INTERNATIONAL ENERGY AGENCY

Energy Policies of IEA Countries

SWITZERLAND

2007 Review

INTERNATIONAL ENERGY AGENCY

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It carries out a comprehensive programme of energy co-operation among twenty-six 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.

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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.

International Energy Agency (IEA),
Head of Communication and Information Office,
9 rue de la Fédération, 75739 Paris Cedex 15, France.

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EXECUTIVE SUMMARY

Since the last in-depth review in 2003, Switzerland has continued to perform well in most areas of energy policy. The electricity sector will be reformed as from 2008, supplies of oil and gas have been secure and energy efficiency and renewable energy are receiving increased attention. Yet, as in all countries, challenges also remain. The biggest ones concern electricity generation and climate change.

Oil and gas supply continues to be secure. Oil supply is well diversified, both by country of origin and by import route. Natural gas is also supplied by several countries through various routes. Switzerland consistently holds emergency stocks much in excess of those required by the IEA. Oil stocks are also part of gas security. As Switzerland does not possess large-scale gas storage, dual-fired users are obliged to hold large stocks of fuel oil. Switzerland's energy security policy is fundamentally sound, which is a necessity for a landlocked country with no domestic production of fossil fuels.

Security of electricity supply is a question of wider international interest, as Switzerland is a major player in the European electricity markets, and, traditionally, a net exporter of electricity. Reforming the Swiss electricity market has been long in the making, and now, with the recently approved Law on Electricity Supply, it will turn into a reality. The law contains the necessary elements for effective market liberalisation: an independent regulator, an independent transmission system operator, regulated third-party grid access, and freedom to choose the supplier. The law comes into force in two phases during 2008, and it is set to fully open the Swiss electricity market by 2013. The IEA commends Switzerland for this progress.

In contrast, the gas market remains essentially unreformed. The IEA encourages the Swiss government to proceed to liberalise it. Gas market reform would bring increased incentives for investment in gas infrastructure, important to support a potentially very strong demand growth. It would also help Switzerland ensure that mechanisms to allocate cross-border capacity and procedures to manage congestion are compatible with those of the neighbouring countries.

Future generating capacity is one of the major energy issues in Switzerland. The country has traditionally been a net exporter of electricity, but for the past two years, imports have exceeded exports. Electricity demand is growing faster than generation, and plans for new large-scale capacity are few. According to the government's energy scenarios published in early 2007, a supply gap will start widening in the late 2010s and early 2020s, when long-term import contracts with France expire and the oldest nuclear power plants – one–third of the nuclear capacity – reach the end of their operational life. Renewable energy and energy efficiency are projected to cover only part of this gap. The government wants to avoid dependence on electricity imports, thereby leaving Switzerland the option to build more nuclear and/or gas-fired capacity.

The process to construct new nuclear power plants would take a long time, about 16 to 18 years from submitting the proposal for a general licence to generating power, but the project would still likely face a referendum. The government has plans to streamline the licensing procedure without having to amend the Nuclear Energy Law. Regardless of whether new nuclear plants are built, nuclear waste management will need to be addressed. The government is making commendable progress on this issue.

Constructing gas-fired power plants is challenged by the current CO_2 regime. Emissions reductions at home are expected to cost some ten times more than those realised abroad. Switzerland has allocated its quota of emissions reductions from the Kyoto mechanisms unevenly across sectors, strongly favouring the use of transport fuels at the expense of electricity generation and industry.

As in most industrialised countries, energy and climate policy is challenged by transport. Switzerland plans to shift freight transport from road to rail in the transalpine routes and major projects are now under way to improve rail infrastructure. These projects will still take years to finalise, but will support a more sustainable transport system.

Curbing the rising CO_2 emissions from private cars and light-duty vehicles is proving to be a major challenge. The trend is unsustainable and the voluntary system in place, the Climate Cent, does not provide sufficient incentives for change. For the long term, continuing on the current basis is not an option. It is therefore encouraging that the government is planning to introduce a bonus-malus (feebate) system to promote energy-efficient new cars to replace inefficient ones. It is also considering supplementary measures to enforce a cap on CO_2 emissions per kilometre for new cars. Excise taxes on biofuels will be abolished and those on gas-based fuels lowered, whereas taxes on gasoline will be raised, thereby improving diesel's competitiveness to gasoline.

Energy efficiency has long been a government priority. Good results have been achieved in many sectors. For example, the voluntary Minergie building standards are of a very high level, and the cantons are now harmonising their

building codes towards these levels. In a welcome development, the Department of the Environment, Transport, Energy and Communications (DETEC) published in early September 2007 draft action plans to increase energy efficiency (especially a best-practice strategy for household equipment and electric motors) and the use of renewable energy in Switzerland. The draft plan on energy efficiency is broadly in line with the International Energy Agency's (IEA) recommendations to the G8, which were endorsed by the IEA Energy Ministers in May 2007.

Goals beyond 2012 need to be supported by effective policies and measures. To ensure compatibility with the climate strategy, energy efficiency's role in reaching Switzerland's climate policy targets should be clearly defined and quantified. Another compatibility issue concerns energy research and development (R&D). In the second half of this century, Switzerland is striving towards a 2 000-watt society, *i.e.* more than halving energy needs per capita from today's levels. Energy challenges are daunting, so ambitious R&D goals are certainly needed. These goals have to be supported by strong policies and measures. Reconciling the short-term energy scenarios and the long-term R&D scenarios is crucial. Switzerland's strength in energy R&D provides a solid basis for these efforts.

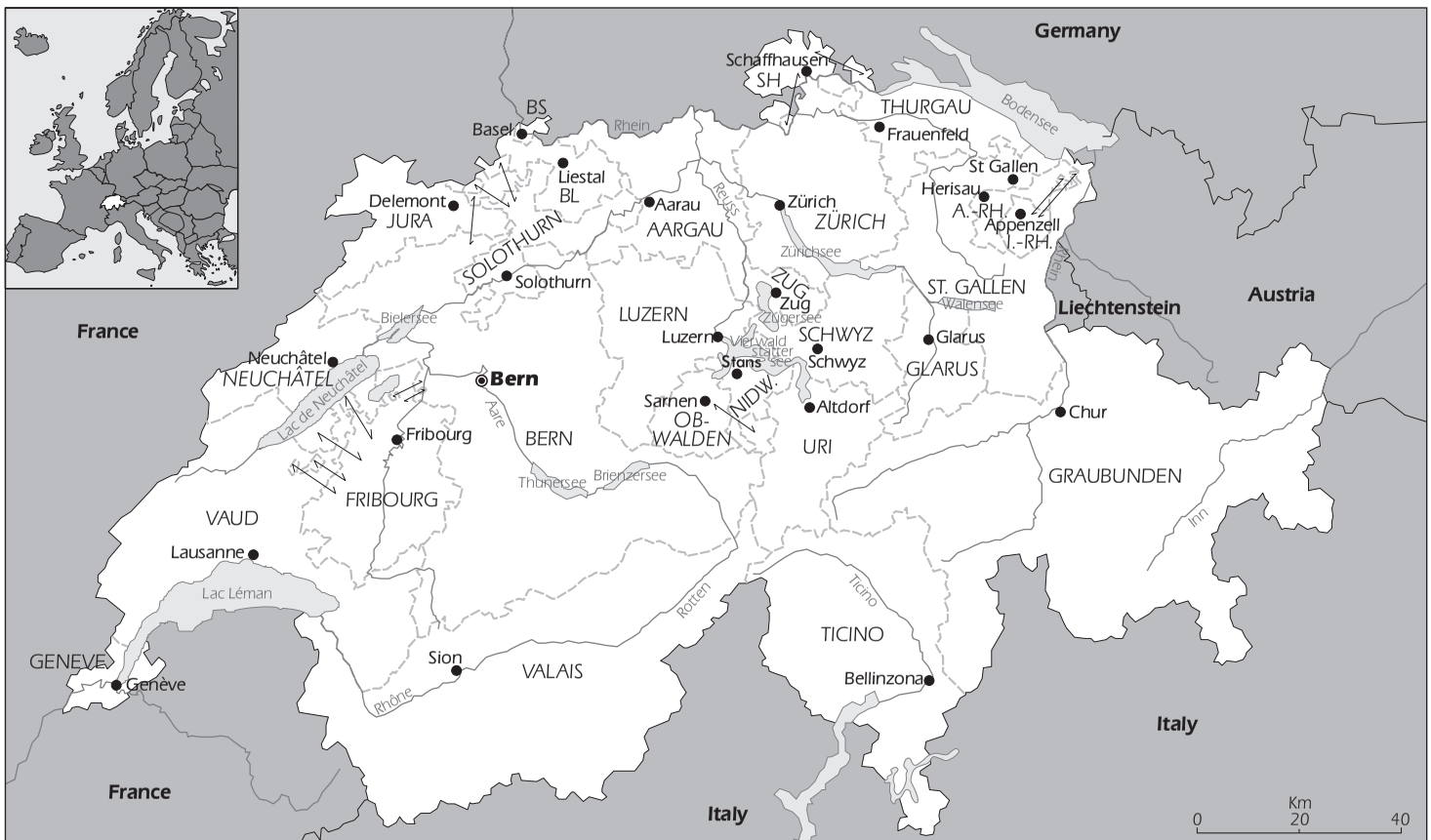
KEY RECOMMENDATIONS

The government of Switzerland should:

- *Increase adequacy of future electricity generation capacity by creating stronger incentives for energy efficiency and setting more favourable conditions for investing in generation.*
- *Ensure compatibility and consistency between the short- and medium-term goals for energy efficiency and climate policy and the long-term goals for energy R&D.*
- *Implement swiftly the Law on Electricity Supply and consider initiating reforms in the gas market.*

Figure 1

Map of Switzerland



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

COUNTRY OVERVIEW

The Swiss Confederation (hereafter Switzerland) is located in the centre of Europe, and borders on Germany, France, Italy, Austria and Liechtenstein. Its surface area is approximately 41 285 km^2 of which two-thirds is mountainous terrain. Switzerland has a population of 7.5 million. Its valleys and lowlands are heavily populated. The country has three official languages; German is the mother tongue for 64% of the population, French for 20% and Italian for 7%.

Independent since 1291, Switzerland has stayed out of wars during the past two centuries and has built up a reputation for prosperity and economic stability. Per-capita gross domestic product (GDP) (USD 37 700 at PPP in 2006) is higher than in the big European economies, and unemployment has remained at less than half the European Union (EU) average. The economy is dominated by services (72% of GDP in 2005). Industry (27% of GDP) is concentrated, among others, on pharmaceuticals and customised engineering products, such as machines, precision instruments and watches. Owing to a lack of mineral resources, heavy industry is scarce. Agriculture accounts for only 1% of GDP. Annual GDP growth amounted to 2.3% in 2004, 1.9% in 2005 and 2.7% in 2006.

Switzerland comprises 26 largely autonomous cantons, including six half-cantons, each with a constitution and an assembly. All policies not explicitly assigned to the federal level are the responsibility of the cantons. At the federal level, the country has a bicameral parliament (Federal Assembly). It consists of the Council of States (46 seats; two representatives from each canton and one from each half-canton) and the National Council (200 seats; members are elected by popular vote on the basis of proportional representation).

Switzerland has a strong tradition of direct democracy. Popular votes are common at national, cantonal and municipal levels, and the Federal Constitution requires proposals for important new legislation to be submitted for public consultation. As a rule, popular votes can be held on all binding decisions, including laws, taken by the parliament. Thus, the federal government pays particular attention to holding wide and open consultations with the cantons and the relevant interest groups before submitting a bill to the parliament.

Also typical to Switzerland is the tradition for light-handed regulation. In drafting laws, the federal government and the cantons are obliged to follow the subsidiarity principle, which gives priority to private-sector measures over government intervention.

SUPPLY AND DEMAND

SUPPLY

Switzerland's total primary energy supply (TPES) was 27.2 million tonnes of oil equivalent (Mtoe) in 2005 (see Annex B). From 1990 to 2005, TPES increased by 9%. All fossil fuels are imported, and all renewable energy is domestically produced (see Figure 3). Import dependence has remained stable at roughly 60% for the past two decades. In 2005, imports accounted for 60.5% of TPES.

Compared to the IEA average, oil use (47.1% of TPES) is high, whereas coal use is minimal (0.6% of TPES). Electricity generation is almost CO_2-free: depending on hydrological conditions, hydro and nuclear power account for some 95-97% of annual total generation. In recent years, renewable energy has provided some 14-16% of TPES; in 2005, its share was 15%. Owing to the structure of the Swiss economy and energy supply, energy and CO_2 intensities are some of the lowest among the IEA countries, both per capita and per GDP.

