.

PRICES AND TAXES

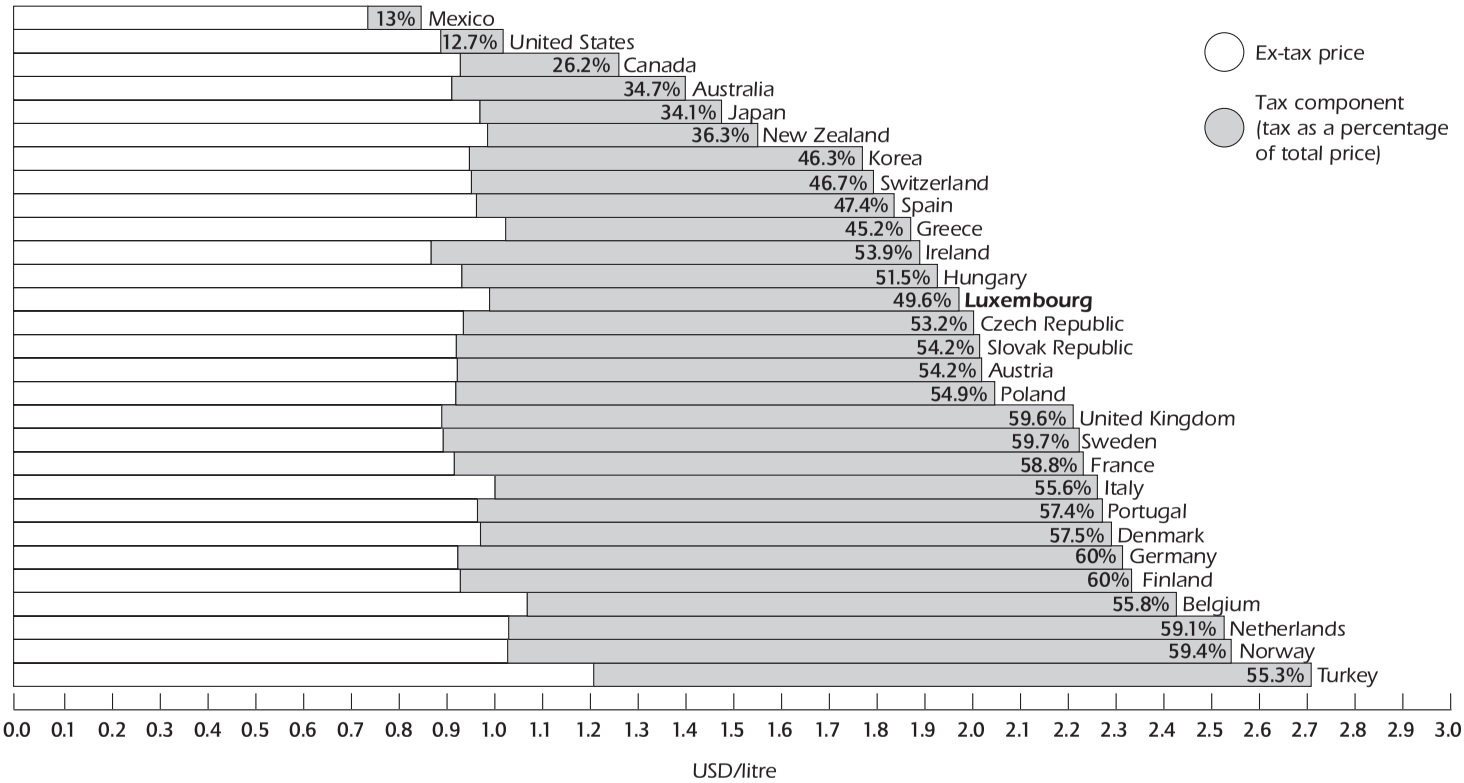
Luxembourg maintains a price setting mechanism for oil products through a signed agreement with oil-importing companies. This sets a maximum price for oil products sold to the end-consumer, including gasoline, automotive diesel, heating oil and liquefied petroleum gas (LPG). The pricing formula is based on the published price of oil products (Platt's Antwerp CIF product prices), to which the government adds a standard cost of transport from Antwerp to Luxembourg, a standard distribution margin covering the profits of the importers and the filling stations, and the cost of compulsory storage. These different costs are determined by the government after discussion with the oil companies' association (Groupement Pétrolier Luxembourgeois) and the retailers.

The government decides when to change the maximum price according to market price variations in Antwerp, and there is a four-day delay between the time prices are quoted and the time retailers are able to adjust to a new maximum rate. Roughly two-thirds of fuel is sold at the maximum level, with the rest sold by small independent retailers which set prices below this level.

As transport fuels in Luxembourg cost less than in the neighbouring countries (see Figures 11 and 12), because of lower taxes on gasoline and diesel fuel, foreign motorists and truckers often fill their tanks on their way. This group includes commuters, representing around 40% of the country's workforce, that cross into the country daily from Belgium, France and Germany.

Figure 11

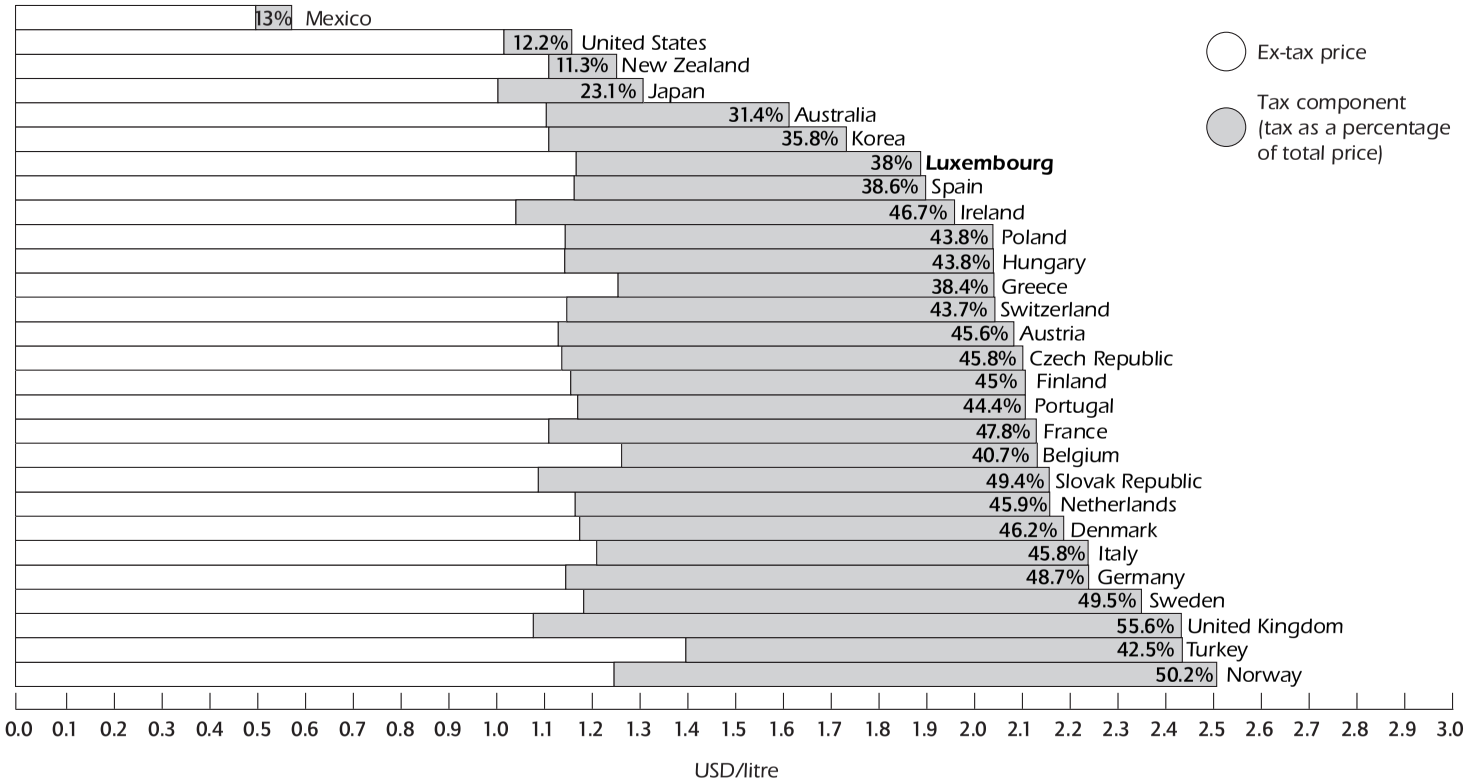
OECD Unleaded Gasoline Prices and Taxes, Second Quarter 2008



Source: *Energy Prices and Taxes*, IEA/OECD Paris, 2008.

Figure 12

OECD Automotive Diesel Prices and Taxes, Second Quarter 2008



Note: data not available for Canada.

Source: *Energy Prices and Taxes*, IEA/OECD Paris, 2008.

The government raised its excise duties on diesel in 2008, to EUR 0.302 per litre, in line with the EU directive setting minimum levels of taxation on energy products (2003/67/EC). This now puts Luxembourg's excise duties on diesel closer to Belgium's (EUR 0.32/litre), while still significantly below those of France and Germany (EUR 0.43 and EUR 0.47/litre, respectively), which maintain levels well above the European minimum. At the same time, Luxembourg's VAT, at 15%, remains below the rate of all three of its bordering countries (21%, 19.6% and 19% respectively in Belgium, France and Germany in 2008).

STORAGE

There are currently six main storage facilities used by oil companies in Luxembourg to supply the domestic market. These have a total combined capacity of just over 196 000 cubic metres, or 1.23 million barrels (Mb) (see Table 4). This is roughly the equivalent of 20 days of total oil demand in the country, according to 2007 figures.

Table 4

Oil Storage Capacity at 1 January 2008

Storage site	*Gasoline*		*Distillates*		*Jet fuel*		*Total products*	
	m^3	*kbl*	*m^3*	*kbl*	*m^3*	*kbl*	*m^3*	*kbl*
Bertrange	40 761	256	52 372	329	–	–	93 133	586
Dippach	–	–	12 400	78	–	–	12 400	78
Findel (airport)	–	–	–	–	10 000	63	10 000	63
Hollerich	–	–	17 252	109	–	–	17 252	109
Leudelange	–	–	5 600	35	–	–	5 600	35
Mertert	21 800	137	36 000	226	–	–	57 800	364
TOTAL	62 561	393	123 624	778	10 000	63	196 185	1 234

Source: Luxembourg's Ministry of Economic Affairs and Foreign Trade.

The largest of these storage sites, Bertrange, and the nearby site of Hollerich, have operating permits which are set to expire in 2012/2013. These two sites have more than half of the country's storage capacity. If the permits were not renewed, total capacity to store diesel and heating oil would fall to 340 000 barrels from the 778 000 barrels currently. In terms of 2007 diesel demand, distillate storage capacity would decline from 19 to eight days of demand cover.

EMERGENCY PREPAREDNESS

Emergency response policy is under the responsibility of the Directorate for Energy within the Ministry of Economic Affairs and Foreign Trade. This team is responsible for maintaining and implementing emergency response measures in an oil supply disruption. Its responsibilities also include collecting data and monitoring the

domestic oil market, the maximum oil price mechanism and industry's compulsory oil stockholding. In carrying out these responsibilities, the Directorate for Energy works closely with the chairman and general secretary of the association of oil-importing companies (Groupement Pétrolier Luxembourgeois).

In the event of an oil supply emergency, the Minister for Economic Affairs and Foreign Trade has the legal authority to take a decision on emergency measures "if oil products supply is endangered". This can be either by means of decrees or by notification to individual companies, which could regulate imports, trade and consumption of oil products.

Emergency measures available to the government in an oil supply disruption are limited. With no domestic production or refining, short-term surge production is non-existent. There is also no scope for short-term switching away from oil use, where transportation represents nearly 88% of all oil consumption. Opportunities to switch to other fuels, such as using natural gas instead of fuel oil in the production of electricity, have already occurred. Given the size and location of the Grand Duchy, measures to quickly cut oil demand must take account of regional concerns. A common Benelux guideline exists for oil demand restraint, which the Luxembourg government could rely upon for co-ordinating measures such as reducing speed limits or restricting driving. However, the drawing down of oil stocks remains the country's primary response measure in an oil supply disruption.

All oil stocks in Luxembourg are held by oil companies. Luxembourg meets its minimum stockholding obligations as a member of the IEA and the European Union by placing a stockholding obligation on industry. All oil importers are obliged to maintain stocks of petroleum products equivalent to at least 90 days of deliveries into domestic consumption during the previous calendar year. This applies to each of the three categories covered by the EU compulsory stockholding obligations (gasoline, distillates and fuel oil). According to IEA and EU rules, Luxembourg allows companies to meet their obligation by holding stocks in other countries with which the government has bilateral agreements guaranteeing access in an emergency. Luxembourg has such agreements with Belgium, France, Germany and the Netherlands.