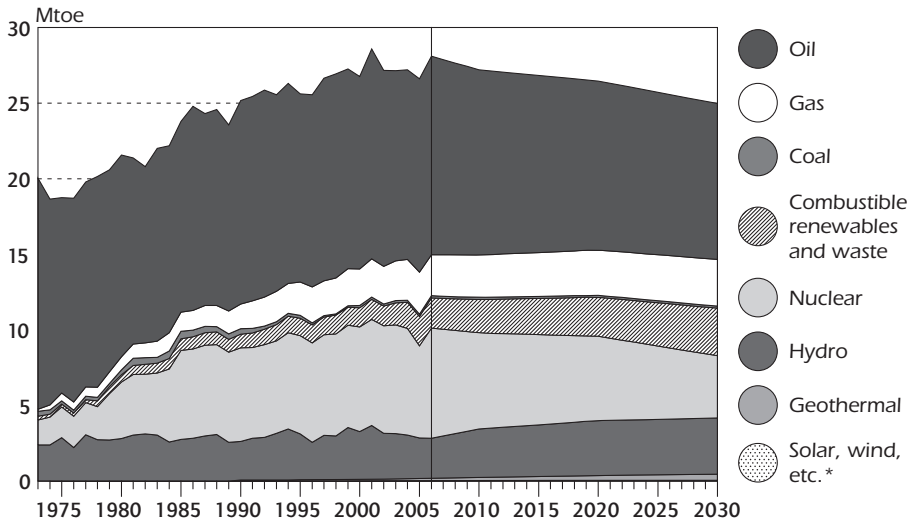
In the short term, the government expects TPES to stabilise at the current levels and start to decline after 2010. The government projects total electricity generation to remain more or less at today's levels. Future generating capacity is a major question, because demand is expected to continue to grow. Overall, future energy supply remains subject to policy decisions. In February 2007, to support formulating energy policy, the government published four sets of energy scenarios spanning to 2035. None of the four has been officially endorsed.

DEMAND

In 2005, total final consumption of energy (TFC) was 22.5 Mtoe, an all-time high. From 1990 to 2005, final consumption grew by 14%, slightly less than GDP (16%). TFC increased faster than TPES, implying improvements in energy efficiency. Oil remains the largest source for energy (57% of TFC in 2005). Oil use in heating is much more common than in most IEA countries. Energy use is discussed in more detail in Chapter 4.

Figure 2

Total Primary Energy Supply, 1973 to 2030

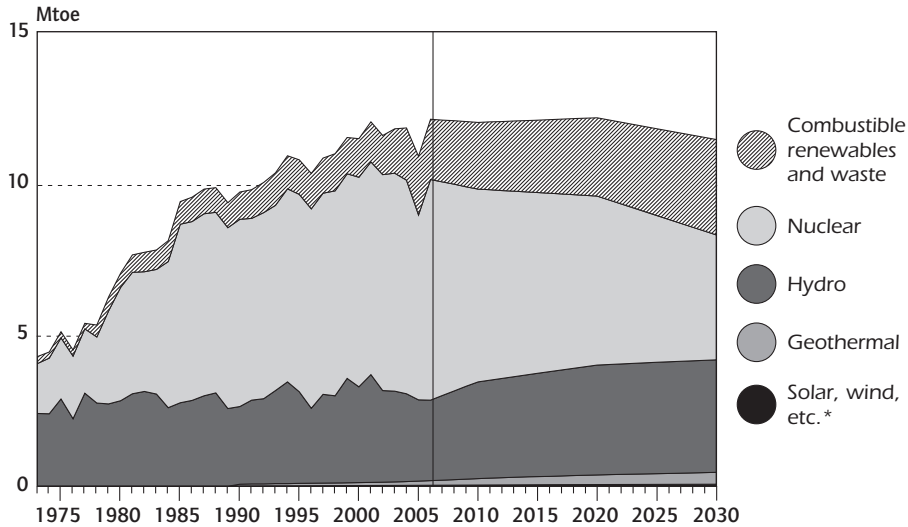


* negligible.

Sources: *Energy Balances of OECD Countries*, IEA/OECD Paris, 2007 and country submission.

Figure 3

Energy Production by Source, 1973 to 2030

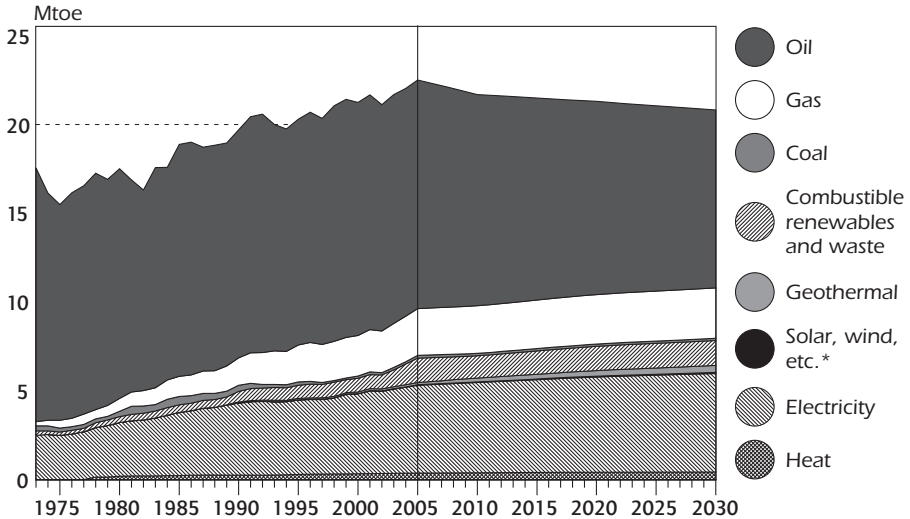


* negligible.

Sources: *Energy Balances of OECD Countries*, IEA/OECD Paris, 2007 and country submission.

Figure 4

Total Final Consumption by Source, 1973 to 2030



* negligible.

Sources: *Energy Balances of OECD Countries*, IEA/OECD Paris, 2007 and country submission.

INSTITUTIONS

Energy policy is a shared responsibility between the federal state and the 26 cantons. Federal energy policy making has been strengthened in recent years (in matters such as standards and labels), chiefly by means of the 1998 Energy Law and its subsequent amendments. In other domains such as buildings, cantons have clung to their prerogatives and merely consented to harmonised regulations and standards. Another example of the shift towards harmonisation are feed-in tariffs for renewables; as of 2008 new federal regulation will replace previous minimum standards, which left it to the cantons to pursue more generous policies.

The Department (Ministry) of the Environment, Transport, Energy and Communications (DETEC) is the lead ministry in charge of Switzerland's energy policy, for both its formulation and implementation. The harbouring of the energy and environmental portfolios under a single ministry is intended to strengthen sustainability concerns in energy policy making. Within DETEC, energy policy is the responsibility of the Swiss Federal Office of Energy (SFOE).

The federal government is a collective executive body. Other departments (ministries) than DETEC are closely consulted, particularly if an energy policy proposal has an impact on their remit: this is mostly the case for the Department of Economic Affairs, the Department of Finance (for fiscal issues)

and, for biofuels, the Federal Office for Agriculture. Within DETEC, the SFOE co-operates closely with the Federal Office for the Environment, the Federal Office for Transport and the Federal Office for Spatial Development. Draft laws are adopted collectively by the federal government before being submitted to parliament.

Cantons are consulted during federal energy policy and law making processes. Cantons have much leeway to adopt their own energy laws, policies and measures, within the boundaries set by federal legislation. As a result, there is a diversity of cantonal policies and measures.

KEY POLICIES

Switzerland's energy policy is guided by Article 89 of the Federal Constitution, which calls for sufficient, reliable, diversified, cost-effective and environmentally-sound energy supply, and emphasises the importance of energy efficiency.

The federal government confirmed its energy policy principles on 21 February 2007. To secure energy supplies and to mitigate climate change, more focus will be given to energy efficiency and renewable energy. Meeting the rising demand for electricity is a growing challenge, because from the late 2010s, the long-term import contracts with France start expiring, and from the early 2020s, a third of Switzerland's nuclear capacity reaches the end of its operational life. The government has suggested building more power plants (nuclear and gas). Finally, attention will be given to international relations, in particular, those with the EU.

Following the February decision, DETEC published two action plans on energy efficiency and renewable energy in September 2007 (see box). The plans comprise 18 measures for energy efficiency and eight for renewables. They propose the following targets for 2020: reducing CO_2 emissions and fossil fuel demand by 1.5% per year; stabilising electricity demand at the 2006 level; and increasing the share of renewables in TPES by 50% from the current 16.2% to 24%. The action plans are open for public consultation until mid-October. On the basis of the outcome, DETEC intends to implement the measures within its own remit. Proposals for measures that require legal action are planned to be submitted to the federal government by the end of 2007, and after that to the parliament.

DETEC will also prepare a strategy for external relations in the energy sector and make efforts to streamline licensing and commissioning procedures for energy infrastructure, including new nuclear power plants under existing legislation.

Box
DETEC's action plans on energy efficiency and renewable energy, 3 September 2007

MEASURE	IMPLEMENTATION
Energy Efficiency	
Buildings	
1. National promotion programme for buildings refurbishment to Minergie standard or equivalent during 2010-2020. CHF 185 million p.a. for residential and CHF 30 million p.a. for service buildings, to be financed through earmarking of CO_2 tax revenues.[1] The programme replaces the Climate Cent Buildings Programme when it ends in 2009.	Legal basis to be prepared in 2008
2. Revision of MuKEn model prescriptions for new builds and refurbishments. As from 2008, 60 kWh/m^2 per year (vs. the current 90 kWh/m^2) for new builds, and max. 140% of new build value for refurbishments. Increasing the minimum share of renewable energy for space and water heating from 20 to 30% for new builds. New rules to ban fossil and electric heating when replacing old systems. Further tightening planned by 2015.	Immediate recommendations to cantons for implementation
3. Introduction of a harmonised building certificate.	Amendment to Energy Law in 2008
4. Renewed agreements with cantons with more stringent conditions (*i.e.* adoption of stricter building regulation) for federal co-financing of cantonal programmes.	By end 2008
5. Reduction of legal barriers to refurbishments (rental and tax laws, harmonisation of cantonal planning regulations).	Immediate recommendations to cantons
Transport	
6. Introduction of a CO_2 tax on transport fuels within a range of CHF 64 to 210/t CO_2 (equivalent to CHF 0.15 to 0.50 per litre). As from 2013, the tax is to be folded into a new post-Kyoto climate tax.	Based on CO_2 Law, Government proposes tax rate to parliament for approval
7. New agreement with car importers' association to limit average CO_2 emissions from new cars to 130 g/km by 2012 (analogous to EU plans), supplemented if necessary by mandatory regulation.	Amendments to ordinances in 2008
8. Bonus-malus (feebate) system on car import duty by 2010. CHF 3 000-4 000 reduction for most efficient cars.	Draft law by end 2008
9. Harmonised cantonal annual car registration fees based on fuel/emissions standards.	Immediate recommendation to cantons
Appliances and Motors	
10. MEPS and/or accelerated industry agreements (best-practice strategy) for electric appliances, office equipment, consumer electronics, set-top boxes, stand-by, lamps, electric motors, water dispensers, coffee machines – aligned when possible with EU norms and codes of conduct.	Before end 2008

1. On average in 2006, CHF 1 = USD 0.7985.

Industry	
11. Introduction of efficiency quotas and tariffs for utilities.	Draft concept by end 2008
12. Introduction of white certificates.	
Energy Efficiency RD&D, Technology Transfer, Education & Training, Information, Counselling	
13. More pilot and demonstration projects in field of energy efficiency; stepped-up information and counselling of SwissEnergy and agency networks.	Proposed CHF 16.5 million annual budget increase for SwissEnergy
14. Enhanced training/retraining for energy efficiency at vocational schools, technical universities and universities.	
15. Increased RD&D in the field of energy efficiency.	Proposed CHF 10 million annual budget increase for energy RD&D
Public Sector Procurement	
16. New builds and refurbishments of public buildings to Minergie standard or equivalent, to Minergie-P standard for new builds as from 2012; similar recommendations for cantons and municipalities.	Immediate
17. Public purchasing of A-label or better equipment and vehicles, use of biofuels, at least 50% of certified green electricity.	Immediate
18. Energy impact study of all new federal activity and legislation.	Immediate
Renewables	
1. Feed-in tariffs to prompt replacement of fossil district heating by renewables and waste heat, and biomass strategy.	Draft legislation by end 2008
2. Replacing fossil heating and warm water systems by renewables and heat pumps, partly through financial incentives (financed through earmarking of CO_2 tax) and possibly regulation for new buildings.	Draft legislation by 2008
3. Spatial development: possible obligation for connection to renewables-based district heating, revision to zoning legislation to ease use of hydro, biomass and wind power.	Legal amendments by end 2008, recommendations to cantons
4. Optimising water legislation for hydropower, more flexible water royalties to promote hydropower investment.	End 2008
5. Mandatory quotas for biofuels (parallel to EU 2020 targets).	Immediate
6. Increase budget for renewable RD&D and pilot plants by CHF 10 million annually.	Proposed CHF 17.5 million annual budget increase for SwissEnergy, including CHF 10 million for RD&D from 2009
7. Accelerated technology deployment through promotion of pilot and demonstration projects.	
8. Enhanced training/retraining in renewables technologies at vocational schools, technical universities and universities; counselling, information dissemination.	

SECURITY OF SUPPLY

Oil supplies to Switzerland are well diversified, both by country of origin and by import route. Switzerland consistently holds more oil stocks than required under the IEA obligations. Natural gas is also supplied by several countries through various routes, although most gas flows through Germany. Security of gas supply is further enhanced given that more than 40% of the contract volume is interruptible. In addition, the gas industry is obliged to maintain compulsory stocks of heating oil to cover at least four-and-a-half months of gas consumption of industrial customers with dual-fired capacity.

Security of electricity supply has repercussions beyond Switzerland's borders, given the country's role in electricity trade and transit in Europe. Reforming the electricity market, and establishing a regulator and a transmission system operator (TSO), will improve electricity security. The causes for the 2003 black-out in Italy revealed that network operations and standards also need to be better harmonised between Switzerland and EU countries. In the long term, the government does not consider it desirable to increase electricity imports to close the looming gap in electricity supply.

ENVIRONMENTAL CONCERNS

Climate change is the leading environmental concern in Switzerland's energy policy. The Swiss commitment to meeting the Kyoto target is to reduce greenhouse gas (GHG) emissions by 8% below the 1990 level by 2008-2012. Since 1990, emissions have remained flat. The government plans to meet the target through the use of a combination of domestic and international measures. To date, domestic measures have been primarily voluntary – and weak. From the beginning of 2008, a CO_2 "incentive tax"[2] on heating and process fuels will be introduced to complement these measures. Since October 2005, transport fuels have been subjected to the Climate Cent surcharge. The government decided in September 2007 to maintain the surcharge until the end of 2012, though it can be supplemented with a CO_2 tax on transport fuels, depending on trends in CO_2 emissions. A tax reform for biofuels has been decided and a reform of car taxation is also planned. Furthermore, by the end of 2007, the government will prepare a climate strategy to address post-Kyoto challenges.

MARKET REFORM

Since the last review, the government has worked hard to relaunch the liberalisation of the Swiss electricity market. As a result, the Law on Electricity Supply comes into force in 2008, partly from 1 January and fully from 1 October.

2. "Incentive tax" (translated from German "Lenkungsabgabe" or French "taxe incitative") is a levy, which is fully recycled to the population and/or economy and is designed to "direct", *i.e.* "inflect" demand.

The law contains the necessary elements for effective market liberalisation: an independent regulator, an independent system operator, regulated third-party grid access, and freedom to choose the supplier. It is set to fully open the Swiss electricity market by 2013. Switzerland has also decided to negotiate an agreement with the EU to regulate cross-border electricity transmission and mutual market access.

The gas market remains essentially unreformed, although the gas industry has voluntarily moved to improve conditions for competition, and rules for third-party access (TPA) to the grid do exist. The sector continues to be characterised by strong vertical integration and supply is dominated by long-term contracts. The government, however, is now planning to take steps to reform the gas sector.

SWISSENERGY PROGRAMME

The main policy instrument for increasing energy efficiency and use of renewable energy is the SwissEnergy programme. Running from 2001 to 2010, it aims to reduce fossil fuel use and CO_2 emissions as required by the 1999 CO_2 Law (see Table 1). It also has targets for electricity generation and heat production from renewables. SwissEnergy is managed by the SFOE. It includes a wide array of projects, most of them voluntary. The projects are normally run in close co-operation between the SFOE, cantons, municipalities, industry and environmental and consumer associations. Programme results are subject to detailed monitoring and verification. In 2006, programme funding from the SFOE amounted to CHF 42 million, supplemented by yet larger amounts of co-funding from associations and cantons.

Table 1

Objectives and Implementation Status of the SwissEnergy Programme

	Goal for 2010, compared to 2000	*Status in 2006*	*Status in 2006, without SwissEnergy*
Use of fossil fuels	–10%	2.4%	10.7%
Electricity use	max. +5%	10.3%	15.3%
CO_2 emissions (vs. 1990)	–10%	0.6%	6.6%*
– from heating fuels	*–15%*	*–4.6%*	*2.7%**
– from transport fuels	*–8%*	*9.1%*	*13.0%**
Hydropower generation	stable	2.3%	
Other RES-electricity	+0.5 TWh	+0.33 TWh	+0.25 TWh
RES-heat	+3 TWh	+1.88 TWh	+0.34 TWh

RES: renewable energy sources.
* Status 2005 without SwissEnergy
Source: *SwissEnergy annual report 2006/2007*.

Initially, the SwissEnergy programme had four general priority areas. Three focused on end-use efficiency and one on renewables. The programme was reviewed in 2005, and its priorities were shifted more strongly towards energy efficiency (see Chapter 4).

ENERGY TAXES

All energy use in Switzerland is subject to a 7.6% value-added tax (VAT), which is refundable to businesses. The country has a tradition for "incentive taxes", that is revenue-neutral measures, which are intended to "direct" (or inflect) demand. A good example is the CO_2 tax on heating and process fuels, which comes into force on 1 January 2008 (see Chapter 3). Switzerland has long had one of the lowest taxes on heating oil for households. It is also one of the few IEA countries, in which diesel costs more than gasoline per litre. The fuel tax reform for biofuels implies a partial move towards a CO_2-based taxation system. To promote electricity from renewable sources, a grid levy will be set on the use of the transmission grid from 2008; the levy will be set according to required feed-in tariffs and is capped at CHF 0.006 per kilowatt-hour (kWh).

Table 2

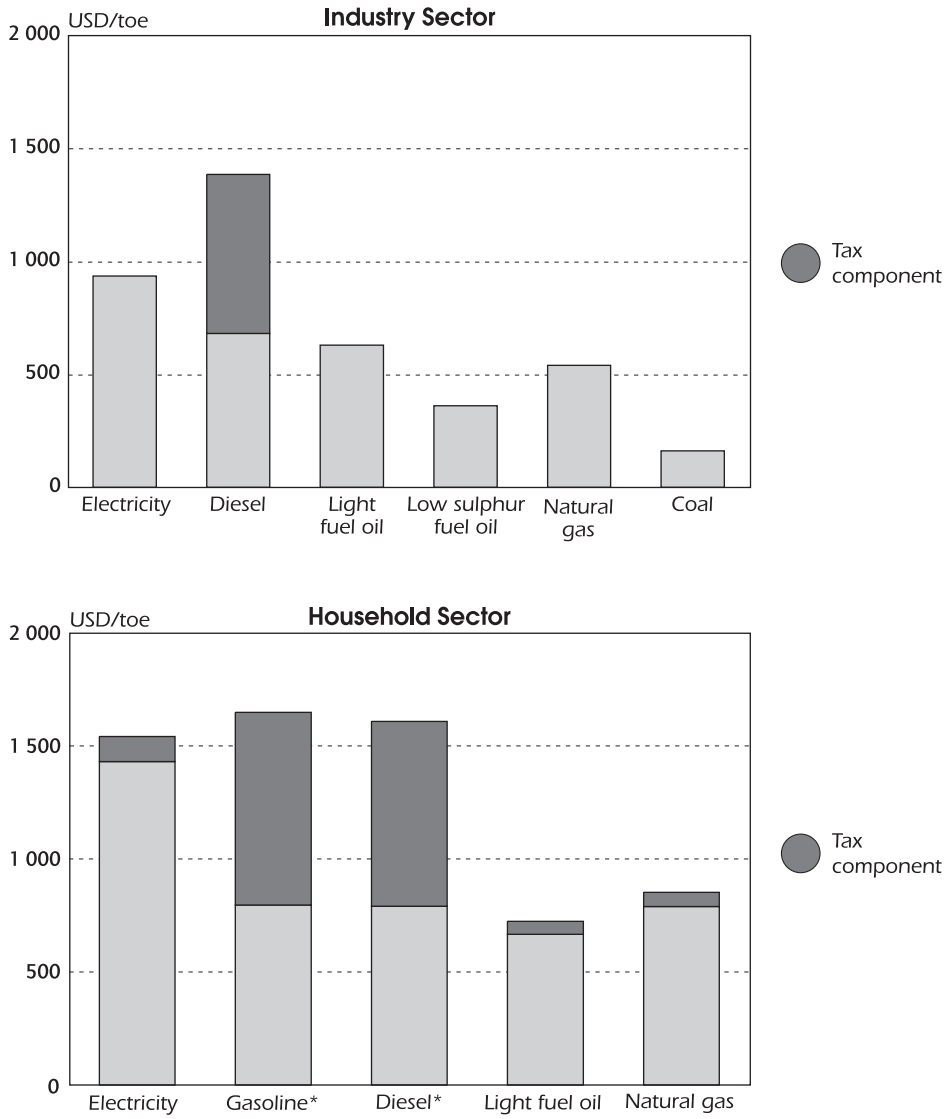
Energy Taxes in Switzerland, 2007

Energy source	*Levies*			
	VAT for households	*Excise tax, CHF/litre*	*Compulsory stockpiling levy, CHF/litre*	*Climate Cent, CHF/litre*
Light fuel oil	7.6%	0.003	0.0042	–
Diesel	7.6%	0.759	0.0042	0.015
Gasoline	7.6%	0.731	0.0042	0.015
Natural gas for transport use	7.6%	0.48	0.0146 CHF/kWh	–
Natural gas for stationary use	7.6%	0.0009	0.0146 CHF/kWh	–
Coal	7.6%	–	–	–
Electricity	7.6%	–	–	–
Hydropower	"Water royalty" of CHF 0.012/kWh (countrywide average)			

Source: Country submission.

Figure 5

Fuel Prices, 2006



* The prices for gasoline and diesel in USD/litre are as follows:

	Ex-tax	Tax	Total price
Gasoline 98	0.66	0.68	1.34
Diesel	0.68	0.71	1.39

The price of diesel appears lower than that of gasoline in the graph owing to diesel having a lower net calorific value per litre.

Source: *Energy Prices and Taxes*, IEA/OECD Paris, 2007.

CRITIQUE

In February 2007, the federal government presented an outline for its future energy policy. It is based on the government's long-term energy scenarios to 2035 and it was motivated by several concerns, most importantly by that of electricity supply. Electricity consumption is growing but, from the late 2010s and early 2020s, long-term electricity import contracts will expire and the oldest nuclear power plants are due to be shut down. How to fill the looming electricity gap remains an open question. Increasing energy efficiency and the use of renewables will be insufficient, and relying on more imports is not desirable. The government sees two options: building gas-fired and/or nuclear power plants. Both have their limitations. Nuclear power is controversial and, under the current legislation, takes long to build. Gas-fired generation, in turn, must fully compensate for its CO_2 emissions; only 30-50% of emissions reductions may be obtained from abroad. In any case, the government is to be commended for raising the electricity supply issue and being explicit about the option available.

In March 2007, the parliament approved the Law on Electricity Supply, which aims to begin opening the electricity market, starting from January 2008. The market is opened for customers in two phases, although moving to the second phase in October 2013 is to be subject to a facultative referendum. An independent regulator and an independent TSO are being established. After the 2002 referendum, these are important steps in the right direction. The government is to be commended for taking them and, at the same time, encouraged to take more measures in the same direction without delay.

Because of its central location in Europe, Switzerland is a major transit country for gas and electricity between EU countries. Concerns over security of supply are high on the EU energy policy agenda and it is in Switzerland's interests to play by the same rules as its neighbours. Switzerland and the EU are about to start negotiations on developing market-based cross-border trade in electricity, in accordance with relevant EU directives and regulations. Discussions are also on-going relating to the possibility of Switzerland's joining the EU Emissions Trading Scheme (EU-ETS). Switzerland could profit from a single comprehensive strategy on its energy relations with the EU. It might also like to consider becoming an observer to the Energy Community Treaty, a recent initiative to create European energy markets based on the EU directives.

Switzerland's federal structure poses some unique challenges to the federal government. The 26 cantons have much flexibility in implementing the federal energy legislation. The result is a variety of schemes and measures in promoting renewables and energy efficiency, which may prove costly. Encouragingly, harmonisation of the renewables promotion schemes and building codes is under way, and the IEA urges the authorities to keep harmonising them further. An additional issue is to create an integrated

climate policy at all levels and among all actors in the arena. More should be done to co-ordinate efforts on taxation, transportation, energy policy, environmental issues and efficiency programmes. Cost-effectiveness should be given a high priority. In this context, the IEA applauds the decision to focus more strongly on energy efficiency in the SwissEnergy programme for 2006-2010. Improving energy efficiency is normally a more cost-effective way to reduce CO_2 emissions and fossil fuels use than promoting renewable energy. SwissEnergy already measures cost-effectiveness on the basis of expenditure per unit of energy saved and per incremental renewables production. The IEA encourages the government to maintain funding for the programme and to provide long-term institutional stability.

Finally, much can be done to rationalise taxes across the energy sector. Different tax rates between the fuels used for different purposes, or different fuels with similar externalities, lead to inefficient consumption. In addition, the low taxation of heating fuel, even if accounting for the impending CO_2 tax, may not maximise incentives for more environment-friendly heat sources, and the lower relative taxes on transport fuels encourage "fuel tourism" and inefficient transport fuel consumption in Europe.

RECOMMENDATIONS

The government of Switzerland should:

- *Pay due attention to the requirements of building new energy infrastructure, such as shortening regulatory processes, securing supply contracts and rationalising GHG requirements, in addition to energy efficiency measures.*
- *Develop further the electricity market and cross-border trade in accordance with sound market-based principles within the framework and spirit of an internal electricity market in Europe.*
- *Prepare a comprehensive strategy on energy relations with the European Union and continue work to make policies compatible with the EU and neighbouring countries.*
- *Continue efforts to harmonise cantonal energy and environmental policies to the greatest extent possible.*
- *Ensure the continuation of the SwissEnergy programme after 2010 and clarify its interaction with the forthcoming instruments such as the grid levy and the CO_2 tax; adopt regulation whenever voluntary approaches do not deliver sufficient results.*
- *Rationalise taxes across the energy sector, taking due account of externalities.*

CLIMATE CHANGE

OVERVIEW

As a signatory to the Kyoto Protocol, Switzerland has committed itself to reducing its greenhouse gas (GHG) emissions by 8% from 1990 to 2008–2012. Since 1990, the emissions have remained relatively unchanged. In 2005, the latest year for which data are available, total GHG emissions amounted to 53.6 Mt CO_2-eq, which is 0.8 Mt CO_2-eq more than in the 1990 base year (see Table 3). Increases in CO_2 and F-gas emissions have been largely offset by decreases in CH_4 and N_2O emissions.