The stockholding obligation on industry is based on the Decree of 31 October 1973. This stipulates that a significant share of stock should be held on national territory, specifically the equivalent of 45 days for gasoline and 55 days for distillates, on the basis of the previous year's supply. However, existing storage capacity in the country is insufficient to meet this requirement, and industry participants are, therefore, allowed to cover a greater share of their stock obligation by holding stocks abroad. In practice, over 85% of Luxembourg's IEA minimum stockholding obligation is met by stocks held outside the country. Most of these stocks are held in the ARA (Amsterdam, Rotterdam and Antwerp) area. For the most part, these stocks are held in the form of short-term leasing agreements, referred to as "tickets". These must be certified by the government of the country where they are held in order to be counted.

The government is currently reviewing a draft proposal for managing the national oil market with a view to updating legislation on emergency stockholding. This takes into account the current limitations of domestic storage capacity and how the obligation on industry could be optimised. It also includes consideration for the creation of a national stockholding agency and expanding domestic storage capacity.

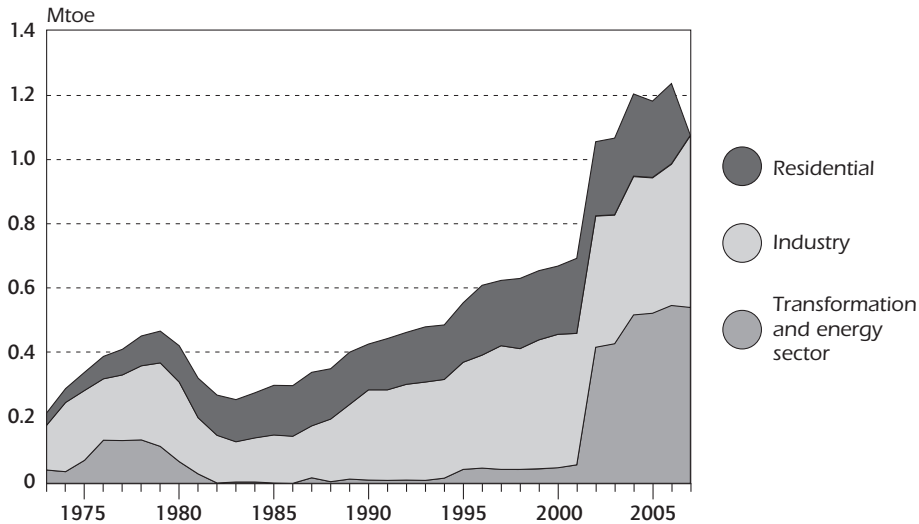
NATURAL GAS

SUPPLY AND DEMAND

Natural gas is the second most important fuel in Luxembourg, after oil. In 2007, it provided 28% of TPES. From 1990 to 2006, use of natural gas increased more than fourfold, from 0.4 Mtoe to 1.3 Mtoe (see Figure 13). In 2006, electricity and heat generation consumed 45% of all gas in the country. The 350 MW Twinerg combined-cycle gas turbine (CCGT) plant, commissioned in 2002, alone uses one-third of gas. At the same time, gas use for purposes other than electricity generation rose from 14% to 18% as a share of TFC. Manufacturing industries used 35% of all gas, and households 20%. Roughly half of all households are supplied with gas. Reflecting the use for heating purposes, natural gas use peaks in winter months. In 2005-2007, 57% of the total was consumed from October to March. The government expects demand for gas to continue to grow in households and non-steel industry, whereas demand for electricity generation is expected to remain flat over the coming years.

Figure 13

Consumption of Natural Gas by Sector, 1973 to 2007



Source: *Energy Balances of OECD Countries*, IEA/OECD Paris, 2008.

All gas is imported. According to the government, in 2006, Norway accounted for 47% of gas imports, Russia for 24%, Qatar for 11%, Algeria for 3% and the Netherlands for 1%. Spot purchases at the Zeebrugge hub in Belgium provided 12% of imports and 2% came from unidentified sources.

MARKET REFORM

Luxembourg's gas market legislation is based on the relevant EU directives: the second EU Gas Market Directive (2003/55/EC) and the Directive Concerning Measures to Safeguard Security of Natural Gas Supply (2004/67/EC). Both directives have been transposed into the national Law on the Organisation of the Natural Gas Market of 1 August 2007.

The natural gas market is regulated by the Institut Luxembourgeois de Régulation (ILR) whose responsibilities include monitoring competition and preventing the abuse of dominant position. ILR also sets the network tariffs and the conditions for access to the network. According to the 2007 Law, the tariffs and access conditions must be transparent and non-discriminatory and based on cost. Network owners are also required to publish their tariffs. The regulator is funded by the network operators.

Principles for setting the network tariffs are laid out in the 2007 Law. Network tariffs are set *ex ante* and follow rate-of-return regulation. ILR sets the criteria, on the basis of which the network operators must calculate the tariffs for the coming calendar year and submit their calculation to the ILR for approval. The final approval of the tariff is by the Minister for Economic Affairs and Foreign Trade. The tariffs for 2008 were based on the 2006 financial data.

The rules governing network access are spelled out in the grid code (Code de Distribution). The code was first prepared jointly by the ILR and the network owners, and has subsequently been updated and revised several times. The current version dates from April 2008.

Although the second Gas Market Directive was transposed belatedly, the gas market has been fully open since July 2007. For industrial customers, it has been open since 1 July 2004. Customer switching, however, has been modest so far.

Legal unbundling of transmission activities from sales activities will apply to the transmission system operator (SOTEG) from 1 July 2009. The distribution system operators, however, all have fewer than 100 000 customers, and are, therefore, not required to legally unbundle the network operations from their other operations.

INDUSTRY STRUCTURE

Luxembourg's natural gas market is dominated by a small number of vertically integrated companies. SOTEG owns and operates the transmission system,

and it supplies the majority of the market. It was created in 1974 to transport natural gas and develop the transport grid, and it maintains a strong position in imports and transportation. SOTEG is owned by the State (21%), E.ON (20%), ArcelorMittal (20%), Cegedel (19%), Saar Ferngas (10%) and the state-owned SNCI fund (10%). Since 2004, SOTEG is also involved in electricity, and it sold 3.3 TWh in 2007. In a move to consolidate Luxembourg's energy sector, SOTEG is undergoing a merger with Cegedel, the electricity incumbent, and Saar Ferngas to form a new cross-regional energy player (see Chapter 6). At the time of writing (December 2008), the merger was yet to be cleared by the competition authorities.

SOTEG purchases most gas under long-term contracts, but also on the spot market of the Zeebrugge hub. There is for the moment no real wholesale market for gas in Luxembourg, and SOTEG supplies all gas to the country's four integrated distribution system operators (DSOs). It also supplies gas to some 20 directly connected large users in the power and manufacturing sectors.

The four DSOs own their grids and have a strong market position in their distribution areas. In 2007, they served a total of 73 000 customers. Two of the DSOs, those owned by the cities of Luxembourg and Dudelange, distribute gas in their municipalities. SUDGAZ, in turn, is owned by 15 municipalities in the south-west of the country to which it supplies gas. LUXGAZ DISTRIBUTION s.a. distributes gas to 41 municipalities. It is owned by the government (30% of shares), municipalities (30%), SOTEG (25%), Cegedel (13.7%) and Fédération des Installateurs (1.3%).

In addition to the network-owning companies, GDF SUEZ, Distrigaz and Cegedel are authorised to supply gas in Luxembourg. Since 2002, GDF SUEZ has been supplying an industrial client and a CHP plant. Cegedel's authorisation dates from 2005.

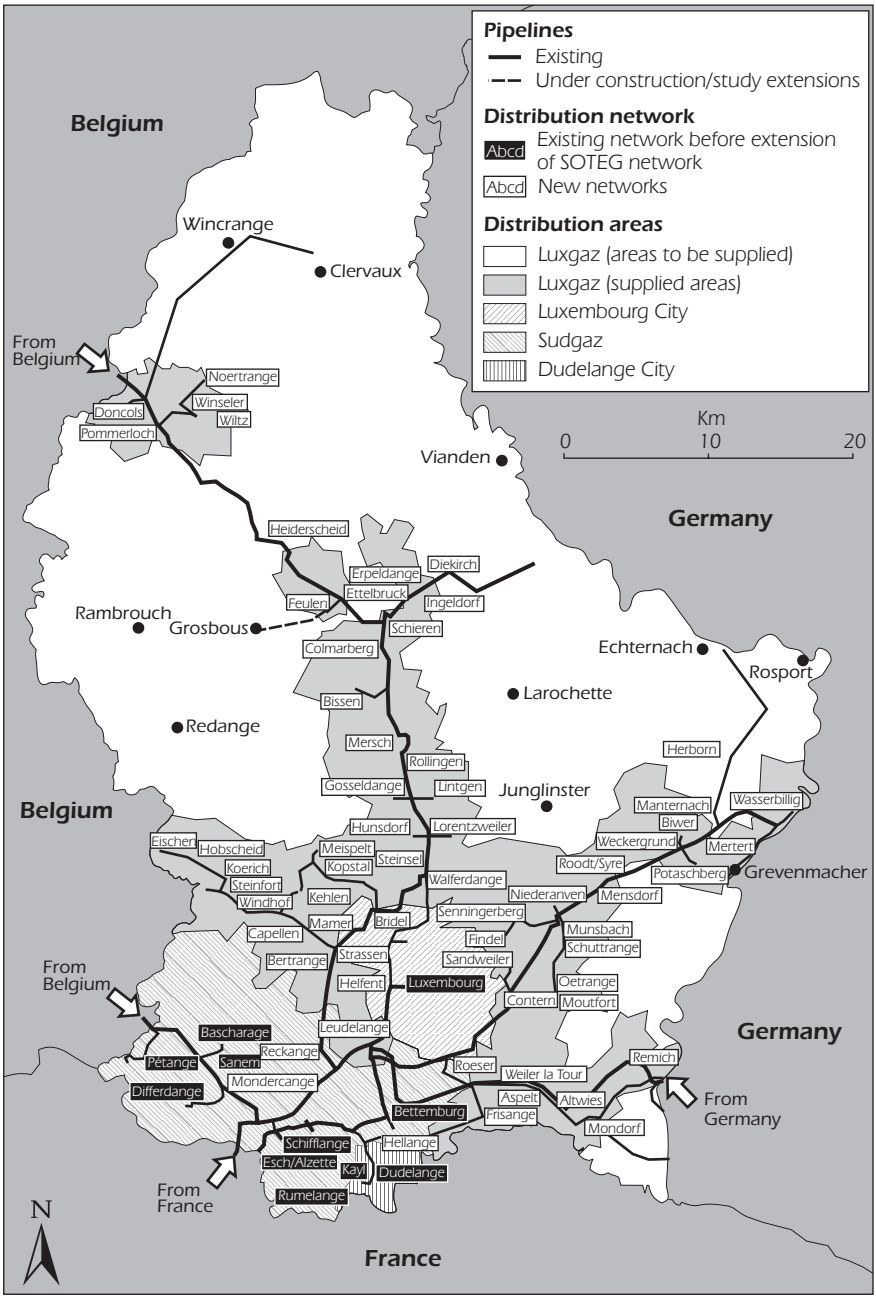
INFRASTRUCTURE

Luxembourg's natural gas grid consists of 380 km of transmission system network and some 2 300 km of distribution system network. The transmission network interfaces with four distribution systems and directly with some large industrial customers (see Figure 14).

There are four entry points to the gas network; two from Petange and Bras in Belgium (from the FLUXYS network, with a maximum capacity of 0.6 + 0.16 mcm Nm^3/h), one from Audun in France (GRTgaz, 0.02 mcm Nm^3/h) and one from Remich in Germany (E.ON Ruhrgas, 0.19 mcm Nm^3/h). The entry points from Belgium and Germany are generally not congested. In 2007, 53% of imported gas entered the country through the German entry point, 46% through the Belgian entry points (Bras: 32.8%, Petange 13.4%), and 1% through the French entry point.

Figure 14

Map of the Natural Gas System



Note: The boundaries and names shown and the designations used on this map do not imply official endorsement or acceptance by the IEA.

Source: SOTEG.