Table 3

Greenhouse Gas Emissions in Switzerland by Gas, 1990 and 2005

GHG	*Emissions, Mt CO_2-eq.*		*Share, %*		*Change, %*
	1990	*2005*	*1990*	*2005*	*2005/1990*
CO_2	44.5	46.0	84.3	85.7	3.3
CH_4	4.4	3.5	8.3	6.6	–19.5
N_2O	3.6	3.3	6.9	6.1	–9.9
F-gases*	0.2	0.9	0.5	1.7	365.6
Total	**52.8**	**53.6**	**100**	**100**	**1.7**

* HFCs (hydrofluorocarbons), PFCs (perfluorocarbons), SF_6 (sulphur hexafluoride).

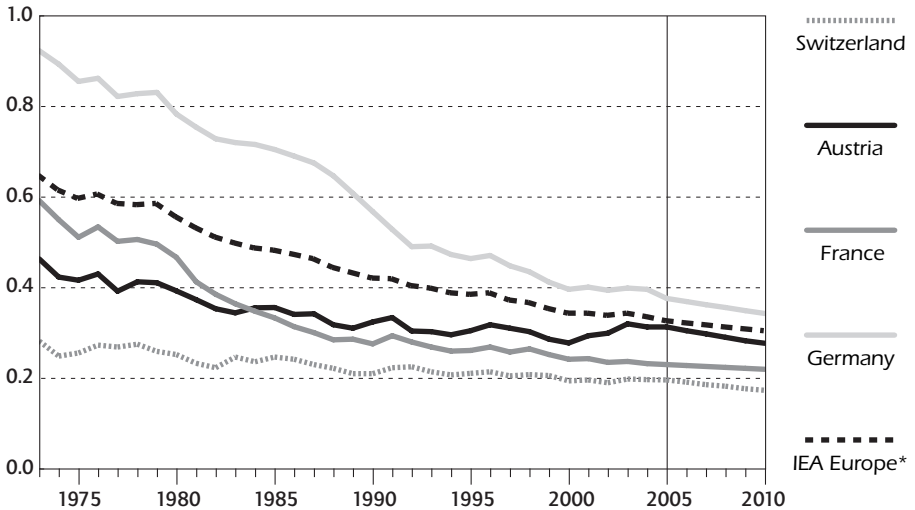
Source: National Inventory Report 2007 to the UNFCCC.

Compared to most IEA countries, energy use in Switzerland produces low CO_2 emissions per unit of GDP (see Figure 6). There are two main reasons for this. On the one hand, the Swiss economy is dominated by services, and within the manufacturing sector, process industries play only a minor role. On the other hand, the carbon intensity of energy supply is low: renewables and nuclear energy have a high share of TPES.

Figure 6

Energy-Related CO_2 Emissions per GDP in Switzerland and in Other Selected IEA Countries, 1973 to 2010

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



* excluding Luxembourg and Norway throughout the series, as forecast data are not available for these countries.

Sources: *Energy Balances of OECD Countries*, IEA/OECD Paris, 2007; *National Accounts of OECD Countries*, OECD Paris, 2007 and country submissions.

CO_2 EMISSIONS FROM FUEL COMBUSTION

CO_2 emissions from fuel combustion rose by 9% from 1990 to 2005 (see Table 4). 54% of this increase originated from transport, the largest emitting sector. In the residential sector, the second-highest emitter, oil and gas are widely used for space heating. The large proportional increase in the energy industry is explained mainly by refinery upgrades.

On a fuel basis, oil is by far the dominant source of CO_2. In 2005, it accounted for 77% of the emissions, down from 84% in 1990. While oil's share has gradually decreased, the share of gas has increased from 9% to 14% in recent years, and the share of industrial and municipal waste has risen from 3% to 7%. Coal remains negligible, accounting for 1% of the emissions.

Table 4

CO_2 Emissions from Fuel Combustion in Switzerland by Sector*, 1990 and 2005

Sector	Emissions, Mt		Share, %		Change, %
	1990	2005	1990	2005	2005/1990
Energy Industry	1.7	2.7	4.0	5.9	58.8
Manufacturing/construction	5.9	6.5	14.4	14.5	10.2
Transport	14.7	16.7	35.5	37.1	13.6
Residential	11.9	12.2	28.7	27.0	2.5
Other**	7.1	7.0	17.3	15.5	–1.4
Total	**41.3**	**45.0**	**100**	**100**	**9.0**

* estimated using the IPCC Sectoral Approach.

** commercial and public services, agriculture/forestry and fishing.

Source: *CO_2 Emissions from Fuel Combustion*, IEA/OECD Paris, 2007.

POLICY

Switzerland's policy on abating CO_2 emissions from fuel use rests on the 1999 Federal Law on the Reduction of CO_2 (CO_2 Law). The law sets targets for reducing emissions by 2010. A variety of voluntary measures exist to meet these targets. The CO_2 Law mandates the introduction of a CO_2 tax if voluntary measures prove insufficient. At the federal level, climate change policy is the responsibility of the Federal Office for the Environment (FOEN). Other government offices involved are those for energy, transport, agriculture, forestry, finance and foreign affairs. Cantons and interest groups participate in decision-making through non-binding consultations on proposed laws, ordinances and strategies.

Federal Law on the Reduction of CO_2

The CO_2 Law, adopted in October 1999, mandates that energy-related CO_2 emissions be reduced by 10% from 1990 to 2010. It has two sub-targets: –15% for stationary (*i.e.* heating and process) fuels and –8% for transport fuels. The law gives priority to voluntary measures, but stipulates that the government will introduce a tax on fossil fuels (CO_2 tax) if the voluntary measures are deemed insufficient to meet the targets.

The need for a CO_2 tax is assessed with energy projection models, which are regularly updated. In 2004, the government concluded that, under the business-as-usual (BAU) scenario, both the Kyoto and the CO_2 Law targets would not be met. Under BAU, in 2010, total CO_2 emissions would be only

3.9% lower than in 1990, emissions from stationary fuels only 11.4% lower and emissions from transport fuels 8.5% higher than in 1990. Hence, acting on article 3(2) of the CO_2 Law, the federal government was to set a CO_2 tax.

By that time, existing measures to reduce CO_2 emissions fell into three categories: voluntary action by the industry and transport sectors (co-ordinated under the SwissEnergy programme); cantonal activities mostly in the building sector (Minergie programme, among others); and the heavy vehicle fee. The SFOE has calculated that without SwissEnergy and Energy 2000, its predecessor, CO_2 emissions in 2005 would have been 7.2% higher than what they actually were.

In June 2005, in the background report of the CO_2 tax bill, the federal government estimated that without additional measures, Switzerland would exceed the CO_2 Law target of –10% by 2010 by 2.9 Mt. It concluded that, considering measures already planned, the annual gap could be closed with the following additional emissions reductions:

- 1.8 Mt from the Climate Cent Initiative on transport fuels.
- 0.7 Mt from a CO_2 tax on stationary fuels.
- 0.4 Mt by reforming transport fuel and car taxes.

Climate Cent Initiative

According to the CO_2 Law, certain large consumers may be granted exemption from a possible CO_2 tax, if they make a formal and binding commitment to the federal government to limit their CO_2 emissions. For transport fuels, such an exemption has been in place since October 2005: instead of a CO_2 tax, the Climate Cent applies.

The Climate Cent is a surcharge of CHF 0.015 per litre on gasoline and diesel. It is levied both on imports of gasoline and diesel, and on crude oil used to produce gasoline and diesel at the Swiss refineries. The surcharge finances CO_2 emissions reductions, which for the transport fuel sector are 1.8 Mt CO_2 per year. At least 0.2 Mt CO_2 of the annual reductions must originate in Switzerland, and at most 1.6 Mt CO_2 can be obtained from abroad. The annual revenues, which are expected to reach CHF 100 million, are managed by the private-sector Climate Cent Foundation.

The Climate Cent Initiative was launched by the Oil Industry Union, the Swiss Business Federation (Economiesuisse), the Swiss Association of SMEs and the Swiss Road Federation. In March 2005, following several years of preparations and a round of consultations, the federal government agreed to give it a temporary mandate until the end of 2007. To implement the initiative, the Climate Cent Foundation started levying the Climate Cent on 1 October 2005.

According to the Foundation's business plan (see Table 5), some 54% of the total revenues until the end of 2012 (CHF 395 million) would be spent on domestic projects, and 29% (CHF 214 million) on purchasing certificates from joint implementation (JI) and clean development mechanism (CDM) projects under the Kyoto Protocol. Domestic measures would account for 20% of the total emissions reductions, while international measures would cover 80%.

In September 2007, after examining the Climate Cent Foundation's business plan, the federal government decided to extend the Climate Cent scheme until 2012. However, the Climate Cent will have to take on an additional emissions reduction objective, because the latest projections show that Switzerland would otherwise miss the CO_2 Law target by 0.5 Mt. The Climate Cent's revised objective and the distribution between domestic versus foreign measures will be negotiated with DETEC by the end of 2007. The Climate Cent Foundation will have to surrender any excess reduction credits to the federal government (instead of selling them). The Foundation may have to use its financial reserve for its additional objective. Finally, the government retains the possibility of introducing a CO_2 tax on transport fuels at any time, if emission trends are not curbed enough to reach the target of the CO_2 Law.

Table 5

Climate Cent Foundation's Budget, 2005 to 2012*

	Budget, CHF million	*Emissions reduction, Mt CO_2*	*Abatement cost, CHF/t CO_2*
Total	**735**	**12.80**	**57**
Building refurbishment	185	0.49	378
Project finance	97	0.95	102
Allowances from companies in voluntary commitments	112	1.16	97
Sub-total domestic	**395**	**2.60**	**152**
International certificates	214	10.20	21
Administration	14		
Reserve	112		

* subject to revision after the September 2007 decision by the federal government.

Source: Climate Cent Foundation: *Jahresbericht 2006*.

Measures within Switzerland focus on three areas: refurbishing buildings; financing energy efficiency and renewables projects in transport, space heating, process heat and waste heat; and acquiring allowances from companies that are exceeding their voluntary reduction targets under the CO_2 Law.

In practice, the Climate Cent Foundation purchases the allowances from companies associated with the Energy Agency for the Economy (EAEc). EAEc is an umbrella organisation for some 1 600 companies, which produce roughly a third of the industrial CO_2 emissions. The Climate Cent Foundation has offered to pay a maximum of CHF 80 per t CO_2 (USD 64) for allowances from stationary fuel users and a maximum of CHF 125 per t CO_2 (USD 100) for allowances from transport fuel users.

CO_2 tax on stationary fuels

In March 2007, the parliament approved the criteria for a tax on CO_2 emissions from stationary fuels (see Table 6). The tax is levied on heating and process fuels. As the 2006 emissions were only 4.6% below those of 1990, the tax will come into force on 1 January 2008. On a fuel basis, the tax of CHF 12 per t CO_2 equals CHF 0.03 per litre of heating oil and CHF 0.025 per m^3 of natural gas. Depending on progress towards emissions reduction targets, the tax may be increased in the following years. The tax is revenue-neutral; the revenues are redistributed to employers in accordance with wages paid and to the population on a per-capita basis. The government expects the tax revenues to reach roughly CHF 220 million in 2008 and up to CHF 650 million in 2010.

Table 6

Conditions for the Introduction of a CO_2 Tax on Stationary Fuels

Enters into force on	*On condition that emissions are reduced by less than*	*Rate, CHF per t CO_2*
January 1, 2008	6% from 1990 to 2006	12
January 1, 2009	10% from 1990 to 2007	24
January 1, 2010	13.5% from 1990 to 2008	36

Source: Country submission.

In March 2007, the parliament also decided that all future gas-fired power plants will have to compensate for all of their CO_2 emissions. Up to 30% of the total credits can come from emissions reductions abroad. The federal government can increase this ratio to up to 50% on the basis of security of electricity supply concerns.

Emissions trading scheme

To avoid the CO_2 tax on stationary fuels, companies were invited to enter into legally binding commitments to reduce their energy-related CO_2 emissions. To do this, the companies already in voluntary commitments to reduce CO_2 emissions

had to convert those commitments into legally binding ones. The other companies had to work out an emissions reduction plan with the EAE and submit it to the FOEN. The deadline for joining this scheme was 1 September 2007.

Companies are being set an annual emissions target, which applies from the year of joining the scheme until 2012. The target is calculated bottom-up, *i.e.* assessing the company's technical and economic potential to reduce emissions based on its projected production and emissions. For small- to medium-sized enterprises (SMEs), a simplified top-down approach is used.

Corresponding to their emissions targets, companies will be granted tradable emission permits. The permits are granted free of charge. Each year, companies must retire to the national emissions trading register (a body under the FOEN) the quantity of allowances corresponding to their actual emissions. Depending on the balance of actual emissions versus the emissions target, companies can either sell or buy allowances. Up to 8% of the total reductions can be obtained from abroad. Companies can also save the excess allowances for the post-2012 commitment period. If they fail to possess the required permits, they must pay the CO_2 tax retroactively for each tonne of CO_2 emitted since exemption was granted. Companies exempted from the CO_2 tax are also excluded from the redistribution of the tax revenue.

By July 2007, more than 600 companies had joined the scheme. The scheme will take effect on 1 January 2008. Setting these conditions for a functioning CO_2 market is also a prerequisite for joining the EU Emissions Trading Scheme.

Reforming taxes on transport fuels and cars

To reduce fossil fuel use in transport, taxes on biogas and other fuels from renewable sources, which meet sustainability standards, will be abolished, and taxes on natural and liquefied petroleum gas (LPG) will be lowered by CHF 0.4 per litre of gasoline equivalent. The resulting decline in tax revenues is to be fully offset by higher taxes on gasoline. The tax reform is expected to enter into force on 1 January 2008. Thus, gasoline taxes will rise by CHF 0.01-0.02 per litre in 2008 and around CHF 0.06 per litre in 2010.

The parliament is also preparing legislation to introduce a bonus-malus system (a feebate scheme) for new cars. Vehicle taxes would be differentiated to take account of the vehicle energy efficiency and pollutant emissions. The system will be revenue-neutral. The cantons are planning to revisit vehicle circulation fees according to similar criteria.

Medium- and long-term climate change policy

The federal government has given DETEC the mandate to prepare a strategy for Switzerland's post-2012 targets by the end of 2007. In accordance with the CO_2 Law, the federal government will then submit the proposals to the Federal

Assembly for endorsement. The strategy will be based on the energy perspectives' projections as well as studies on the impact of climate change on Switzerland.

LOCAL AIR POLLUTION

OVERVIEW

Figures for recent and projected emissions of the most important energy-related pollutants are set out in Table 7. In the past two decades, emissions have been cut dramatically. Following initial reductions in the 1980s, emissions of non-methane volatile organic compound (NMVOC) decreased from 1990 to 2005 by 64%, SO_2 by 59%, NO_x by 45% and PM_{10} by 27%. For SO_2, the main contributor to this reduction was the use of low-sulphur fuel oil. Decreases in NO_x and NMVOC emissions mainly resulted from using catalytic converters in passenger cars. Reductions in PM_{10} emissions from stationary sources were partly offset by emissions from diesel cars.

Emissions levels that are considered safe for humans and the environment are embedded in the air quality standards in the Ordinance on Air Pollution Control. To reach them, reductions from the 2000 levels would have to be about 60% for NO_x, about 50% for NMVOC and about 45% for particulate matter (PM). Emissions of SO_2 would have to remain below the 2000 level.

Table 7

Historical and Projected Emissions of Selected Air Pollutants in Switzerland

Pollutant	*Emissions in 1990, kt*	*Emissions in 2000, kt*	*Emissions in 2005, kt*	*Projection for 2010, kt*	*CLRTAP target for 2010, kt*
SO_2	42	18	17	14	26
NO_x	158	104	86	69	79
NMVOC	282	136	101	90	144
PM_{10}	26	21	19	19	–

Source: Gothenburg Protocol; Annual Report to the UNECE/CLRTAP – 2007 submission.

LEGAL FRAMEWORK

Switzerland has ratified the 1979 United Nations Economic Commission for Europe (UNECE) Convention on Long-Range Transboundary Air Pollution (CLRTAP) as well as the eight protocols subsequently added to it. The

protocols aim to reduce the emissions of NO_x, SO_2, NMVOC, NH_3, PM, persistent organic pollutants and heavy metals. The CLRTAP's 1999 Gothenburg Protocol to Abate Acidification, Eutrophication and Ground-level Ozone sets country-specific targets to reduce emissions of NO_x, SO_2, NMVOC and NH_3 by 2010. Switzerland ratified the Gothenburg Protocol in 2005.

International obligations have been incorporated into federal law. Principles of air pollution control are stated in the 1983 Law on the Protection of the Environment, and emission-specific limit values in the 1985 Ordinance on Air Pollution Control. More specific legal acts are the 1997 Ordinance on Incentive Taxes on volatile organic compounds (VOCs), the 1997 Ordinance on the Incentive Tax on Extra Light Fuel Oil and the 2003 Ordinance on the Incentive Tax on Sulphur-Containing Motor Vehicle Fuel.

Swiss legislation to limit emissions from new vehicles is harmonised with that of the EU. Current requirements are those of the EURO 4 Regulation, which aims to limit emissions of NO_x, CO and PM. They will be followed by those of the EURO 5 Regulation, which will be introduced in 2008 for heavy duty vehicles and, depending on transposition, in 2009 or later for passenger cars and light duty vehicles.

Road transport is the largest emitter of these pollutants in most developed countries, also in Switzerland. Technological development, spurred by more stringent emissions limits, is expected to bring down the emissions per car. However, increasing popularity of fuel-efficient diesel cars, the main source for PM_{10}, might slow down these developments in the short to medium term.

The CLRTAP obliges Switzerland to report annually on the emissions covered by it. The data on air pollution concentrations are compiled by the National Air Pollution Monitoring Network (NABEL), and subsequently published in an annual report. Data on the current air pollution levels are accessible on-line.[3]

CRITIQUE

CLIMATE CHANGE

Switzerland's target under the Kyoto Protocol is to reduce its GHG emissions by 8% below 1990 levels by 2008–2012. In addition to the Kyoto target, Switzerland has a self-imposed target for energy-related CO_2 emissions of –10% from 1990 to 2010. It also has two sub-targets: –15% for emissions from stationary fuels and –8% for emissions from transport fuels. Reaching the national target for CO_2 emissions would virtually guarantee meeting the Kyoto target for GHG emissions.

3. http://www.bafu.admin.ch/luft/luftbelastung/aktuell/index.html?lang=en

CO_2 emissions from energy use remain roughly at the 1990 level. Without the measures already implemented, most of them voluntary, emissions would be markedly higher. This is especially the case for emissions from using heating and process fuels. The government has acknowledged that more has to be done and expects further reductions from three additional measures: imposing a CO_2 tax on stationary fuels; reforming taxes on cars and transport fuels; and entrusting the Climate Cent Foundation with offsetting emissions from transport fuels. The IEA applauds Switzerland for laying out clearly how it will meet its Kyoto target.

The CO_2 tax for stationary fuels is to be commended for its design. Recycling the tax revenues to all citizens and enterprises is sound fiscal practice. Companies can also be exempted from the tax if they commit themselves to legally binding emissions reductions. If companies exceed the reduction targets, they can offer to sell the resulting emission credits to the Climate Cent Foundation or, yet untested, trade them under the Swiss emissions trading scheme. However, even with the CO_2 tax, heating oil prices remain very low, compared to OECD Europe. To increase incentives to use non-fossil fuels, the government could consider adjustments, including earmarking part of the CO_2 tax revenues for energy research and development (R&D) and direct incentives. The government should also consider emission caps on more sectors, including refineries.

For Switzerland, it would be costly to meet the reductions targets by domestic measures alone. Under the Kyoto Protocol, the country can use some 2 Mt CO_2 of JI/CDM credits annually. The issue here is how to allocate this amount across sectors. In the current situation, the Climate Cent Foundation would use 80% of the country's JI/CDM credits, which is equivalent to almost 89% of its reduction objective. In contrast, the electricity sector could cover 30-50% and industry 8% of their reduction obligation with measures abroad.

The government should allocate rights to use JI/CDM credits more cost-effectively across sectors. Of course, there are limits to this. It would certainly be too expensive to try to reach the CO_2 Law's target for emissions from transport fuels by measures in the transport sector alone; emissions would have to be cut by 17% from 2005 to 2010. Still, with the looming electricity supply gap, and the uncertainty over new nuclear power capacity, continuing to favour road transport on this scale can hardly be the optimal allocation for Switzerland.

Costs could be better balanced across sectors by increasing the Climate Cent surcharge – or a CO_2 tax on transport fuels – and using a higher share of the revenues for reducing emissions within Switzerland. A higher surcharge would have the following benefits. First, the surcharge is currently too low to have any meaningful effect on driving behaviour. Obliging the Climate Cent

Foundation, or levying a CO_2 tax on transport fuels, to decrease emissions more at home might change this. Second, a higher surcharge would provide welcome liquidity to domestic emissions trading and reduce abatement costs for industry. For additional liquidity, Switzerland should also consider joining the EU Emissions Trading Scheme, the largest in the world.

Transport is a crucial sector for long-term emissions reductions. The government is aware of this and has for years worked on improving the public transport system, already of a very high standard. Efforts to shift freight traffic from road to rail have also been successful. These efforts will be further strengthened by the opening of the Lötschberg and Gotthard baseline railway tunnels. The IEA applauds the government for this progress.

However, the government should increase its efforts to tackle emissions from the transport sector given that increasing use of passenger cars threatens to undermine success in other areas. The private car is the dominant form of transport and, according to the Federal Statistics Office, passenger kilometres from private cars increased by 27% from 1990 to 2005 – faster than in any other mode of transport. External costs from private car use remain largely to be internalised. All stakeholders need to increase efforts to limit emissions. The authorities should consider the following measures: raising taxes on vehicle purchase, registration, use and motor fuels; increasing road and parking pricing; reducing parking space, and increasing public transport. To offset the impact of rising incomes, taxes and fees should be indexed to real income growth.

For post 2012, the government is to present a climate change strategy before the end of 2007. Building on the energy scenarios up to 2035, the strategy should identify a range of attainable targets for the medium to long term. It should give strong focus to measures in the transport and the residential/commercial sectors, which have the highest emissions.

AIR POLLUTION

Stronger efforts to reduce CO_2 emissions from transport would also speed up progress in decreasing other transport-related air emissions. Emissions of most air pollutants have diminished significantly and are in line with Switzerland's international obligations. Further progress can be expected from increasing the share of biofuels and low-carbon fuels in transport. However, emissions of PM_{10} and ground-level ozone remain a concern, as do NMVOCs and NO_x, ozone's precursors. The government should consider stronger measures to further reduce these emissions. The focus should be on the transport sector, the largest source for those emissions.

RECOMMENDATIONS

The government of Switzerland should:

Climate change

- *Continue efforts to meet the Kyoto target.*
- *Allow all sectors to rely equally on international flexibility mechanisms to reduce CO_2 emissions as cost-effectively as possible.*
- *Prepare for the post-Kyoto period by developing a medium- to long-term strategy, with a particular focus on reducing emissions in the transport sector.*

Air pollution

- *Increase efforts to reduce emissions of NO_x, PM_{10}, NMVOCs and, in particular, diesel soot.*

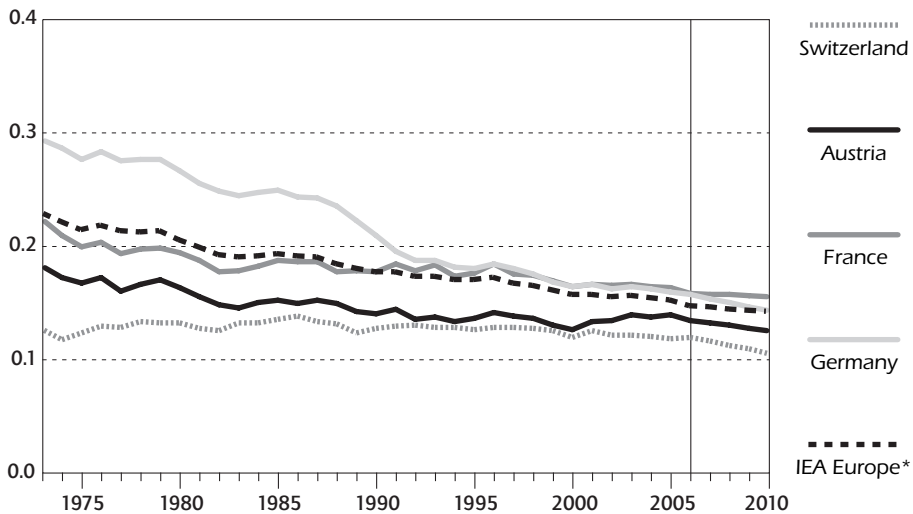
OVERVIEW

Switzerland's total final consumption of energy (TFC) expanded from 1990 to 2005 by 14%, at the same pace as the economy at large. Implying efficient use of energy, Switzerland has the lowest energy intensity among the IEA countries. In 2005, for each USD of gross domestic product (GDP), Switzerland needed 45% less primary energy than the average IEA country. This is for several reasons. On the one hand, the Swiss economy relies heavily on high value-added services, and heavy industry is scarce. On the other hand, electricity in Switzerland is mostly produced from hydropower which, unlike fuels, does not lose energy in the generation process. Apart from being low, energy intensity has also been remarkably steady over recent decades, owing to Switzerland's structurally stable national economy and energy supply (see Figure 7).