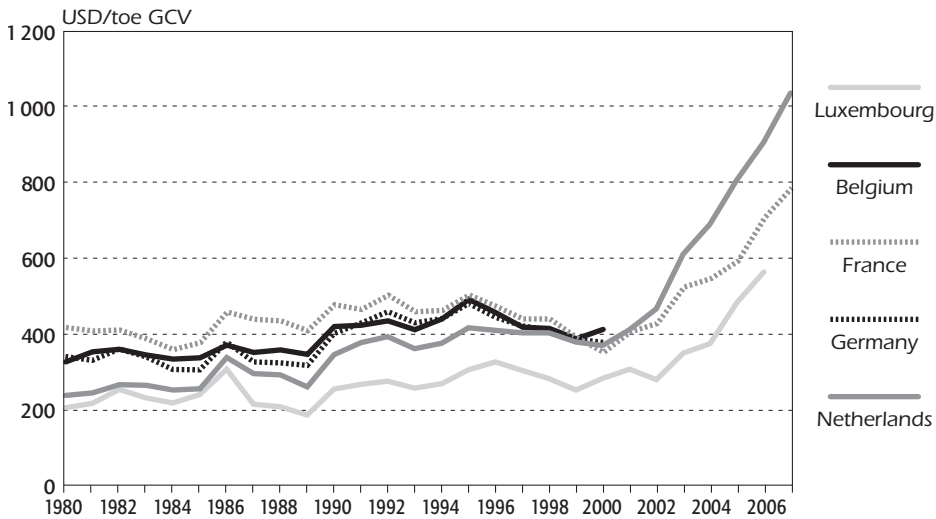
The existing grids are not designed for transit. The Luxembourg network does not have a compressor station; therefore, its network depends on the compressors of neighbouring countries (Belgium and Germany). There is no gas storage in the country.

PRICES AND TAXES

Prices of gas imports are based on long-term contracts and linked to the price of oil products. For the past several years, prices for end-users have been steadily rising, reflecting higher oil prices. Historically, household gas prices have been well below the IEA-Europe average, because of low before-tax prices and also relatively low value-added taxes (see Figure 15). Gas prices for industrial users are currently somewhat higher than the IEA-Europe average.

Figure 15

Natural Gas Prices for Households in Luxembourg and in Other Selected IEA Member Countries, 1980 to 2007



Source: *Energy Prices and Taxes, IEA*/OECD Paris, 2008.

SECURITY OF SUPPLY

Luxembourg's legislation on security of gas supply is based on the second EU Gas Market Directive (2003/55/EC) and the Directive Concerning Measures to Safeguard Security of Natural Gas Supply (2004/67/EC). These directives have been transposed into the national Law on the Organisation of the Natural Gas Market of 1 August 2007.

Suppliers must guarantee supply to end-users in times of supply disruptions and extreme weather conditions, including under exceptionally high demand for gas during very cold periods (statistically recorded every 20 years). The law also obliges the system operators to invest in grids in order to ensure their security and safety, and to guarantee transporting and distributing gas in extreme weather conditions.

The law also sets a public service obligation on gas suppliers, requiring them to contribute to the overall supply of the domestic market during a disruption. This includes participating in solidarity with the other suppliers to maintain a steady supply to network operators. In this way, spare supply from the other suppliers may be utilised when any one of the four suppliers to the national market faces difficulties during defined periods of extreme circumstances.

In addition to the grid code, the system operators must develop a five-year network development plan, and update it every two years. To limit the impact of supply disruptions on end-users, they have concluded interruptible contracts with several large users. In 2007, these covered 18% of gas use. By sector, 35% of industrial customers have interruptible contracts, and so have 15% of public distribution customers. The single largest user, the Twinerg CCGT plant, is not interruptible. The Ministry of Economic Affairs and Foreign Trade is responsible for monitoring the general state of the networks and interconnections as well as the security of supply.

As Luxembourg has no natural gas storage and no substantial line pack in its transmission grid, there is little supply flexibility within the country to compensate for lost gas supplies. With four entry points, there is the potential to compensate for reduced flows through one of these by increasing supply through the others. However, with over half of the country's gas supplied through the German entry point, a significant reduction to capacity at this point would be difficult to compensate for from the other directions. Because of the historic design of a part of the transmission network, the French entry point usage is limited to a rather low import contribution (1% of 2007 imports entered the country through this point).

COAL

Coal has nowadays little importance in Luxembourg. All coal is imported and it is used in the cement industry and, to a smaller extent, the steel industries. In 2006, coal consumption was 0.1 Mtoe, which accounted for 2.5% of TFC. Consumption is not expected to dramatically increase in the future.

CRITIQUE

OIL

Luxembourg, being totally dependent on oil imports with over 85% of its IEA minimum stockholding obligation met by stocks held in neighbouring

countries, is particularly vulnerable to oil supply disruptions. Moreover, its high level of reliance on the use of short-term leasing contracts, or tickets, could leave the country facing a sharp reduction in its available oil stocks during periods of tight or disrupted oil supplies, as renewal of such contracts is not guaranteed. Recognising this problem, the government has over the years announced its intention to change the relevant legal framework to create a stockholding agency and to increase domestic storage capacity.

Luxembourg faces a potential domestic storage capacity problem, as over half of its current capacity is likely to be closed in the next five years, if permits are not renewed. If the storage sites of Bertrange and Hollerich are closed, and the capacity is not replaced, an even greater proportion of stocks will need to be held outside the country. This will place a significant logistical challenge to the oil industry in Luxembourg, which will have considerably less ability to maintain continuous supply of oil products to consumers. Without action, the country will face serious risks in its domestic oil supply chain, becoming more vulnerable to disruptions caused by events such as labour strikes or weather conditions which hinder fuel deliveries by road or rail.

Therefore, the government should speed up the development of a plan to address storage capacity issues by taking concrete measures to maintain sufficient domestic storage capacity. This should include replacing the facilities scheduled for closure, or delaying such closures until new capacity is made available. The government should also, without further delay, revise its stockholding regime. The new stockholding regime, based on IEA methodology, should seek to reduce notably the share of short-term ticket contracts and lead to more physical stockholding, both domestically and within a reasonable distance from the country. In devising this new regime, the government should consider the possible role of a specialised stockholding agency, which could be industry-based, government-based, or based on a regionally co-ordinated framework.

The maximum price-setting mechanism which fixes oil product prices for end-users has been improved over the years, using a formula based on market prices. However, this still entails a four-day delay for retailers in implementing new prices. Potentially, such a scheme can have a stifling effect on industry investment in the country's supply infrastructure. Moreover, maintaining such a price-setting mechanism requires the dedication of staff resources within the Ministry of Economic Affairs and Foreign Trade. Such resources should urgently address the storage capacity needs and the revision of the stockholding regime.

NATURAL GAS

Since our previous review in 2004, the legal framework of Luxembourg's natural gas market has been extensively revised. According to EU legislation, the government has opened the market to competition and set requirements

for transparent, non-discriminatory third-party access (TPA). It has decided to regulate the network tariffs *ex ante*, which increases regulatory certainty, and introduces clear criteria for determining network tariffs to this effect. The IEA applauds these developments.

The government has also taken measures to increase security of gas supply, from an already fairly strong position. Supplies are relatively well diversified by country of origin and by transportation route. Nevertheless, the government should study how the entry capacities could be raised in order to further improve supply security and to provide greater flexibility for supply routes. The networks are well maintained, and interruptible contracts are further adding to security of supply. The 2007 legislation takes very positive steps in assuring network operators, suppliers and wholesale customers guarantee the security of supply to end consumers. However the government does not clearly define what constitutes a disruption in gas supplies, in terms of amount and duration. Moreover, the single largest user of gas in the country, the Twinerg CCGT plant, is not covered in the measures for gas security. The Twinerg plant's electricity generation can be backed up by generation in Belgium, but with gas generating more than 90% of Luxembourg's electricity output, the government should establish a plan on how it would respond to disrupted gas supplies to its power generators.

As in many other countries, the gas market in Luxembourg continues to be dominated by a small number of vertically integrated companies. SOTEG owns the transmission system and imports practically all of the gas the country uses. The distribution sector has four players who traditionally have held a monopoly in their supply areas. The gas market is very small, completely dependent on imports, and gas use is dominated by a single 350-MW CCGT plant. A vertically integrated industry structure tends to strongly limit competition and lead to costs to end-users. Luxembourg's use of relatively low excise taxes on gas has, however, kept prices to households lower than in the neighbouring countries. The government should reflect on effective unbundling of network operations from the utilities' other activities in order to assess its positive impacts on a well-functioning gas market.

The focus in gas policy to date has been on securing deliveries to end-users, and competition in the gas market has been characteristically that of gas against other forms of energy. Market opening is a recent phenomenon, and so far, customer switching has been limited. As long as almost all gas is imported by SOTEG, it may be unrealistic to expect gas-to-gas competition to reach high levels. More competition between gas companies could bring benefits to customers without jeopardising their supplies. Especially in light of the ongoing consolidation of the electricity and natural gas markets in the country, the government

should take further steps to deliver a sufficient level of competition and consider measures to increase it, in conformity with the spirit of a well-functioning European internal market.

RECOMMENDATIONS

The government of Luxembourg should:

Oil

- *Urgently implement a plan to maintain sufficient domestic storage capacity.*
- *Swiftly revise the stockholding regime, including:*
  - *Limiting the use of short-term ticket contracts.*
  - *Increasing the level of physical oil stocks.*
  - *Considering a possible role for a stockholding agency*
- *Consider eliminating the maximum price-setting mechanism.*

Natural gas

- *Analyse the possibilities for network development in order to further improve supply security and to provide greater flexibility for supply routes.*
- *Define what constitutes supply disruption.*
- *Establish a plan for dealing with disruption of gas supplies to the transformation sector.*
- *Ensure effective unbundling of network operations from the utilities' other activities.*
- *Ensure sufficient level of competition in the natural gas market and consider measures to increase it.*

SUPPLY AND DEMAND

The latest available information indicates that renewable energy sources and waste provided 2.5% of Luxembourg's total primary energy supply in 2007, up by more than half from 2006 (see Figure 16). Since the mid-1990s, the volume of renewable energy has increased, but at the same pace as total TPES, keeping the share around 1% of TPES. The sudden increase in 2007 resulted from the introduction of a biofuels blending obligation (see below).

Biomass-based fuels and waste, including biofuels and biogas, accounted for 85% of total renewable energy. Hydropower provided 9% and wind 5%. The remaining 1% came from solar power. Ranked among the 28 IEA member countries, Luxembourg has the third-lowest share of renewables in its TPES (see Figure 17).

Renewable energy used for heat production was almost entirely biomass. Detailed data for heating energy are not readily available, but biogas was used for heat production at small-scale CHP plants, whereas wood pellets are gaining ground in the residential sector. In transport, biofuels accounted for 2% of TPES in 2007, a strong increase from 2006. Biodiesel made up 97% of biofuels. All bioethanol and 98.6% of biodiesel supply were imported in 2007.

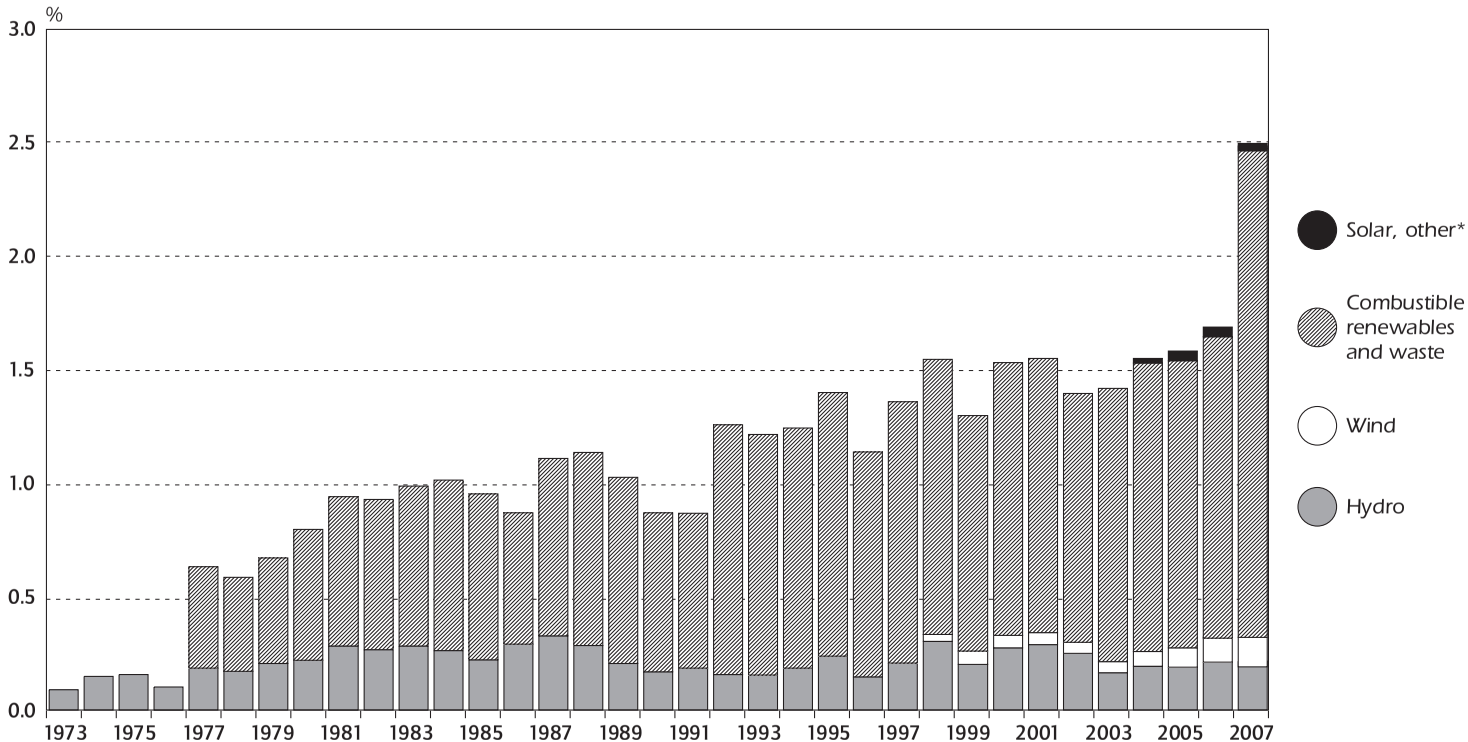
Electricity generation from renewable sources and waste accounted for 9.5% of total generation in 2007. This share is logically much lower than before the commissioning of the Twinerg CCGT plant in 2002, but in absolute terms the volume of electricity from renewable sources and waste has increased by 50% since then, to 305 GWh in 2007.

In 2007, hydropower provided 38% of total generation from renewable sources and waste. The share of biomass was 34%, including electricity from waste and biogas. Wind power provided 21% of the total and solar photovoltaics (PV) 7%. In 2007, Luxembourg's share of renewables in its electricity generation was close to the median of all 28 IEA member countries (see Figure 18). Excluding the 1 100 MW pumped storage plant at Vianden, renewable electricity generation capacity totalled 117 MW in 2006. Strong increases are most likely in wind power capacity.

Luxembourg has at least two companies offering green electricity, EIDA and Cegedel's Nova naturstroum. A large customer for green electricity supplies is the state railway company, which switched to renewable electricity in January 2008.

Figure 16

Renewable Energy as a Percentage of Total Primary Energy Supply, 1973 to 2007

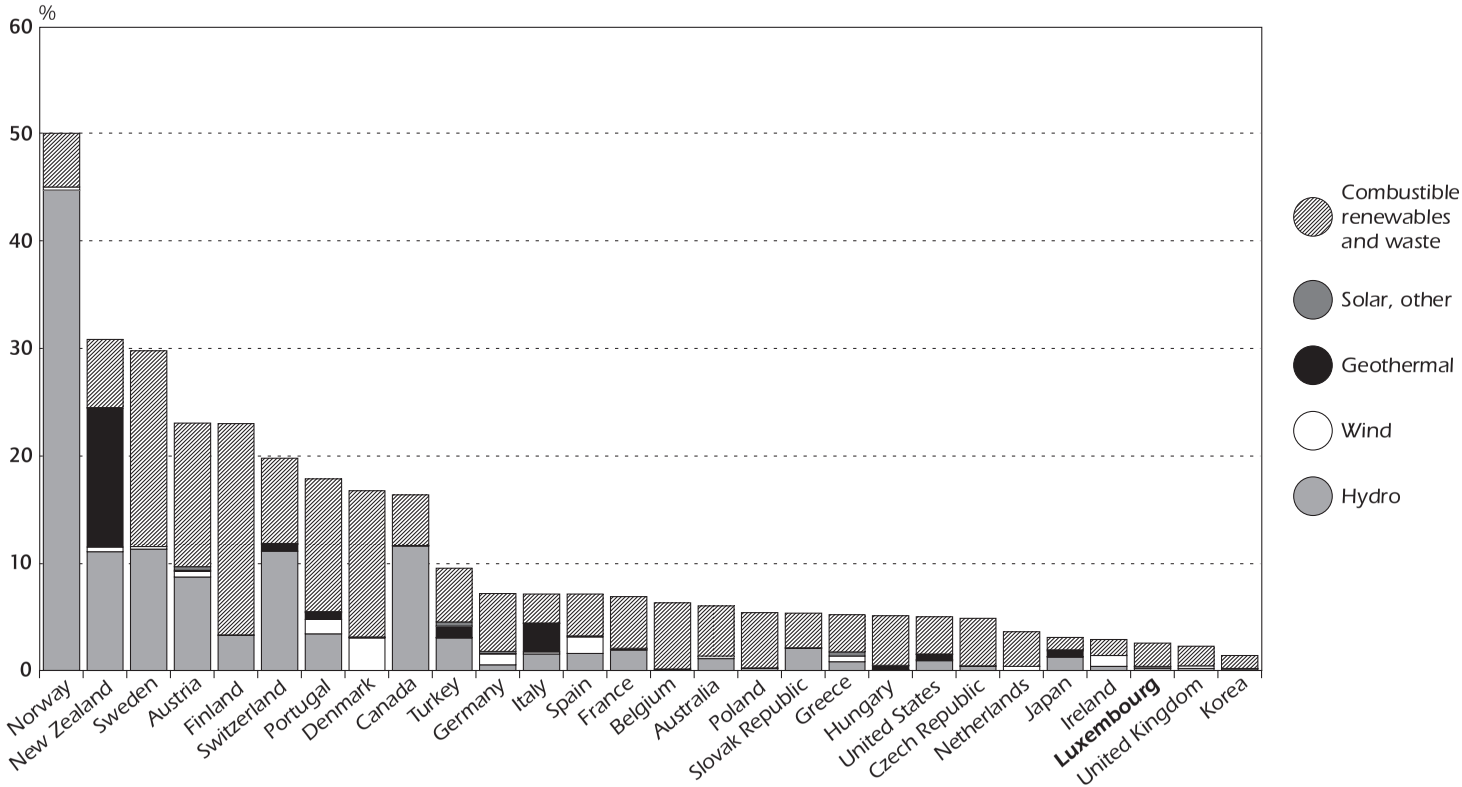


* negligible.

Source Source: *Energy Balances of OECD Countries*, IEA/OECD Paris, 2008.

Figure 17

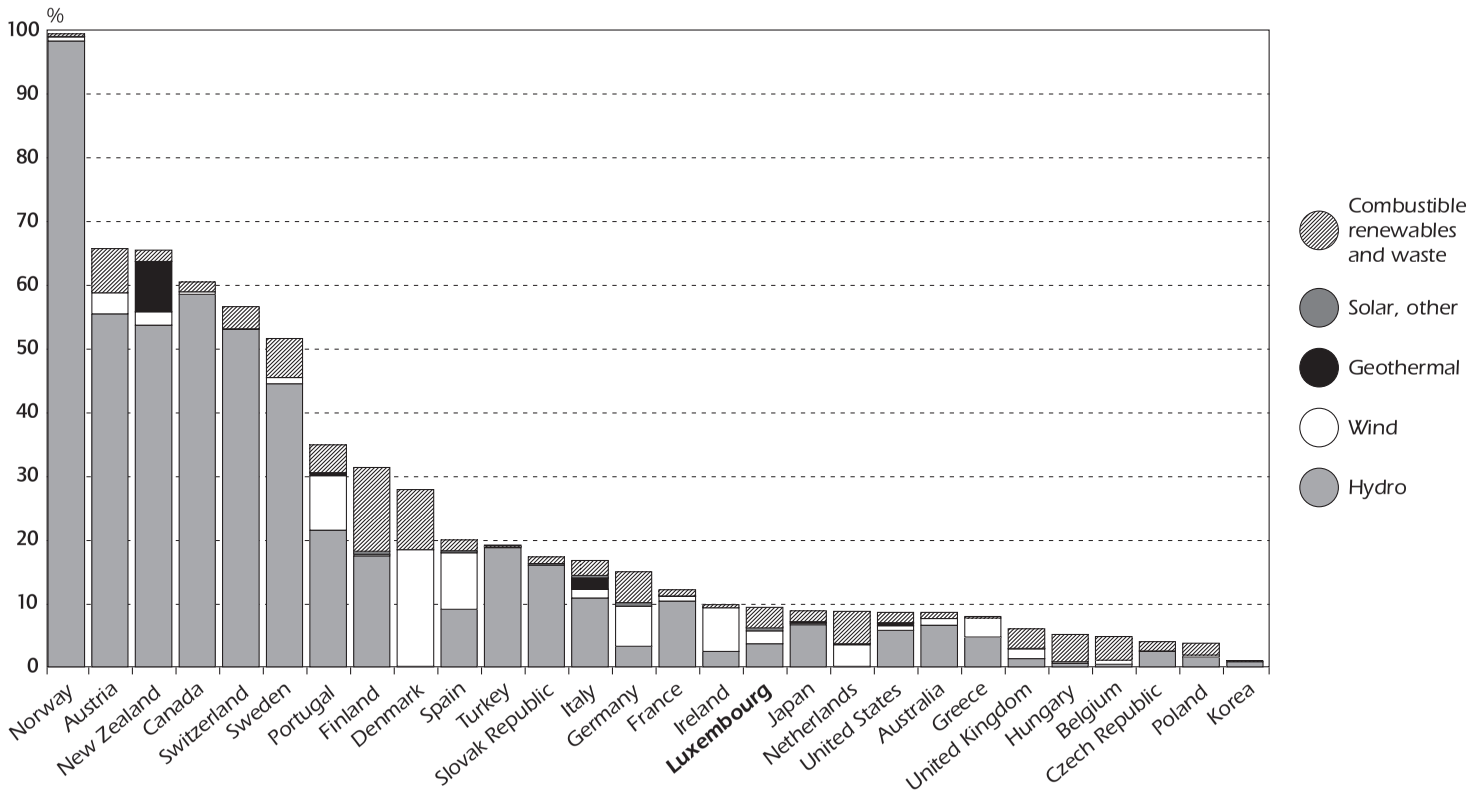
Renewable Energy as a Percentage of Total Primary Energy Supply in IEA Member Countries, 2007



Source: *Energy Balances of OECD Countries*, IEA/OECD Paris, 2008.

Figure 18

Electricity Generation from Renewable Energy Sources as a Percentage of All Generation in IEA Member Countries, 2007



Source: *Energy Balances of OECD Countries*, IEA/OECD Paris, 2008.

POLICIES AND MEASURES

Luxembourg's renewable energy policy is strongly influenced by several EU directives and quantitative targets. The Directive 2001/77/EC sets Luxembourg a national indicative target of 5.7% by 2010 for the share of electricity from renewable sources of gross electricity consumption. The Directive 2003/30/EC in turn sets an indicative national target of 5.75% by 2010 for the share of biofuels in transport fuels.

These non-binding targets will be followed by a binding national target for 2020 for the share of renewable energy sources in final consumption of energy, on the basis of the directive proposed in January 2008. The proposed share for Luxembourg is 11%, as compared to the actual share of 0.9% in 2005. In addition to this overall target, a separate target for biofuels to cover 10% of transport fuel demand in 2020 has been proposed. At the time of writing, the proposals were yet to be adopted by the EU member states and the EU Parliament.

Since the early 1990s, Luxembourg has implemented a range of measures to promote the use of renewable energy. Measures have consisted of feed-in tariffs for electricity, subsidies for investing in renewable energy technologies, and also tax exemptions for biofuels in transport.

In March 2007, in an effort to boost renewable energy supply, the government published the results of an extensive study on the potentials for increasing renewable energy production in Luxembourg.[4] The study identified a maximum potential for up to 4.5% of energy consumption to be produced from renewable sources by 2020. If transport fuel sales to foreign users were phased out, this share would rise to 8.25% in 2020. The study concluded that realising these production potentials would require strong additional measures, but their benefits would outweigh their costs because of reduced spending on fossil fuels. Following the findings of the study, the government revised its support schemes. The new support schemes entered into force on 1 January 2008 and are explained in more detail below.

ELECTRICITY

Luxembourg supports electricity generated from renewable sources by feed-in tariffs and investment subsidies (see Table 5). The current support system was introduced on 1 January 2008, in replacement of the previous one dating from 2005.

The government decided to revise the subsidy system to accelerate capacity increases and to improve cost-effectiveness. Progress on reaching the indicative target for 2010 had been sluggish and the investment subsidies and feed-in

4. *Bestimmung der Potenziale und Ausarbeitung von Strategien zur verstärkten Nutzung von erneuerbaren Energien in Luxemburg*, March 2007.

tariffs had led to a tremendous growth in solar PV capacity, from 54 kW in 1999 to some 23 500 kW in 2005. In the period 2001 to 2006, solar PV received EUR 68 million in investment subsidies, by far the largest amount among renewable energy technologies, but generated only 31 GWh of electricity in 2006, or around 0.5% of total electricity supply.