Figure 7

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

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

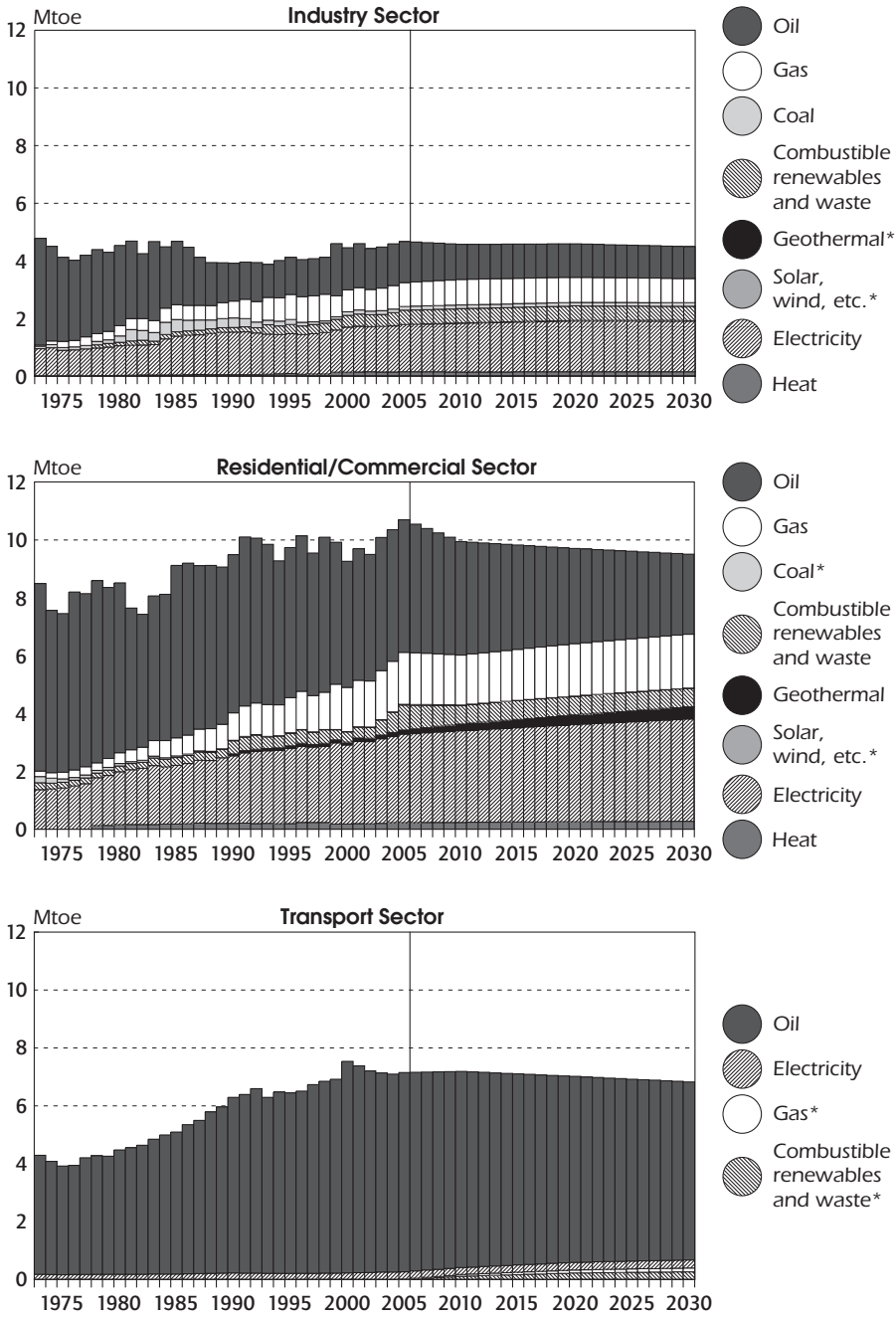


* excluding Luxembourg and Norway throughout the series, as forecast data are not available for these countries.

Sources: *Energy Balances of OECD Countries*, IEA/OECD Paris, 2007; *National Accounts of OECD Countries*, OECD Paris, 2007 and country submissions.

Figure 8

Total Final Consumption by Sector and by Source, 1973 to 2030



* negligible.

Sources: *Energy Balances of OECD Countries*, IEA/OECD Paris, 2007 and country submission.

The government expects TFC to begin to decline from 2005, its all-time high. The decrease should be 4% by 2010 and 5% by 2020. Most reductions are expected in households and services, whereas energy use in transport and industry is projected to remain steady (see Figure 8). CO_2 legislation is seen as the main driver for these developments.

LEGAL AND INSTITUTIONAL FRAMEWORK

The principal law pertaining to energy efficiency is the 1998 Energy Law. It gives the federal government the right to set performance standards on vehicles, systems and appliances. The government is also responsible for energy labelling. Cantons, in turn, are entrusted with building regulations, and must create favourable conditions for increasing energy efficiency and use of renewable energy in buildings. Responsibilities in information dissemination and counselling are shared between the federal government and the cantons. Generally, the federal government emphasises broad public information campaigns, whereas the cantons focus on counselling. The federal government finances R&D in energy efficiency, in consultation with the canton where the project is sited. The federal government also promotes professional training in energy efficiency, in co-operation with the cantons. Indirectly, the 1999 CO_2 Law is also highly relevant to energy efficiency, through its two sub-targets, namely –15% for stationary fuel emissions and –8% for transport fuel emissions from 1990 to 2010.

The government's main instrument for improving energy efficiency is the SwissEnergy programme (see Chapter 1). Following a mid-term review in 2005, the programme was refocused for its second half (2006-2010) on modernisation of buildings, energy-efficient appliances and motors, energy efficiency and waste heat in industry and services, energy-efficient and low-emission transport, and renewable energy.

SwissEnergy's activities are carried out in partnership with about 30 organisations (partners). The SFOE supervises and co-ordinates the partners in charge of individual programmes. It also provides part of the funding. The partners fall into two groups. The cantonal energy desks implement cantonal programmes, while industry and trade associations, consumer associations, non-governmental organisations (NGOs) and municipalities are in charge of sectoral programmes at the national level. These programmes comprise areas such as building codes and standards, voluntary agreements to avoid the CO_2 tax, promoting energy-efficient appliances and improving car fleet efficiency.

The impact and effectiveness of SwissEnergy is assessed annually. In 2005, fossil fuel energy demand was 7.5% lower than it would have been without SwissEnergy and Energy2000, its predecessor in the 1990s. The programme has a high leverage effect, as each Swiss franc triggers 20 times as much private

investment. A cost-benefit analysis (based on SwissEnergy and cantonal expenditures) revealed that some CHF 0.03 of public money had to be invested to save 1 kWh of energy. In 2006-2010, the programme intends to improve efficiency by 25% (in terms of Swiss francs invested per unit of energy saved). Furthermore, SwissEnergy has prepared a draft strategy for energy efficiency and renewable energy, which was released in September 2007.

Since 2004, cantonal programmes are subject to evaluation as a precondition for federal co-financing. The key evaluation criterion is cost-effectiveness, measured as energy savings per Swiss franc over the project life-cycle.

POLICIES AND MEASURES

BUILDINGS

Building regulations are the responsibility of the cantons. Since 2000, the cantons have been harmonising their building codes according to the MuKEn model regulations[4]. They also have a common strategy for energy efficiency in buildings, previously updated in 2005. The MuKEn regulations are now being revised, and the cantons are expected to approve more stringent standards in 2008. Key revisions concern the limits on the maximum annual energy requirement for space and water heating. Following a decision by the cantons to reduce annual heating oil consumption from 9 to 4.8 litres per m^2 for new buildings, the suggested annual limit is 60 kWh per m^2 from 2008 and 30 kWh/m^2 from 2012; and for refurbishment of existing buildings, 84 kWh per m^2 from 2008. A voluntary energy efficiency certificate for buildings will also be introduced, while one canton has already declared it mandatory.

According to the Energy Law, the cantons will have to approve laws in the next few years on restricting electric heating in residences, requiring consumption-based billing of space and water heating in existing buildings and setting minimum requirements for the utilisation ratio of new space and water heating systems.

The cantons and the federal state, together with the private sector, also support a voluntary labelling system for high-efficiency buildings, namely the Minergie. The label is applicable for new and renovated buildings and it comes in several levels of standards (Minergie, Minergie-P, Minergie-Eco). They all set an overall limit on energy use for heating, hot water, ventilation and air-conditioning. This maximum annual energy consumption for new residential buildings is 42 kWh per m^2 (heated gross floor area) and for renovated residential buildings 80 kWh per m^2. Both are less than half of the current requirements in Switzerland.

4. *Mustervorschriften der Kantone im Energiebereich* (MuKEn); Model Cantonal Building Prescriptions.

Standard solutions for meeting the Minergie requirements include improved insulation and, for space and water heating, installing heat pumps, wood-fired systems or waste heat systems. The Minergie label has also been developed for individual building components, such as walls, roofs and floors, windows and exterior doors. By summer 2007, some 7 400 buildings with a total floor area of 7 million m^2 had been Minergie-certified. About 12% of new residential buildings and 15% of new office buildings have the certificate, and almost one building in five is built to meet the standard.

Current trends in energy-related building refurbishment should receive a boost from the Climate Cent buildings programme, which has earmarked CHF 185 million per year to finance up to 10% of the refurbishment cost per project. It is, however, still premature to assess the programme's impact.

SwissEnergy also promotes the Energy City label. To obtain it, municipalities have to commit themselves to formulating broad energy policy programmes with clear objectives, deadlines, budgets and quantifiable results. More than 140 municipalities, home to one Swiss in three, have qualified for the label.

APPLIANCES

Energy labels compatible with those of the EU are used for household appliances and lighting. The minimum requirements for new appliances are gradually being tightened. From 2009, category A will be required for new household appliances, such as ovens, freezers, refrigerators, dishwashers and washing machines. Stand-by use in consumer electronics and information technology (IT) equipment must be reduced, as a first step, to a range from 0.3 watt for mobile phones to 8 watt for set-top boxes.

For household lamps, the minimum category will be E from 2008, D from 2012 and B from 2015, if similar obligations are enforced in the EU. From 2010, minimum energy efficiency requirements will be set for ballasts and street lighting.

The two key organisations for promoting energy-efficient appliances are the Swiss Agency for Electric Appliances (EAE) and the Swiss Agency for Efficient Energy Use (SAFE)[5]. The EAE maintains a database on labelled appliances. SAFE runs a website ranking the ten most energy-efficient appliances, including non-labelled ones, in each appliance category. Both are partners of the SwissEnergy programme.

5. *Energie-Agentur-Elektrogeräte* and *Schweizerische Agentur für Energieeffizienz.*

INDUSTRY

The largest improvements to energy efficiency in industry result from CO_2 legislation. To avoid the CO_2 tax to be introduced in 2008, most companies in industry and service sectors have agreed to cut emissions voluntarily, and now they will have to convert these voluntary agreements into legally binding commitments. The agreements are managed by the private sector's Energy Agency for the Economy *(Energie-Agentur der Wirtschaft)* in close co-operation with the SFOE. By the end of 2006, the agreements with some 1 600 companies covered more than 37% of industry's CO_2 emissions. The cement industry is covered by a separate 2003 agreement with DETEC.

Electric motors in industry account for about 25% of Switzerland's electricity consumption. In 2004, SFOE signed a voluntary agreement with industry to achieve a market penetration of 20% for highly efficient "eff 1"-class motors by 2010.

COMBINED HEAT AND POWER PRODUCTION

Combined heat and power (CHP) production is a small-scale activity in Switzerland, and likely to remain so. According to the Swiss energy statistics, in 2006, total installed capacity was 487 MWe. It was divided between 1 088 installations, 32 of which were more than 1 MW of capacity. Electricity production amounted to 1.6 TWh, which accounted for 2.7% of total generation in Switzerland. Heat production was 0.9 TWh (excluding the 32 biggest installations). CHP plants mostly use fossil fuels, but renewables are now gaining ground. SwissEnergy's efforts have been pivotal here, and the programme is increasing its support for small-scale CHP from renewables.

TRANSPORT

Legally binding measures to promote energy efficiency in transport include harmonising annual registration fees on motor vehicles across cantons, and in 2009, establishing a bonus-malus system (a feebate scheme) on the purchase of new cars to favour fuel-efficient vehicles at the expense of the inefficient ones.

Voluntary measures to improve energy efficiency of vehicles include the 2002 agreement between DETEC and car importers to reduce the average fuel consumption of new cars from 8.4 litres per 100 km in 2000 to 6.4 litres per 100 km in 2008. In 2006, the figure was 7.6 litres per 100 km, and the agreement is likely to miss its target, because increases in car weight have offset improvements in fuel efficiency. As part of the agreement, the

government has introduced a compulsory energy label for new passenger cars. According to SwissEnergy, the energy label has contributed to reducing energy use by 40 terajoules (TJ) per year (1 ktoe). SwissEnergy also promotes energy-efficient driving by supporting the Eco-Drive courses, which are now a prerequisite for obtaining a driver's licence. The courses are expected to reduce fuel demand by 10-15% among the course participants. DETEC is considering a new agreement with the car importers' association, coupled with supplementary measures, to limit average CO_2 emissions from new cars to 130 g per km by 2012. However, Switzerland is still far from such a target: CO_2 emissions from new cars averaged 187 g CO_2 per km in 2006, while the whole fleet averaged 200 g CO_2 per km – among the highest in IEA Europe.

Shifting from road to rail is the government's principal policy in freight transport. The 1999 Federal Modal Shift Law aims to cut the number of lorries crossing the Swiss Alps by half from 1999 to 2010. Since 2001, vehicles weighing more than 3.5 tonnes are subject to a heavy vehicle fee (HVF). The HVF is vehicle-specific and based on weight, mileage and pollutant emissions. According to the OECD, by 2008, annual revenue from the HVF is estimated at CHF 1.7 billion. One-third of this will be spent on infrastructure projects in the cantons and two-thirds on improving transalpine railways, mainly to finance the construction of two major tunnels, namely Lötschberg (34 km, due to open in 2007) and Gotthard (57 km, the world's longest railway tunnel, due to open in 2015). Combined with the increased weight limit for lorries (from 34 tonnes in 2001 to 40 tonnes since 2004), the HVF has raised energy efficiency by triggering fleet renewal and better logistics. In 2007, the HVF and the higher weight limit are estimated to reduce CO_2 emissions by 6-8% from business-as-usual levels.

CRITIQUE

Energy efficiency is a high priority for Switzerland. To reflect this, the government strengthened energy efficiency's position within the SwissEnergy programme for the years 2006-2010. Following the subsidiarity principle, primarily voluntary measures are used to improve energy efficiency. This approach, however, is only partially delivering results. Compared to BAU, SwissEnergy has reduced demand for fossil fuels by some 7.5%, but efficiency gains are often offset by increases in consumption volume or changes in consumption structure. For example, electricity use in households is growing fast and average car weight keeps increasing. Therefore, the government is well advised to consider more regulation, especially in the building and transport sectors.