The current subsidy system is simpler and more transparent than the previous one. It has only two elements – investment subsidies and feed-in tariffs – whereas the previous system also had a third element – a premium tariff. Investment subsidies for hydropower were introduced (20% of total cost), those for wind power were increased from 10% to 20–25%, and those for solar PV doubled from 15% to 30%. Feed-in tariffs are generally higher than in the previous system and they are also more differentiated between technology and generating capacities. To increase investor security, feed-in tariffs are guaranteed for 15 years, and they have a degression rate of 0.25% per year for all technologies except for solar PV, for which the rate is 3%. The current subsidy system applies to installations connected to the grid after 1 January 2008 and, under some conditions, to biogas-fired power plants connected to the grid after 1 January 2007.

Under the current system, network operators have an obligation to purchase the electricity produced from renewable sources. The feed-in tariff is financed from the so-called compensation mechanism, managed by the regulator. In 2008, end-users with an annual consumption of up to 25 MWh were required to contribute EUR 8.8 per MWh, and large industrial users (with a connection of at least 65 kV or annual use of at least 20 GWh) EUR 0.75 per MWh. Those not belonging to these two groups contributed EUR 3 per MWh. The mechanism also covers co-generation.

Table 5

Support System for Electricity Generated from Renewable Sources

Technology	*Capacity limit*	*Maximum investment subsidy, % of eligible cost*	*Feed-in tariff, EUR/MWh*
Wind power	unlimited	20–25	82.7
Solar PV	0–30 kW	30	420
	31–1 000 kW	30	370
Hydropower	0–1 MW	20	105
	1–6 MW	20	80
Biogas	0–150 kW	50	150
	151–300 kW	50	140
	301–500 kW	50	130
	501–2 500 kW	50	120
Sludge and landfill gas	unlimited	90	65
Solid biomass	0–1 MW	20	145
	1–5 MW	20	125
Waste wood (pellets)	0–1 MW	20	130
	1–5 MW	20	110

Source: Luxembourg's Ministry of Economic Affairs and Foreign Trade.

HEAT

The government subsidises households for investing in solar heating, heat pumps, and biomass boilers. Purchases of solar thermal technologies are subsidised 50% of actual cost (maximum of EUR 3 000 for domestic hot water production and EUR 5 000 for domestic hot water and auxiliary central heating). Heat pumps receive a 40% subsidy (maximum EUR 6 000 for ground heat pumps and EUR 3 000 for air-to-air heat pumps). Biomass-fired central heating and stoves generally receive a 30% subsidy, with a maximum of EUR 4 000 for central heating and EUR 2 500 for pellet stoves.

Heat from renewable energy sources can also receive feed-in tariffs, under certain conditions. Biogas, solid biomass and wood waste are eligible for a feed-in tariff of EUR 30 per MWh for heat that is supplied to commercial customers. For biogas, the condition is that in the first three years of generation, at least 25% of the heat must be supplied to commercial customers, and after the first three years, 50%. For solid biomass and waste wood, the minimum levels are 35% in the first three years and 75% after that.

TRANSPORT FUELS

Luxembourg's efforts to meet its non-binding national target of 5.75% for the share of biofuels in all transport fuels by 2010 were initially focused on fiscal measures. In 2005 and 2006, biofuels were partially exempt from excise taxes on transport fuels, but the policy was not successful, largely because of the already lower level of excise taxes than in neighbouring countries. The government decided to change the policy, and in 2007 introduced compulsory blending of biofuels in all transport fuels sold in Luxembourg. The blending obligation was 2% in 2007. It can only be met with imported biofuels. The post-2010 biofuels regime depends on the EU developments.

CRITIQUE

Luxembourg has one of the lowest shares of renewable energy in TPES among the IEA countries, around 2% in 2007 according to the latest information. Its policies to increase the use of renewable energy are derived from the EU directives. Luxembourg's target for renewable energy as a share of final energy use in 2020, as proposed by the EU Commission, is 11%. The country will be facing a tremendous challenge in trying to meet the target, as economically viable potential for new production is limited by its size, topography, nature protection policies and population density. Yet, the government should explore all opportunities to develop domestic resources for renewable energy and analyse the feasibility of reaching the 2020 target partially through projects and actions abroad.

Encouragingly, the government is aware of the urgency of the challenge. Having realised that the previous policies and measures for promoting renewable energy were not bringing sufficient results, it revised the subsidy system for renewable electricity. The current system, effective since 1 January 2008, is a clear improvement to the previous one on several accounts. It is more transparent and predictable as the rates are guaranteed for 15 years. It also gives incentives to improve performance as the tariffs are decreasing over time. It also differentiates the tariffs by technology and capacity in more detail.

Investment subsidies for technologies with the most potential, such as wind, have been increased substantially. Grid access and market design are also supportive of renewable electricity generation. Moreover, the government has increased efforts to promote heat from renewable energy sources. It deserves to be applauded for all these improvements.

It appears, however, that consideration for cost-effectiveness of measures could be emphasised more. The concern with subsidising high-cost renewables (photovoltaics, for example) is that it limits not only funds available for more cost-effective renewable energy technologies, but also funds that could go to energy efficiency investments, which are often more cost-effective in reducing CO_2 emissions. The government should consider setting caps to prevent any single renewable energy technology from draining a disproportionate and economically ineffective share of total subsidies.

The broader energy policy dilemma for Luxembourg is that the country is not likely to reap high rewards from increased use of renewable energy sources in terms of improving its energy security and curbing its GHG emissions at a reasonable cost. Electricity from renewable sources contributes very little or nothing to the country's Kyoto target, or any future GHG target. This is because domestic generation of renewable electricity only replaces electricity imports, and these imports are not counted in Luxembourg's GHG balance, regardless of the energy source they are generated from. Biofuels, in turn, do contribute to reducing the country's GHG emissions, but do little to improve its energy security, as they are all imported directly, or in the form of feedstocks.

As oil use in transport accounts for such a high share of the country's TPES, it would seem worthwhile to try and meet the 2020 renewable energy target by increasing the biofuels blending obligation. The government has already introduced such an obligation and would only need to tighten it in the EU framework. In doing so, it should pay close attention to defining and adhering to the sustainability criteria for the products. In all circumstances, it would clearly be in Luxembourg's interest to work towards a cost-effective and flexible EU-wide policy framework for meeting the eventual 2020 target, both for electricity and biofuels.

RECOMMENDATIONS

The government of Luxembourg should:

- *Explore all possibilities to develop domestic renewable energy sources and analyse the feasibility of reaching the 2020 target partially through projects and actions abroad.*
- *Make cost-effectiveness a key criterion when designing subsidy systems for renewable energy sources and evaluate the implementation of these subsidy systems regularly.*
- *Set a cap on the share of individual renewable energy technologies in total spending on subsidies; in this context, reconsider the large subsidies available to solar photovoltaics.*
- *Pursue cost-effective and flexible EU-wide solutions to reach the future targets for renewable energy.*

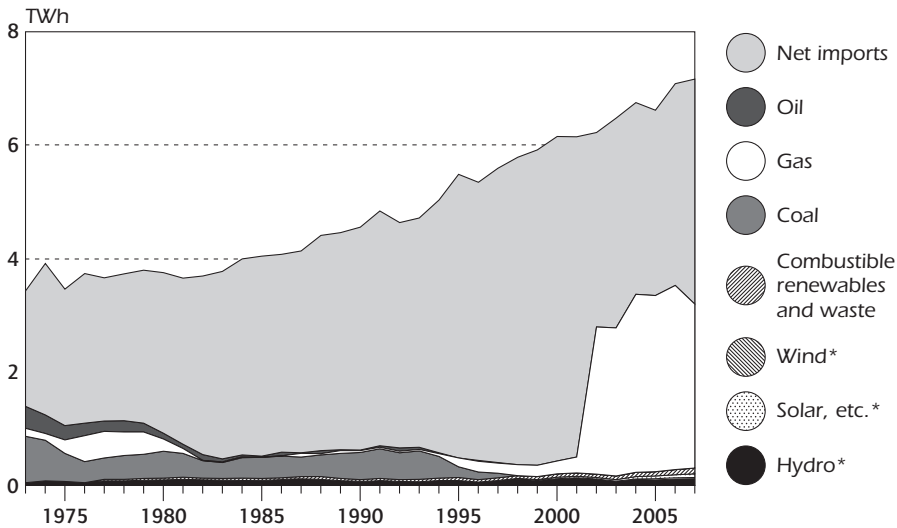
SUPPLY AND DEMAND

SUPPLY

Luxembourg depends on imports for around half of its electricity supply. In 2007, the share was 57%. Electricity generation, in turn, is dominated by natural gas, accounting for 90.5% of the total in 2007 (see Figure 19). Gas-fired power is primarily generated at a single 350-MW combined-cycle plant (Twinerg). Other electricity sources are hydro (3.7% of total generation in 2007), biomass (3.2%), and wind and solar power (2.7%). Coal and oil are no longer used for power generation. In 2007, total generation amounted to 3.2 TWh. Since the commissioning of the Twinerg plant in 2002, annual generation has remained slightly higher than 3 TWh.

Figure 19

Electricity Supply by Source, 1973 to 2007



* negligible.

Source: *Energy Balances of OECD Countries*, IEA/OECD Paris, 2008.

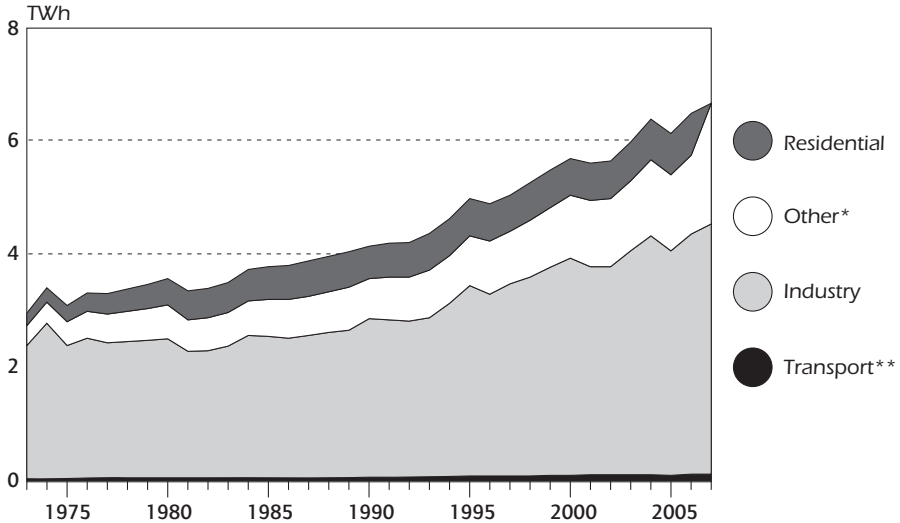
DEMAND

Luxembourg's electricity intensity is increasing. Annual use is almost 14 MWh per citizen, one of the highest in the world, and two-thirds above the IEA average. This is explained by the large industrial needs, especially in the electric-arc furnaces of the steel industry, and by the service sector's intensive

use of information technology. Electricity consumption has constantly increased over the last years, and in 2007 it reached 6.7 TWh, an all-time high. Industry accounted for 66% of the total, services and the primary sector for 21%; households for 11%; and transport for 2% (see Figure 20).

Figure 20

Final Consumption of Electricity by Sector, 1973 to 2007



* includes commercial, public service, agricultural, fishing and other non-specified sectors. For 2007, also includes the residential sector.
** negligible.

Source: *Energy Balances of OECD Countries*, IEA/OECD Paris, 2008.

Net maximum generating capacity, as measured on 31 December 2006 was 1.7 GW, higher than ever before. Capacity growth, however, has been slow since 2002, and since 2004, capacity has only increased by 10 MW. Capacity for renewable electricity is set to grow as Luxembourg will need to boost its efforts to meet the EU renewables target for 2020 (see Chapter 5).

In 2007, peak capacity use in the Cegedel Net network was 735 MW and in the SOTEL network was 392 MW (see below for description of the network system). The combined peak capacity use in the two networks was 1 086 MW, reached on 29 November 2007 at 18h15.

The largest power plant in Luxembourg is the 1 100-MW Vianden pumped storage facility. It is, however, not connected to the grid of Luxembourg but to that of Germany. As a pumped storage plant, it is used for peak power production, and it consumes more power than it generates. In 2006, it used 1.1 TWh to pump the water up to its reservoir to generate 0.8 TWh of peak power.

MARKET REFORM

Luxembourg's electricity market legislation is based on the relevant EU directives. The second EU Electricity Market Directive (2003/54/EC) and the Directive Concerning Measures to Safeguard Security of Electricity Supply and Infrastructure Investment (2005/89/EC) have been transposed into the national Law on the Organisation of the Electricity Market of 1 August 2007. Luxembourg is also applying Regulation 1228/2003 on Cross-Border Exchanges in Electricity.

The electricity market is regulated by the Institut Luxembourgeois de Régulation (ILR). As in the natural gas market, the regulator's responsibilities include monitoring competition and preventing the abuse of dominant position. It also sets the network tariffs and the conditions for access to the network. According to the 2007 law, the tariffs and access conditions must be transparent and non-discriminatory, and based on cost. Network owners are also required to publish their tariffs. The regulator is funded by the network operators.

Principles for setting the network tariffs are laid out in the 2007 law. Network tariffs are set *ex ante* and follow rate-of-return regulation. ILR sets the criteria, on the basis of which the network operators must calculate the tariffs for the coming calendar year and submit their calculation to the ILR for approval. The final approval of the tariff is by the Minister for Economic Affairs and Foreign Trade. The tariffs for 2008 were based on the 2006 financial data.

Although the second Electricity Market Directive was transposed belatedly, the electricity market has been fully open since July 2007. For industrial customers, it has been open since 1 July 2004. Market entry for producers and suppliers requires an authorisation from the Minister for Economic Affairs and Foreign Trade.

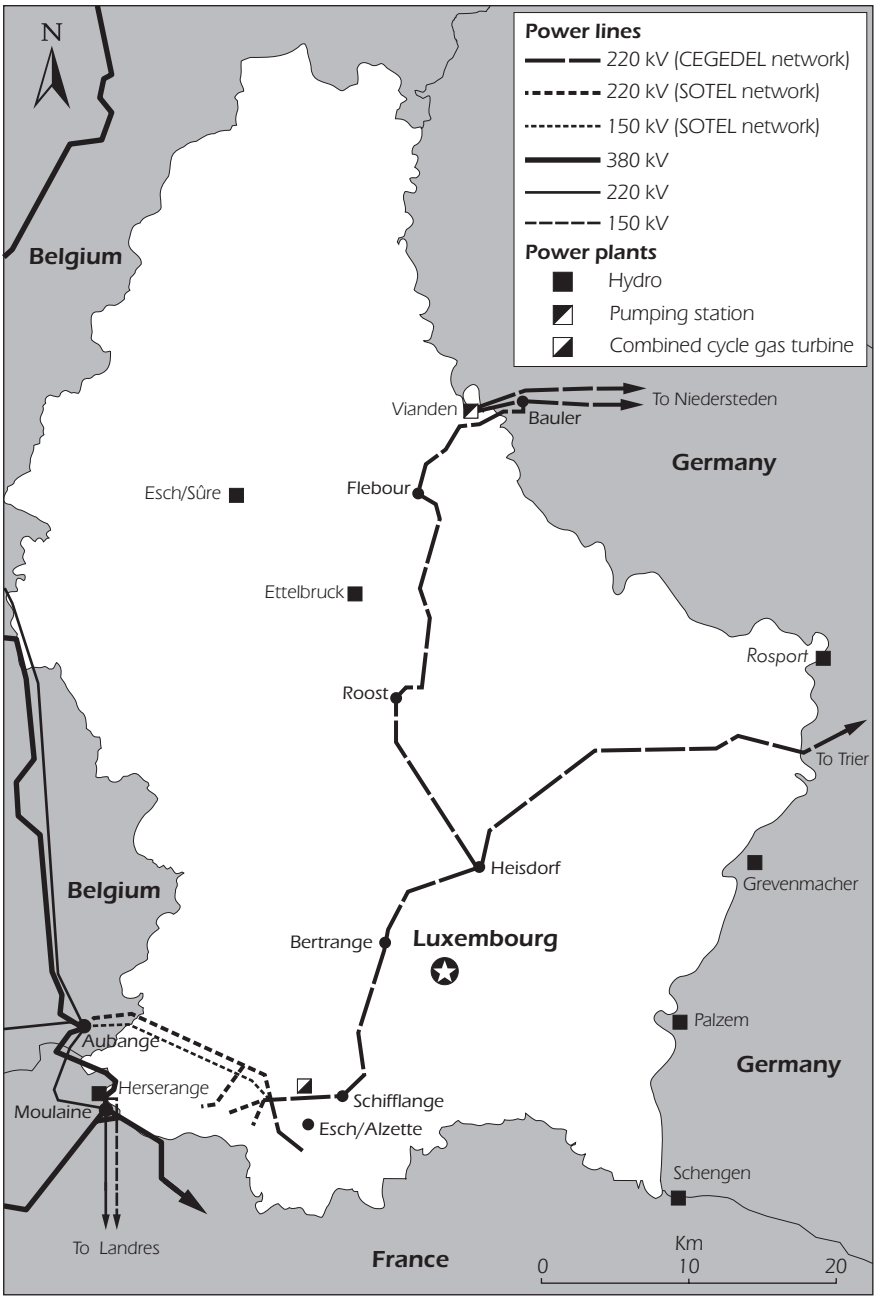
Transmission activities of the TSO must be legally unbundled from sales activities. The distribution system operators, however, all have fewer than 100 000 customers, and are therefore not required by the second Electricity Market Directive to legally unbundle the network operations from their other operations, although accounting for these operations must be separated.

INDUSTRY AND INFRASTRUCTURE

Luxembourg's electricity sector has two historical major players: the *Compagnie Grand-Ducale de l'Électricité* (Cegedel) and the *Société de Transport de l'Electricité* (SOTEL). They are the two transmission system operators in the country, each operating its own grid (see Figure 21).

Figure 21

Map of the High-Voltage Electricity Grid



Note: The boundaries and names shown and the designations used on this map do not imply official endorsement or acceptance by the IEA

Source: Cegedel

Cegedel transmits and distributes electricity, and is involved in generation through joint ventures. In 2007, it sourced roughly half of the electricity it supplied from the European Energy Exchange (EEX). The Twinerg CCGT plant provided 30% and other local generation the remaining one-fifth of the total.

At the end of 2007, its shareholders were the State of Luxembourg (32.8%), *Luxempart-Energie* (30.4%), *Société Nationale de Crédit et d'Investissement* (SNCI, 11.9%), *Electrabel* (7.8%) and others (17.1%). SNCI is 100% government-owned, and *Luxempart-Energie* is owned by Luxempart, a holding company listed in the national stock exchange.

Cegedel is involved in a planned merger with SOTEG, the gas incumbent, and Saar Ferngas, a gas distribution company majority-owned by ArcelorMittal. The main shareholders of the merged energy company would be the State of Luxembourg (28.3% directly, 10.8% through the SNCI), the steel group ArcelorMittal (25.3%), RWE (19.8%), E.ON (10.8%) and Electrabel (5.1%). The merger plan was announced in July 2008 and requires approval by the competition authorities.

Since 2005, Cegedel network operations have been legally unbundled from its other operations. Cegedel Net owns and operates 560 km of transmission grid and 6 730 km of distribution grid (less than 35 kV). Some 5 200 km of these are underground cables. The Cegedel network transmits around two-thirds of end-use electricity in Luxembourg. In 2007, total generating capacity in the Cegedel network was 211 MW, and 87% of the electricity used in the Cegedel network area were imports. The Cegedel grid is connected to the RWE grid in Germany and it is part of the RWE balancing area.

SOTEL purchases mainly electricity for the steel industry. Through its legally unbundled network company SOTEL Réseau, it owns and operates a 186-km transmission grid in the south-west of the country. The SOTEL network transmits around one-third of end-use electricity in the country. The Twinerg CCGT is the only generating plant in the SOTEL network area. SOTEL network is connected to the ELIA grid in Belgium and part of that balancing area. In normal conditions, it is not connected to Cegedel Net's grid. SOTEL is owned by ArcelorMittal (77%), EDF (21%) and Electrabel (2%).

Competition in the wholesale market depends on the availability of imports. Competition has emerged as six foreign companies are involved in cross-border electricity trade, in addition to Cegedel and SOTEL. In 2007, 13% of the electricity imported to Luxembourg was re-exported.

DISTRIBUTION

More than 250 000 customers are connected to Luxembourg's electricity networks. Most of the distributing companies are owned by municipalities, and these municipal distributing companies also own their networks. In an

open electricity market, distributors are turning away from Cegedel, their traditional wholesale supplier. In 2007, they received 45% of the electricity from new wholesale suppliers, up from 32% in 2006.

According to the regulator's annual report to the European Commission, the residential sector comprises 198 800 customers, and in 2007 they were supplied a total of 0.8 TWh by 10 companies. Cegedel was by far the largest supplier, accounting for 74.6% of the volume. City of Luxembourg had 13.4% of the market and the city of Esch/Alzette 5.0%. The seven smallest suppliers had a market share of less than 1.5% each. In 2007, there was one supplier independent from the TSOs and DSOs serving residential customers, with a tiny share of the market.

The 53 600 non-household customers in the Cegedel network area were supplied a total of 3.7 TWh by 12 companies. Cegedel supplied 40.6% of the volume, SOTEG 33.4% and the city of Luxembourg 21.0%. The eight smallest suppliers had a market share of less than 1% each. The industry-only SOTEL network supplied roughly 2 TWh to its customers, 95% to steel industry and the rest to the state railways and one clinker plant. Independent suppliers accounted for one-fifth of the volumes to customers with an annual consumption of more than 2 GWh.

Supplier switching in the residential sector has been very modest. From July to December 2007, only 0.2% of residential users switched supplier (measured in electricity volume). As for enterprises consuming less than 2 GWh per year, the switching rate in 2007 was not much higher: 0.4%. In industry consuming more than 2 GWh per year, however, supplier switching is more active, and in 2007, 15.5% of them changed supplier. In the Cegedel network area, 55% of industrial electricity use is now supplied by companies other than Cedegel, the historical monopoly.

REGIONAL ELECTRICITY MARKET

Together with France, Germany, Belgium and the Netherlands, Luxembourg is developing an integrated Central-West European regional electricity market. Under the auspices of the Pentalateral Energy Forum, the five countries' governments, regulators, TSOs, power exchanges and the market players' platform in June 2007 signed a Memorandum of Understanding (MoU) on market coupling and security of supply. They have five priorities:

- Implementing a day-ahead flow-based market coupling by January 2009.
- Implementing cross-border intra-day trade.
- Maximising the amount and use of cross-border capacities.
- Harmonising and improving the rules for long-term explicit auctions.
- Increasing transparency.

Luxembourg is connected with the other countries in the region through Germany (Cegedel-RWE interconnection) and Belgium (SOTEL-ELIA interconnection). Both interconnections have sufficient capacity for Luxembourg's needs, but to improve security of supply in the region, Cegedel Net is planning to commission an interconnection with the ELIA network in 2012, consisting of two 220-kV lines.

Cegedel Net is participating in CASC-CWE (Capacity Allocation Service Centre for the Central-West European Electricity Market). CASC-CWE was established in October 2008 by the TSOs in France, Belgium, the Netherlands, Germany (excluding Vattenfall) and Luxembourg to develop capacity allocation in the interconnections and thus facilitate market coupling and help create an integrated regional market.

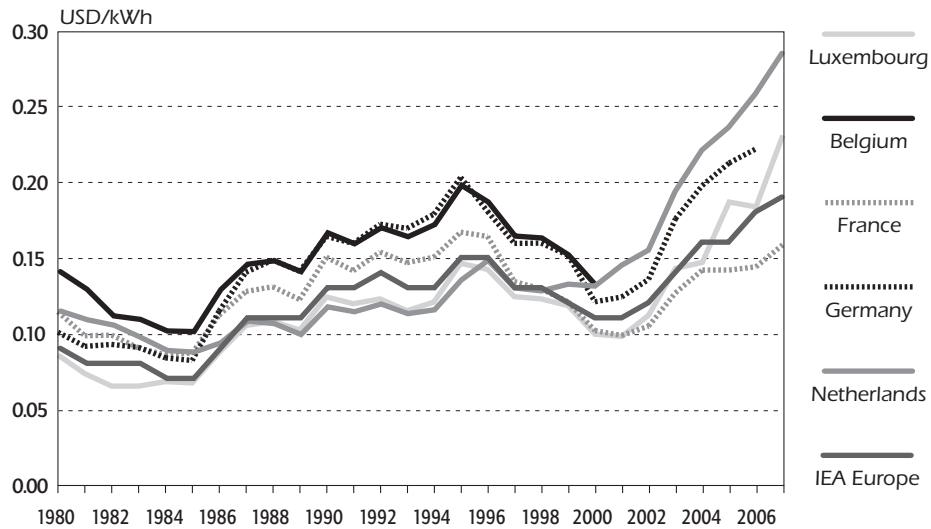
PRICES AND TAXES

Wholesale electricity prices in Luxembourg are based on the reference prices in the Central European electricity exchanges. Wholesale prices have been driven higher in recent years by more expensive fossil fuels, and, since 2005, by the EU-ETS.

Retail prices in Luxembourg have been traditionally close to the IEA Europe average (see Figures 22 and 23), with the exception of 2007. Since 2005, they have increased steadily, mostly because of the same factors that affect the wholesale prices – more expensive fossil fuels and the EU-ETS.