Buildings are the largest end-user of energy and they also have the longest service life of all energy-using products, spanning decades or even centuries. Building codes are the key instrument for promoting energy efficiency. In

international comparison, Switzerland is performing well and the Minergie standard sets a strong example for other countries. The current standards provide a solid basis for more ambitious measures, and the consensus on the need to further strengthen and harmonise the cantonal building codes is highly encouraging.

In addition to its stringency, other commendable features of Minergie are its flexibility and openness to innovation. It sets a goal for the overall efficiency (energy use per floor area), but leaves it to the planners and builders to decide on how to reach this goal. The IEA recommends making Minergie standards binding in all new buildings. Generally, building codes should require minimising the life-cycle cost of energy use in new buildings over a period of at least 30 years. The authorities should also continue to update regularly the minimum requirements to encourage a move towards zero-net energy or passive house energy performance levels.

In the existing buildings, more challenges remain. Some 60% of the Swiss population are tenants, and renovating to the Minergie standard increases renovation costs by up to 10%. Landlords can only pass 40-60% of the renovation costs to the tenants. The result is a disincentive to improve energy efficiency in existing buildings in general, and to the highest standards, in particular. As a solution, the authorities should consider stronger financial and tax incentives. They should also stimulate energy efficiency services and financing solutions, such as performance contracting. Mandatory energy certification for buildings is also worth considering.

Integrating energy considerations into urban planning is crucial for long-term energy efficiency. Planning decisions, especially in greenfield developments, can lock communities into unsustainable energy consumption patterns for decades. Thus, the IEA gives credit to the EnergyCity programme for increasing awareness of energy issues among decision-makers.

Appliances and equipment represent one of the fastest growing energy loads in most countries. The IEA applauds Switzerland's use of energy labelling across a wide range of appliances and equipment. The government's policy of gradually raising the minimum efficiency requirements is essentially sound. Voluntary measures would be too weak, as the appliances are becoming cheaper in real terms.

Saving energy by adopting efficient lighting technology is particularly cost-effective. The IEA welcomes Switzerland's decision to phase out the most inefficient incandescent bulbs from 1 January 2008 and gradually raise the minimum efficiency requirement to class B from 2012. The IEA encourages the government to accelerate this phase-out, if commercially and economically viable.

Electricity savings could be given a higher priority, especially in light of the foreseen gap between demand and supply. In this context, plans to restrict traditional electric heating in new buildings are commendable.

In the transport sector, the IEA applauds Switzerland's plans to reform taxes on transport fuels and vehicles, and commends Switzerland's decision to include courses on fuel-efficient driving in the requirements for acquiring a driver's licence. As voluntary efforts to improve energy efficiency in the transport sector have not been sufficiently successful, the IEA recommends the introduction of mandatory fuel efficiency standards for new cars and small trucks.

The government is planning a new efficiency strategy, running to 2020. Focusing on the long term is well-founded, because of the long service life of many energy-related products, such as cars and appliances, let alone factories, power plants and buildings. To ensure compatibility with the climate strategy, the role of energy efficiency in reaching Switzerland's climate policy targets should be clearly defined and quantified. Part of the long-term efforts should also be harmonising energy efficiency policies across cantons. To improve energy efficiency at a lower cost, the government should also closely follow international developments and look for ways to increase compatibility of measures with other countries, especially those of the EU, Switzerland's main trading partner.

RECOMMENDATIONS

The government of Switzerland should:

- *Continue efforts to harmonise and strengthen minimum energy performance requirements for new and renovated buildings, such as by adopting those of Minergie.*
- *Stimulate energy retrofits in the refurbishment of buildings by reducing barriers to investment; to this effect, consider revising taxation and, possibly in the longer term, further adjusting rent rules.*
- *Stimulate the development of new energy efficiency services and financing solutions, such as energy services contracting.*
- *Introduce stronger measures in the transport sector, such as vehicle taxes based on fuel efficiency or mandatory fuel efficiency standards for new cars.*
- *Continue to harmonise energy efficiency policies and measures with other countries, especially those of the EU.*

PRODUCTION

TOTAL PRIMARY ENERGY SUPPLY

Renewable energy makes up around 15% of total primary energy supply (TPES) in Switzerland (see Table 8). Most of this is hydropower, followed by biomass. Growth in renewables supply has averaged 1.5% per year since 1990 and has been concentrated in biomass, geothermal (heat pumps), solar thermal and photovoltaics (PV). Hydropower has mostly remained flat.

ELECTRICITY

Renewables make up more than half of electricity production in Switzerland (see Table 9). More than 96% of this is hydropower. The rest comes mostly from biomass, and a negligible amount from geothermal (heat pumps), solar PV and wind. Since 1990, hydropower generation has increased only slightly, though with strong annual fluctuations. Average annual growth rate for biomass is more than 6% and for solar PV, more than 20%. Since 2000, wind generation has been increasing at an annual rate of nearly 20%. Nevertheless, the overall share of renewables in electricity generation has declined since 1990 and since 2000.

BIOFUELS IN TRANSPORT

Biofuels account for a negligible share of total transport fuels in Switzerland. They entered the market in 2004, and now make up just over 0.1% by energy content of total transport fuels, with almost 95% coming from biodiesel.

INSTITUTIONS

The SFOE is the primary federal office responsible for managing renewables policy. SwissEnergy manages implementation of most federal renewables policies. The cantons are free to set more rigorous renewables policies, and they also have additional programmes.

Table 8

Renewables Supply, 1970 to 2006*

Units: ktoe	*Hydro-power*	*Bio-mass***	*Geo-thermal*	*Solar thermal*	*Solar PV*	*Wind*	*All renewables*	*TPES*	*Renewables in TPES*
1970	2 658	241	0	0	0.0	0.0	2 900	16 481	17.6%
1980	2 821	472	0	0	0.0	0.0	3 293	20 861	15.8%
1990	2 562	614	61	8	0.1	0.0	3 245	24 992	13.0%
1995	3 025	768	78	15	0.4	0.0	3 886	24 989	15.6%
1996	2 472	783	86	17	0.5	0.1	3 359	25 461	13.2%
1997	2 928	745	82	19	0.7	0.2	3 774	26 057	14.5%
1998	2 879	801	88	20	0.7	0.3	3 789	26 415	14.3%
1999	3 440	754	91	22	0.8	0.3	4 308	26 390	16.3%
2000	3 168	779	91	23	0.9	0.3	4 062	26 159	15.5%
2001	3 552	823	107	25	1.0	0.3	4 509	27 676	16.3%
2002	3 028	814	109	22	1.2	0.4	3 976	26 774	14.8%
2003	2 994	889	119	23	1.5	0.4	4 027	26 870	15.0%
2004	2 902	1 038	124	24	1.5	0.5	4 090	27 134	15.1%
2005	2 685	1 216	137	25	1.6	0.7	4 066	27 153	15.0%
2006	2 663	1 267	151	26	1.6	0.7	4 109	28 334	14.5%
Share of TPES in 2006	9.4%	4.5%	0.5%	0.1%	0.0%	0.0%	14.5%	100.0%	N.A.
Share of renewables in 2006	64.8%	30.8%	3.7%	0.6%	0.0%	0.0%	100.0%	N.A.	N.A.
Annual growth rate (1990-2006)	0.2%	4.6%	5.8%	8.1%	20.2%	N.A.	1.5%	0.8%	0.7%
Annual growth rate (2000-2006)	–2.9%	8.4%	8.8%	1.9%	9.5%	17.8%	0.2%	1.3%	–1.1%

* estimated. ** excludes industrial and non-renewable municipal waste.
Source: *Energy Balances of OECD Countries*, IEA/OECD Paris, 2007.

Table 9

Electricity Generation from Renewables, 1970 to 2006*

Units: ktoe	*Hydro-power*	*Biomass***	*Solar PV*	*Wind*	*All renewables*	*Total electricity*	*Share of renewables in total electricity*	*Share of renewables (excluding hydro) in total electricity*
1970	30 910	0	0.0	0.0	30 910	34 776	88.9%	0.0%
1980	32 805	173	0.0	0.0	32 978	48 175	68.5%	0.4%
1990	29 795	438	1.0	0.0	30 234	54 988	55.0%	0.8%
1995	35 169	575	5.0	0.0	35 749	62 249	57.4%	0.9%
1996	28 745	616	6.0	1.0	29 368	56 252	52.2%	1.1%
1997	34 043	676	8.0	2.0	34 729	61 997	56.0%	1.1%
1998	33 471	698	8.0	3.0	34 180	62 307	54.9%	1.1%
1999	40 004	759	9.0	3.0	40 775	68 676	59.4%	1.1%
2000	36 834	842	11.0	3.0	37 690	66 126	57.0%	1.3%
2001	41 308	879	12.0	4.0	42 203	71 060	59.4%	1.3%
2002	35 214	918	14.0	5.0	36 151	65 475	55.2%	1.4%
2003	34 819	947	17.0	5.0	35 788	65 403	54.7%	1.5%
2004	33 748	983	17.0	6.0	34 754	63 876	54.4%	1.6%
2005	31 226	1 023	19.0	8.0	32 276	57 752	55.9%	1.8%
2006	30 960	1 127	19.0	8.0	32 114	62 286	51.6%	1.9%
Share of total electricity in 2006	49.7%	1.8%	0.0%	0.0%	51.6%	100.0%	N.A.	N.A.
Share of renewables in electricity in 2006	96.4%	3.5%	0.1%	0.0%	100.0%	N.A.	N.A.	N.A.
Annual growth rate (1990-2006)	0.2%	6.1%	20.2%	N.A.	0.4%	0.8%	–0.4%	5.4%
Annual growth rate (2000-2006)	–2.9%	5.0%	9.5%	17.8%	–2.6%	–1.0%	–1.7%	6.2%

* estimated. ** excludes industrial and non-renewable municipal waste.
Source: *Energy Balances of OECD Countries*, IEA/OECD Paris, 2007.

POLICIES AND MEASURES

The SwissEnergy programme has two indicative targets for renewables, namely to increase the share of non-hydro renewables in electricity generation from 1.3% in 2000 to 2.3% in 2010 (a 500 GWh increase), and to increase the share of heat generated from renewables by three percentage points, equivalent to an increase of 3 TWh. (The production of electricity from hydropower is to be maintained at the level recorded in 2000.) The country is on track to meet these targets. By 2006, 62.8% of the ten-year electricity target and 65.3% of the ten-year heat target had been met.

The government is in the process of setting a target for renewable transport fuels. Biogas penetration is increasing owing to a voluntary industry initiative to mix up to 10% of biogas in compressed natural gas.

ELECTRICITY

The current promotion mechanism for renewables in electricity generation is a federal minimum feed-in tariff of CHF 0.15 per kWh for independent producers of new renewables and small hydro. Cantons are free to offer more generous feed-in tariffs, which both Basel City and Geneva have done.

As from 1 October 2008, a new feed-in tariff scheme will take effect, which will apply only to installations built or enlarged after 1 January 2006 (older installations will continue to receive the previous tariff of CHF 0.15 per kWh). The subsidies are funded through a grid levy; total subsidies will be capped so that the levy shall not exceed CHF 0.006 per kWh. Under a complicated system, the tariff rates vary by type and size of installation, with various add-ons for installations with particular characteristics (see Table 10). This new tariff system is designed to attain the long-term (2030) target of adding 5.4 TWh of renewable electricity (10% of current consumption), of which at least 2 TWh will originate from large hydropower plants. This target is set in the new Law on Electricity Supply.

Caps have been instituted to prevent any single renewable energy technology from draining a disproportionate and economically ineffective share of total subsidies. Thus, hydro may not absorb more than 50% of total subsidies; PV may not absorb more than 5% as long as the cost per kWh above market price (*i.e.* the feed-in tariff) exceeds CHF 0.50 per kWh. If the feed-in tariff decreases to CHF 0.40-0.50 per kWh, PV may absorb 10% of subsidies; if the feed-in tariff decreases to CHF 0.30-0.40 per kWh, it may absorb 20%. Technologies requiring less than CHF 0.30 per kWh (including PV when its feed-in tariffs have fallen below that level) may each capture up to 30% of subsidies. Energy efficiency tenders may absorb at most 5% of subsidies.

Table 10

Feed-in Tariffs by Technology, as from 1 October 2008*

Technology	*Tariff for installations built since 2006 (Swiss cents/kWh)*	*Years of guaranteed payments*	*Yearly degression rate*
Small hydropower (<10 MW)	5-28 + various technology bonuses, but max. 35	25	0%
Photovoltaics	46-98	20	5%
Wind energy	23-31 during initial five years	20	0.5% or more depending on production
Geothermal	15-28 + risk guarantee for 50% of DHM drilling cost	20	0.5% as from 2018
Biomass (waste incineration)	10-17	20	0%
Biomass (sludge incineration)	10-17	20	0%
Biomass (sewage and landfill gas)	20-30	20	1%
Biomass (other)	15-24 plus bonus, incl. for CHP, max. 39	20	0%

*tariffs as proposed by the federal government, subject to a public consultation until 15 October 2007.
Source: Country submission.

Switzerland also promotes renewable electricity through branding. Since the beginning of 2006, all electricity bills must disclose the source of the electricity, in order to facilitate customer choice and encourage customers to select more renewable energy mixes. One particularly stringent renewables label is "naturemade", which is given to electricity mixes that are certified by an independent association as having 100% renewable power. There are two classes of naturemade labels, corresponding to certain quality and environmental criteria.