Figure 22

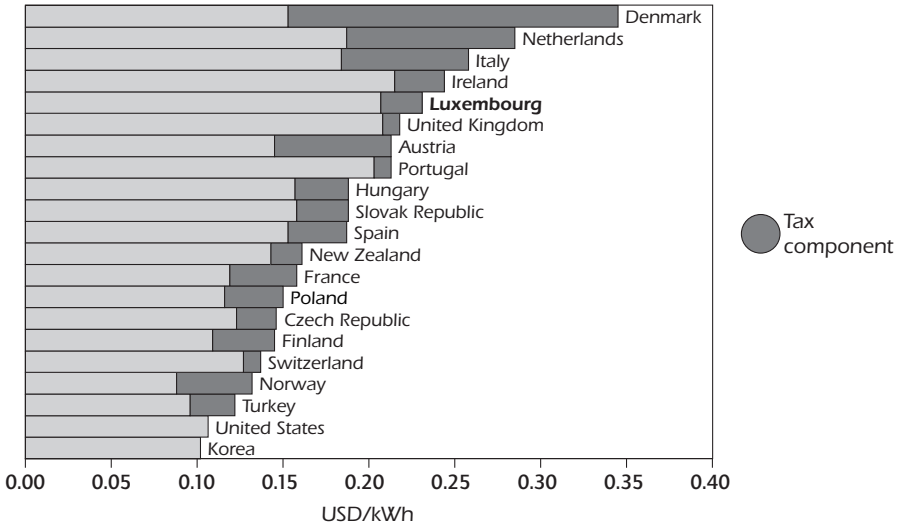
Electricity Prices for Households in Luxembourg and in Other Selected IEA Member Countries, 1980 to 2007



Source: *Energy Prices and Taxes*, IEA/OECD Paris, 2008.

Figure 23

Electricity Prices for Households in IEA Member Countries, 2007



Note: Tax information not available for Korea. Price excluding tax for the United States. Data not available for Australia, Belgium, Canada, Germany, Greece, Japan and Sweden.

Source: *Energy Prices and Taxes*, IEA/OECD Paris, 2008.

Electricity prices before taxes are higher than in almost any other IEA member country, especially for smaller companies and households. Since 2000, household electricity prices have steadily increased. According to Eurostat, in 2007 before-tax prices for households were more than one-quarter higher than the EU15 average. Industrial users paid ex-tax prices closer to the EU15 average. In 2007, ex-tax prices for a user with an annual consumption of 2 GWh were 15% above the EU15 average. The high ex-tax prices are partly explained by the small market size and the large share of costly underground distribution cables. To compensate for the high ex-tax prices, Luxembourg applies a very low tax rate on household electricity prices, an average of 10.4% of the total price in 2007, one of the lowest within the IEA member countries.

SECURITY OF SUPPLY

Luxembourg's legislation on security of electricity supply is based on the second EU Electricity Market Directive (2003/54/EC) and the Directive Concerning Measures to Safeguard Security of Electricity Supply and Infrastructure Investment (2005/89/EC). These directives have been transposed into the national Law on the Organisation of the Electricity Market of 1 August 2007.

The 2007 law obliges system operators to guarantee high-quality service to end-users and take measures to avoid interruptions. The TSOs and DSOs must also invest in grids to guarantee their security and safety. The law also sets them a public service obligation in the Cegedel network area, requiring them to contribute to the overall supply of the domestic market during a disruption.

Because of the large share of electricity imports, Luxembourg's security of electricity supply depends on the functioning of the evolving regional electricity market. The MoU of the Pentalateral Energy Forum of July 2007 outlines joint action on security of supply in the following areas: system adequacy forecast; harmonised incidents classification scale; TSO co-operation platform; and regional transmission capacity plan.

Luxembourg receives close to 40% of its electricity from the Twinerg CCGT plant. The plant's capacity of 350 MW is divided between Electrabel for the Belgian grid (150 MW), and SOTEL and Cegedel (100 MW each). If the plant's gas supply is cut off, Electrabel is obliged to provide backup electricity.

The interconnection capacity is sufficient for Luxembourg's current needs, but this situation may change as electricity demand is likely to grow over the long term. On these assumptions, Cegedel Net intends to build an interconnection to ELIA's grid in Belgium.

SOTEL also has plans for more interconnections. In 2007, it applied for a licence for a grid connection with France. This would serve to improve the security of supply to the ArcelorMittal electric-arc furnaces that currently depend on one 225-kV line from Belgium for their electricity. The licensing and approval procedures are still pending. There have also been talks about permanently connecting the country's two transmission grids and creating a single TSO for the country.

CRITIQUE

Since the last review, Luxembourg's electricity market legislation has been fundamentally reformed on the basis of EU directives. All customers are now free to choose their supplier, the regulator is strengthened, and the transmission system operations are legally unbundled. The country has also adopted *ex ante* regulation on network tariffs. These are all highly commendable developments.

Luxembourg relies heavily on imports for its electricity supply and its electricity security largely depends on developments in neighbouring countries. It is therefore very positive that the government, the regulator and Cegedel as a TSO are actively involved in developing a truly integrated regional electricity market in Central-West Europe.

Luxembourg has two separate transmission networks which are connected to different networks in neighbouring countries. Although there is at present enough capacity in the existing interconnections, new ones will enhance security of supply in the face of increasing electricity demand in the country and in the region. Therefore, it is encouraging to see that the two transmission network operators are keen to invest in new cross-border connections. Another source for increasing security of supply could be the creation of a single TSO for the whole country. The authorities should further analyse this process.

Sufficient physical capacity in cross-border links and in the national grid is also necessary for competition to develop. As evidence of increasing competition, the number of suppliers and their share of electricity supplied to Luxembourg are growing. Also, supplier switching among the largest users in the Cedegel network area is becoming more and more common.

The electricity sector remains, however, dominated by the historical incumbents, which may reduce benefits to customers. The planned merger of Cegedel, SOTEG and Saar Ferngas would significantly consolidate Luxembourg's energy sector.

The regulator strives to further improve market functioning by, among others, new methods for calculating grid access tariffs and laying the ground for possibly moving to one single network tariff for the country in the long term. The government should support the regulator in these aspirations.

RECOMMENDATIONS

The government of Luxembourg should:

- *Work towards increasing security of supply by facilitating more interconnections with the neighbouring countries and by analysing the way towards a single TSO for the country.*
- *Develop further the national and regional electricity market in accordance with sound market-based principles within the framework and spirit of an internal electricity market in Europe.*

PART III

ANNEXES

ORGANISATION OF THE REVIEW

REVIEW TEAM

The in-depth review team visited Luxembourg from 21 to 24 April 2008. The team met with government officials, energy suppliers, interest groups and various other organisations. The team is grateful for the openness, co-operation and hospitality of the many people it met; they greatly contributed to a successful and productive review. In particular, the team wishes to thank the staff of the Directorate for Energy at the Ministry of Economic Affairs and Foreign Trade for their professionalism displayed in preparing and guiding the review.

The team members were:

Mr. Bernard Nanot
Ministry for Ecology, Sustainable Development and Sustainable Town and Country Planning, France

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Mr. Miika Tommila
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Miika Tommila managed the review and drafted the report, with the exception of the section on oil in Chapter 4 which was drafted by Jason Elliott from the IEA's Emergency Policy Division. Monica Petit and Bertrand Sadin prepared the figures. Marilyn Ferris and Viviane Consoli provided editorial assistance.

ORGANISATIONS VISITED

The team held discussions with the following energy and environment stakeholders:

- Administration de l'Environnement
- Agence de l'Energie
- ArcelorMittal
- City of Dudelange
- City of Luxembourg

- Compagnie Grand-Ducale de l'Electricité (Cegedel)
- Competition Authority
- Fédération des Industriels Luxembourgeois (FEDIL)
- Greenpeace
- Groupement Pétrolier Luxembourgeois (GPL)
- Institut Luxembourgeois de Régulation (ILR)
- Ministry of Economic Affairs and Foreign Trade
- Ministry of the Environment
- Luxenergie S.A.
- Luxgaz
- Société de Transport de l'Electricité (SOTEL)
- Société Electrique de l'Our (SEO)
- SOTEG
- SUDGAZ
- Twinerg

REVIEW CRITERIA

The *Shared Goals* of the IEA, which were adopted by the IEA Ministers at their 4 June 1993 meeting held in Paris, provide the evaluation criteria for the in-depth reviews conducted by the IEA. The *Shared Goals* are set out in Annex C.

ENERGY BALANCES AND KEY STATISTICAL DATA

Unit: Mtoe

SUPPLY

		1973	1990	2000	2004	2005	2006	2007P
TOTAL PRODUCTION		**0.00**	**0.03**	**0.06**	**0.07**	**0.07**	**0.08**	**0.08**
Coal		–	–	–	–	–	–	–
Peat		–	–	–	–	–	–	–
Oil		–	–	–	–	–	–	–
Gas		–	–	–	–	–	–	–
Comb. Renewables & Waste[1]		–	0.03	0.04	0.06	0.06	0.06	0.06
Nuclear		–	–	–	–	–	–	–
Hydro		0.00	0.01	0.01	0.01	0.01	0.01	0.01
Wind		–	–	0.00	0.00	0.00	0.01	0.01
Geothermal		–	–	–	–	–	–	–
Solar/Other		–	–	–	0.00	0.00	0.00	0.00
TOTAL NET IMPORTS		**4.49**	**3.53**	**3.63**	**4.53**	**4.62**	**4.66**	**4.65**
Coal	Exports	–	–	–	–	–	–	–
	Imports	2.44	1.13	0.13	0.09	0.08	0.11	0.08
	Net Imports	2.44	1.13	0.13	0.09	0.08	0.11	0.08
Oil	Exports	0.01	0.01	0.02	0.02	0.02	0.01	–
	Imports	1.67	1.64	2.36	2.97	3.10	3.02	2.89
	Bunkers	–	–	–	–	–	–	–
	Net Imports	1.65	1.63	2.34	2.95	3.08	3.01	2.89
Gas	Exports	–	–	–	–	–	–	–
	Imports	0.22	0.43	0.67	1.20	1.18	1.23	1.34
	Net Imports	0.22	0.43	0.67	1.20	1.18	1.23	1.34
Electricity	Exports	0.07	0.06	0.06	0.27	0.27	0.28	0.25
	Imports	0.24	0.40	0.56	0.56	0.55	0.59	0.59
	Net Imports	0.18	0.34	0.49	0.29	0.28	0.31	0.34
TOTAL STOCK CHANGES		**–0.01**	**–0.01**	**–0.05**	**0.01**	**0.02**	**–0.03**	**–**
TOTAL SUPPLY (TPES)		**4.49**	**3.54**	**3.64**	**4.62**	**4.71**	**4.71**	**4.73**
Coal		2.44	1.13	0.13	0.09	0.08	0.11	0.08
Peat		–	–	–	–	–	–	–
Oil		1.65	1.61	2.29	2.96	3.10	2.98	2.89
Gas		0.22	0.43	0.67	1.20	1.18	1.23	1.34
Comb. Renewables & Waste[1]		–	0.03	0.04	0.06	0.06	0.06	0.06
Nuclear		–	–	–	–	–	–	–
Hydro		0.00	0.01	0.01	0.01	0.01	0.01	0.01
Wind		–	–	0.00	0.00	0.00	0.01	0.01
Geothermal		–	–	–	–	–	–	–
Solar/Other		–	–	–	0.00	0.00	0.00	0.00
Electricity Trade[2]		0.18	0.34	0.49	0.29	0.28	0.31	0.34
Shares (%)								
Coal		*54.3*	*31.9*	*3.4*	*2.0*	*1.7*	*2.3*	*1.7*
Peat		–	–	–	–	–	–	–
Oil		*36.8*	*45.5*	*63.0*	*64.2*	*65.8*	*63.3*	*61.1*
Gas		*4.9*	*12.1*	*18.4*	*26.0*	*25.0*	*26.2*	*28.2*
Comb. Renewables & Waste		–	*0.7*	*1.2*	*1.3*	*1.3*	*1.3*	*1.4*
Nuclear		–	–	–	–	–	–	–
Hydro		*0.1*	*0.2*	*0.3*	*0.2*	*0.2*	*0.2*	*0.2*
Wind		–	–	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*
Geothermal		–	–	–	–	–	–	–
Solar/Other		–	–	–	–	–	–	–
Electricity Trade		*3.9*	*9.5*	*13.5*	*6.3*	*5.9*	*6.5*	*7.2*

0 is negligible, – is nil, .. is not available.
2007 data are preliminary. Forecasts are not available.

Unit: Mtoe

DEMAND

FINAL CONSUMPTION BY SECTOR

	1973	1990	2000	2004	2005	2006	2007P
TFC	**2.93**	**2.93**	**3.57**	**4.37**	**4.44**	**4.42**	**4.41**
Coal	0.98	0.55	0.13	0.09	0.08	0.11	0.08
Peat	–	–	–	–	–	–	–
Oil	1.52	1.61	2.29	2.97	3.10	2.98	2.89
Gas	0.18	0.42	0.62	0.68	0.65	0.68	0.79
Comb. Renewables & Waste[1]	–	–	0.02	0.02	0.02	0.02	0.02
Geothermal	–	–	–	–	–	–	–
Solar/Other	–	–	–	–	–	–	–
Electricity	0.26	0.36	0.49	0.55	0.53	0.56	0.58
Heat	–	–	0.03	0.05	0.06	0.06	0.05
Shares (%)							
Coal	*33.4*	*18.7*	*3.5*	*2.2*	*1.8*	*2.5*	*1.8*
Peat	–	–	–	–	–	–	–
Oil	*51.8*	*54.8*	*64.1*	*68.1*	*69.8*	*67.5*	*65.6*
Gas	*6.1*	*14.3*	*17.4*	*15.6*	*14.7*	*15.5*	*18.0*
Comb. Renewables & Waste	–	–	*0.4*	*0.4*	*0.4*	*0.4*	*0.4*
Geothermal	–	–	–	–	–	–	–
Solar/Other	–	–	–	–	–	–	–
Electricity	*8.7*	*12.2*	*13.7*	*12.6*	*11.9*	*12.7*	*13.0*
Heat	–	–	*0.8*	*1.2*	*1.4*	*1.4*	*1.2*
TOTAL INDUSTRY[3]	**2.09**	**1.36**	**0.97**	**0.98**	**0.97**	**1.04**	**1.10**
Coal	0.94	0.54	0.12	0.09	0.08	0.11	0.08
Peat	–	–	–	–	–	–	–
Oil	0.80	0.29	0.09	0.07	0.10	0.10	0.10
Gas	0.14	0.28	0.41	0.43	0.42	0.44	0.53
Comb. Renewables & Waste[1]	–	–	–	–	–	–	–
Geothermal	–	–	–	–	–	–	–
Solar/Other	–	–	–	–	–	–	–
Electricity	0.20	0.24	0.33	0.36	0.34	0.37	0.38
Heat	–	–	0.02	0.03	0.02	0.03	0.02
Shares (%)							
Coal	*45.2*	*39.9*	*12.8*	*9.6*	*8.4*	*10.6*	*7.3*
Peat	–	–	–	–	–	–	–
Oil	*38.4*	*21.7*	*8.9*	*7.0*	*10.8*	*9.6*	*8.6*
Gas	*6.7*	*20.6*	*42.5*	*43.7*	*43.2*	*41.9*	*48.1*
Comb. Renewables & Waste	–	–	–	–	–	–	–
Geothermal	–	–	–	–	–	–	–
Solar/Other	–	–	–	–	–	–	–
Electricity	*9.7*	*17.8*	*34.1*	*37.2*	*35.4*	*35.2*	*34.5*
Heat	–	–	*1.8*	*2.7*	*2.3*	*2.7*	*1.5*
TRANSPORT	**0.29**	**1.01**	**1.89**	**2.59**	**2.72**	**2.63**	**2.61**
TOTAL OTHER SECTORS[4]	**0.55**	**0.57**	**0.72**	**0.80**	**0.75**	**0.75**	**0.69**
Coal	0.03	0.01	0.00	–	–	–	0.00
Peat	–	–	–	–	–	–	–
Oil	0.43	0.31	0.33	0.32	0.28	0.26	0.19
Gas	0.04	0.14	0.21	0.25	0.24	0.25	0.26
Comb. Renewables & Waste[1]	–	–	0.02	0.02	0.02	0.02	0.02
Geothermal	–	–	–	–	–	–	–
Solar/Other	–	–	–	–	–	–	–
Electricity	0.05	0.11	0.15	0.18	0.18	0.18	0.18
Heat	–	–	0.01	0.03	0.04	0.04	0.04
Shares (%)							
Coal	*6.2*	*1.1*	*0.1*	–	–	–	*0.1*
Peat	–	–	–	–	–	–	–
Oil	*78.3*	*54.5*	*45.7*	*40.6*	*37.7*	*35.2*	*27.7*
Gas	*6.9*	*25.0*	*29.3*	*31.8*	*31.2*	*33.2*	*37.9*
Comb. Renewables & Waste	–	–	*2.2*	*1.9*	*2.0*	*2.1*	*2.2*
Geothermal	–	–	–	–	–	–	–
Solar/Other	–	–	–	–	–	–	–
Electricity	*8.9*	*19.5*	*21.2*	*22.4*	*23.8*	*24.7*	*26.6*
Heat	–	–	*1.3*	*3.3*	*5.2*	*4.8*	*5.3*

Unit: Mtoe

DEMAND

ENERGY TRANSFORMATION AND LOSSES

	1973	1990	2000	2004	2005	2006	2007P
ELECTRICITY GENERATION[5]							
INPUT (Mtoe)	**0.44**	**0.20**	**0.09**	**0.58**	**0.58**	**0.61**	**0.61**
OUTPUT (Mtoe)	**0.12**	**0.05**	**0.04**	**0.29**	**0.29**	**0.30**	**0.28**
(TWh gross)	1.39	0.62	0.43	3.37	3.35	3.53	3.20
Output Shares (%)							
Coal	*58.8*	*76.4*	–	–	–	–	–
Peat	–	–	–	–	–	–	–
Oil	*27.6*	*1.4*	–	–	–	–	–
Gas	*10.2*	*5.4*	*53.1*	*93.2*	*92.7*	*92.1*	*90.5*
Comb. Renewables & Waste	–	*5.4*	*12.9*	*2.3*	*2.2*	*2.6*	*3.2*
Nuclear	–	–	–	–	–	–	–
Hydro	*3.4*	*11.2*	*27.7*	*3.1*	*3.0*	*3.1*	*3.7*
Wind	–	–	*6.2*	*1.2*	*1.6*	*1.6*	*2.0*
Geothermal	–	–	–	–	–	–	–
Solar/Other	–	–	–	*0.3*	*0.5*	*0.6*	*0.7*
TOTAL LOSSES	**1.54**	**0.61**	**0.06**	**0.27**	**0.27**	**0.29**	**0.32**
of which:							
Electricity and Heat Generation[6]	0.32	0.14	0.02	0.24	0.23	0.25	0.28
Other Transformation	1.08	0.41	–	–	–	–	–
Own Use and Losses	0.14	0.06	0.04	0.03	0.04	0.04	0.04
Statistical Differences	**0.02**	**–**	**0.00**	**–0.01**	**–**	**0.01**	**–**

INDICATORS

	1973	1990	2000	2004	2005	2006	2007P
GDP (billion 2000 USD)	7.00	12.40	20.30	23.20	24.30	25.80	27.10
Population (millions)	0.35	0.38	0.44	0.46	0.47	0.47	0.48
TPES/GDP[7]	0.64	0.29	0.18	0.20	0.19	0.18	0.17
Energy Production/TPES	0.00	0.01	0.02	0.02	0.02	0.02	0.02
Per Capita TPES[8]	12.78	9.28	8.29	10.09	10.14	9.96	9.93
Oil Supply/GDP[7]	0.24	0.13	0.11	0.13	0.13	0.12	0.11
TFC/GDP[7]	0.42	0.24	0.18	0.19	0.18	0.17	0.16
Per Capita TFC[8]	8.33	7.68	8.13	9.53	9.55	9.34	9.26
Energy-related CO_2 Emissions (Mt CO_2)[9]	16.4	10.5	8.0	11.0	11.2	11.2	..
CO_2 Emissions from Bunkers (Mt CO_2)	0.2	0.4	1.0	1.3	1.3	1.2	..

GROWTH RATES (% per year)

	73–90	90–00	00–04	04–05	05–06	06–07	73–07
TPES	–1.4	0.3	6.2	2.0	–0.0	0.3	0.2
Coal	–4.4	–19.8	–6.9	–12.8	34.1	–26.4	–9.5
Peat	–	–	–	–	–	–	–
Oil	–0.1	3.6	6.6	4.6	–3.8	–3.1	1.7
Gas	4.0	4.6	15.7	–1.8	4.8	8.2	5.5
Comb. Renewables & Waste	–	5.8	7.6	1.7	5.0	1.6	–
Nuclear	–	–	–	–	–	–	–
Hydro	2.4	5.2	–2.6	–	11.1	–	2.7
Wind	–	–	10.7	33.3	25.0	20.0	–
Geothermal	–	–	–	–	–	–	–
Solar/Other	–	–	–	100.0	–	–	–
TFC	0.0	2.0	5.1	1.7	–0.6	–0.2	1.2
Electricity Consumption	2.0	3.2	2.9	–3.8	5.7	2.7	2.4
Energy Production	12.8	6.3	6.4	1.4	8.1	1.3	9.3
Net Oil Imports	–0.1	3.7	5.9	4.4	–2.2	–4.1	1.7
GDP	3.4	5.1	3.4	4.7	6.2	5.0	4.1
Growth in the TPES/GDP Ratio	–4.6	–4.6	2.7	–2.5	–5.7	–4.9	–3.8
Growth in the TFC/GDP Ratio	–3.3	–2.9	1.7	–2.7	–6.6	–4.7	–2.7

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

FOOTNOTES TO ENERGY BALANCES AND KEY STATISTICAL DATA

1. Combustible renewables and waste comprises solid biomass, liquid biomass, biogas and municipal waste. Data are often based on partial surveys and may not be comparable between countries.

2. Total supply of electricity represents net trade.

3. Industry includes non-energy use.

4. Other Sectors includes residential, commercial, public services, agriculture, forestry, fishing and other non-specified sectors.

5. Inputs to electricity generation include inputs to electricity and CHP plants. Output refers only to electricity generation.

6. Losses arising in the production of electricity and heat at main activity producer utilities and autoproducers. For non-fossil-fuel electricity generation, theoretical losses are shown based on plant efficiencies of approximately 100% for hydro, wind and photovoltaic.

7. Toe per thousand US dollars at 2000 prices and exchange rates.

8. Toe per person.

9. "Energy-related CO_2 emissions" have been estimated using the IPCC Tier I Sectoral Approach from the *Revised 1996 IPCC Guidelines*. 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 2006 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"

The 28 member countries* of the International Energy Agency (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 hydropower, 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 28 member countries of the IEA are 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, Poland (since November 2008), Portugal, the Slovak Republic (since November 2007), Spain, Sweden, Switzerland, Turkey, the United Kingdom and the United States.

the nuclear 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.

b/d	barrels per day
bcm	billion cubic metres
CCGT	combined-cycle gas turbine
CDM	clean development mechanism (under the Kyoto Protocol)
CHP	combined production of heat and power; sometimes, when referring to industrial CHP, the term «co-generation» is used.
CO_2	carbon dioxide
CO_2-eq	carbon dioxide equivalent
DSO	distribution system operator
EU	European Union
EU-ETS	EU Emissions Trading Scheme
F-gases	HFCs (hydrofluorocarbons); PFCs (perfluorocarbons); SF_6 (sulphur hexafluoride)
G8	Group of Eight (Canada, France, Germany, Italy, Japan, Russia, the United Kingdom and the United States)
GDP	gross domestic product
GHGs	greenhouse gases (CO_2, carbon dioxide; CH_4, methane; N_2O, nitrous oxide; see F-gases)
GW	gigawatt, or 1 watt $\times 10^9$

JI	joint implementation (under the Kyoto Protocol)
ILR	Institut Luxembourgeois de Régulation, the regulator for the electricity and natural gas markets
kV	kilovolt, or 1 volt × 10^3
kWh	kilowatt-hour = 1 kilowatt × 1 hour, or 1 watt × 1 hour × 10^3
L	litre
mcm	million cubic metres
Mt	million tonnes
Mtoe	million tonnes of oil equivalent; see toe
MW	megawatt of electricity, or 1 Watt x 10^6
MWh	megawatt-hour = 1 megawatt × 1 hour, or 1 watt × 1 hour × 10^6
NAP	National Allocation Plan
Nm^3	Normal cubic metre
PPP	purchasing power parity: the rate of currency conversion that equalises the purchasing power of different currencies, *i.e.* estimates the differences in price levels between different countries
t	tonne
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
toe	tonne of oil equivalent, defined as 10^7 kcal
TPA	third-party access
TPES	total primary energy supply
TSO	transmission system operator

TW	terawatt, or 1 watt $\times 10^{12}$
TWh	terawatt-hour = 1 terawatt $\times$ 1 hour, or 1 watt $\times$ 1 hour $\times 10^{12}$
UNFCCC	United Nations Framework Convention on Climate Change
VAT	value-added tax

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