Of the country's 900 electricity distribution companies, 390 market green electricity. Some 502 000 household and commercial customers, 13% of the total number, have subscribed to such offers (see Table 11). In 2006, 2.82 TWh (5% of total consumption) were marketed as green electricity. Moreover, a substantial part of Swiss electricity exports are marketed as green electricity. As shown in Figure 9, sales of green electricity soared 13-fold in 2003, mainly because the public utility of the canton of Geneva entered the market by supplying green electricity as the default option. Another boost occurred in the second half of 2006, as the Zurich and Bern utilities began offering green electricity by default. About 6% of green electricity is sold under the more stringent "naturemade star" label.

Table 11

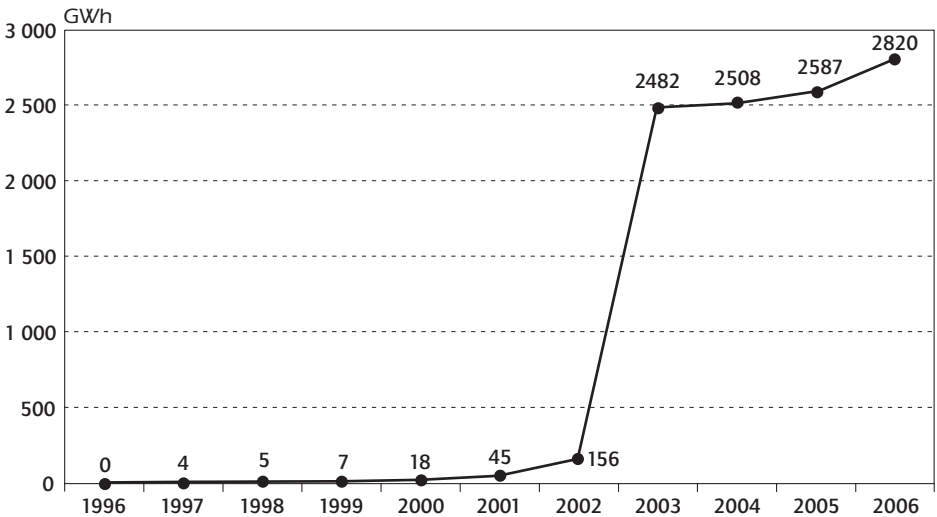
Green Electricity Sales by Mode of Production, 2006

	Utilities offering green electricity	*Subscribing customers*	*Subscribing sold GWh*
Solar	187	31 700	7.7
Wind	49	2 600	6.6
Hydropower	350	255 600	2 516.7
Mixed products	275	212 300	288.8
Total		**502 000**	**2 819.8**
Including naturemade star label			214

Source: Country submission.

Figure 9

Green Electricity Sales, 1996 to 2006



Source: Country submission.

TRANSPORT

The government is using tax policy to increase the use of transport biofuels. Specifically, biofuels in transport will be exempt from the excise tax on motor fuels. Additional measures are being pondered, including possibly a target, which will be higher than the country's limited biofuels production potential

(estimated at some 2%). Consequently, Switzerland will have to rely on imports. The federal government is currently elaborating regulations to ensure that such imports are from environmentally and socially sustainable sources.

OTHER PROJECTS

One major project is the now suspended deep heat mining project in Basel. Initial financing of CHF 50 million (mainly by the Basel authorities) has been secured. A first exploratory well found sufficient heat flow at some 5 000 metres depth in 2006 and started water injection to fracture the rocks, but in December 2006, the region was shaken by seismic tremors with a magnitude of 3.3 and the project had to be suspended in order to investigate the seismic risk. The project foresees a CHP plant with a capacity of 3 MW_e and 20 MW_{th} is to be built at an additional cost of CHF 50 million.

Sales of heat pumps showed robust annual growth rates of 10-15% between 2000 and 2004 in spite of flagging heating oil prices over the same period. Soaring oil prices boosted heat-pump sales by 21% in 2005 (almost 12 000 units sold compared to 17 300 oil and 17 000 gas furnaces). The market share of small heat pumps (<20 kW) for new single-family homes grew from 39% in 2000 to over 50% in 2005. Growth rates of large heat pumps (>50 kW) were also impressive, rising by 9%. Despite the significant sales, only 17-27% of heat pump purchases during recent years were for replacement of existing oil or gas heating systems. The government estimates that there are 800 000 oil and 200 000 gas heating systems in place, and has identified the refurbishment market as an area of focus.

CRITIQUE

Switzerland already relies to a large extent on traditional renewables for its energy mix. Large hydropower plants contribute some 53% to 58% of electricity. The government is now turning its focus towards increasing the share of new renewables (excluding hydropower) in the energy mix, as these sources contribute only some 5% of TPES and 2% of electricity, with combustible renewables providing the major share. The IEA is pleased to see the government undertaking renewed efforts in this area. In particular, making the source of electricity more transparent to customers has helped spur development of green electricity.

The government has set a modest non-binding goal for the growth of electricity produced from new renewables through 2010, and is on track to meet it. In order to rekindle the promotion of renewables, a more ambitious, legally-binding target was set in the new Law on Electricity Supply and underpinned by a new promotion policy. The IEA encourages the government

to monitor the progress, strengthening policies in a cost-effective manner, if necessary.

The current promotion mechanism for renewables in electricity generation is a federal minimum feed-in tariff of CHF 0.15 per kWh for independent producers of new renewables and small hydro. Through new legislation, feed-in tariffs for renewables will significantly increase from 1 October 2008. The enhanced feed-in tariffs will go a long way towards increasing the share of renewables in TPES: they are very generous, particularly to PVs, and guaranteed for at least 20 years. While it is understandable that the government seeks to spur the development of non-hydro renewables, there is a trade-off between diversity of supply sources and cost-effectiveness of the programme. Subsidising high-cost renewables limits funding available for more cost-effective renewable energy technologies, but it also limits funds that could go to efficiency investments, which are usually by far the most cost-effective means of reducing CO_2 emissions.

Furthermore, the complicated tariff structure may encourage developers to game the tariff system, rather than focus on building and operating the facilities as cheaply and efficiently as possible. It is, however, positive that the tariff scheme limits the total amount of subsidies available, in general, and the share of those subsidies available to high-cost technologies, in particular. It is also important that the high-cost subsidies decline over time according to a transparent and firm schedule.

The IEA also encourages the government to include as much flexibility as possible in the support mechanisms. For example, as a small country with access to electricity imports from its many neighbours, the government should work to make the mechanisms more compatible with those of the neighbouring countries. This would enhance the effectiveness of the support mechanisms.

Furthermore, the IEA urges the government to consider moving from the rigidity of the administrative feed-in tariff scheme to one that allows market signals to penetrate. For example, the feed-in tariff system could be modified over time to be closer to a premium system, where a fixed add-on is provided to renewable electricity suppliers in addition to the regular electricity price. This would provide long-term downward pressure on prices, but still provide some revenue guarantees to underpin investment. The government might also consider implementing a quota system, particularly after a few years, when the investor certainty has provided a solid basis for renewables supply. Such a system would make the rate paid to renewables suppliers fully dependent on market conditions. This would also allow the system to integrate not only among cantons, but also with the neighbouring European market, helping bring down the cost of renewables by allowing it to rely on imports,

particularly as it is not ideally situated for certain technologies (*e.g.* wind and solar PV).

To date, penetration of biofuels for transport has been negligible. A preferential tax policy is being implemented to drive the uptake of biofuels for transport. The government should monitor progress towards this target. If preferential tax treatment is not successful, the government should consider sales obligations and other more flexible policies. The government should also work to avoid trade barriers on biofuels for transport as much as possible, as this will lower the cost of incorporating biofuels into the system.

RECOMMENDATIONS

The government of Switzerland should:

- *Enhance the cost-effectiveness of the feed-in tariff.*
- *Design the feed-in tariff for renewable electricity production to be as flexible as possible; over the long term, consider implementing a system that provides a fixed premium as opposed to a guaranteed rate or a quota obligation.*
- *Avoid trade barriers on biofuels imports for transport.*

OIL

SUPPLY AND DEMAND

Supply

Oil continues to be the largest energy source in Switzerland. In 2006, total oil supplies were 13.1 Mtoe, providing 47% of TPES. All oil is imported. In 2004-2006, 56% to 61% of the annual imports were crude oil for Switzerland's two refineries; the remainder was oil products.

Crude oil is imported mostly from OPEC-Africa. In 2006, total imports were 5.5 Mt. The sources were Libya (49%); Nigeria (28%); the former Soviet Union (14%); Algeria (3%); and Angola, Saudi Arabia, Norway and Kuwait (6% in total). OPEC countries contributed 85% of the imports. Crude oil enters Switzerland through pipelines from Italy and France.

Oil products are imported entirely from EU countries. In 2006, total imports were 7.7 Mt. These came from Germany (42%), the Netherlands (22%), Italy (13%), Belgium (12%) and France (10%). Imports come through diverse routes (see Table 12). Switzerland also exports small amounts of oil products, all to EU countries. In 2006, the exports totalled 0.5 Mt; 87% of which was fuel oil.

Table 12

Distribution of Oil Imports by Mode of Transport, 2005

Mode	*Share of total imports, %*
Rhine barges	27.1
Railways	23.8
Road trucks	7.3
Pipelines total	41.8
Incl. Oléoduc du Rhône (Genoa to Collombey refinery)	*16.9*
Incl. Oléoduc du Jura Neuchâtelois (France to Cressier refinery)	*19.9*
Incl. SAPPRO oil products pipeline from France to Geneva*	*5.0*

* SAPPRO *(Société anonyme du pipeline à produits pétroliers sur territoire genevois)* is owned by ten major oil companies active in Switzerland.

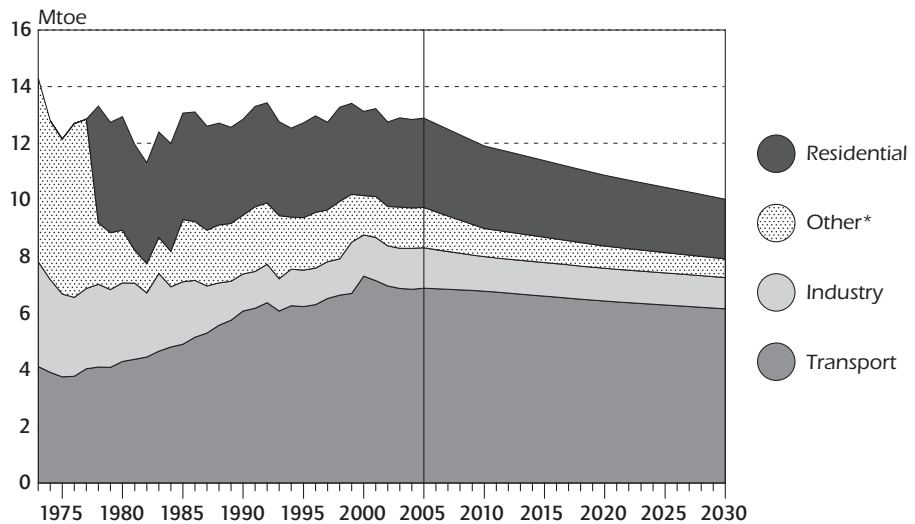
Source: Country submission.

Demand

In 2005, oil accounted for 57% of TFC in Switzerland. At 12.9 Mtoe, oil demand remained practically at the 1990 level. Most oil is used in the transport sector (53.5% of the total). Characteristic to the Swiss oil market is the large use of oil for space heating in the residential sector (24.5% of oil TFC). In recent decades, increased demand from the transport sector has been offset by decreases in use for heating and industrial processes. Within transport fuels, diesel is gaining in popularity. Its share of total transport fuels rose from 23.2% in 1990 to 32.3% in 2005, and the share of diesel cars of all new car registrations increased from 10% in 2000 to 30% in 2006. In heating, oil is steadily losing market share to biomass, natural gas and heat pumps. The government projects total oil consumption to fall by almost one-quarter from 2005 to 2030. In the short term, it expects the CO_2 tax to reduce heating oil use by 2010, and a fuel tax reform to strengthen the use of biofuels and natural gas. In the long term, big improvements are expected through higher energy efficiency (see Figure 10).

Figure 10

Final Consumption of Oil by Sector, 1973 to 2030



* includes commercial, public service, agricultural, fishing and other non-specified sectors.
Sources: *Energy Balances of OECD Countries*, IEA/OECD Paris, 2007 and country submission.

INDUSTRY STRUCTURE

Refineries

Switzerland has two refineries, namely the Collombey refinery (in the canton of Valais), which has an annual capacity of 2.5 Mt, and the Cressier refinery

(in the canton of Neuchâtel), which has an annual capacity of 3.3 Mt. Both refineries are linked to the European pipeline system. In 2006, their combined output was 5.5 Mt, which covered 42% of domestic oil product demand.

Collombey is owned by Tamoil, which, in turn, is majority-owned by Colony Capital, a US investment company, and, through a 35% stake, by the state of Libya. Cressier is owned by Petroplus, a holding company listed on the Swiss stock exchange.

Retail market

The Swiss oil retail market is fully open to competition. The market is dominated by BP, Esso, Shell and Tamoil, which together accounted for more than 70% of retail sales in 2005. At the beginning of 2007, Switzerland had 3 465 filling stations, operated by 19 different companies; 200 stations were also selling biodiesel. The five biggest networks were those of Avia (699 stations), Shell (437), Agrola (410), BP (402) and Tamoil (331), accounting for 66% of the total.

PRICES AND TAXES

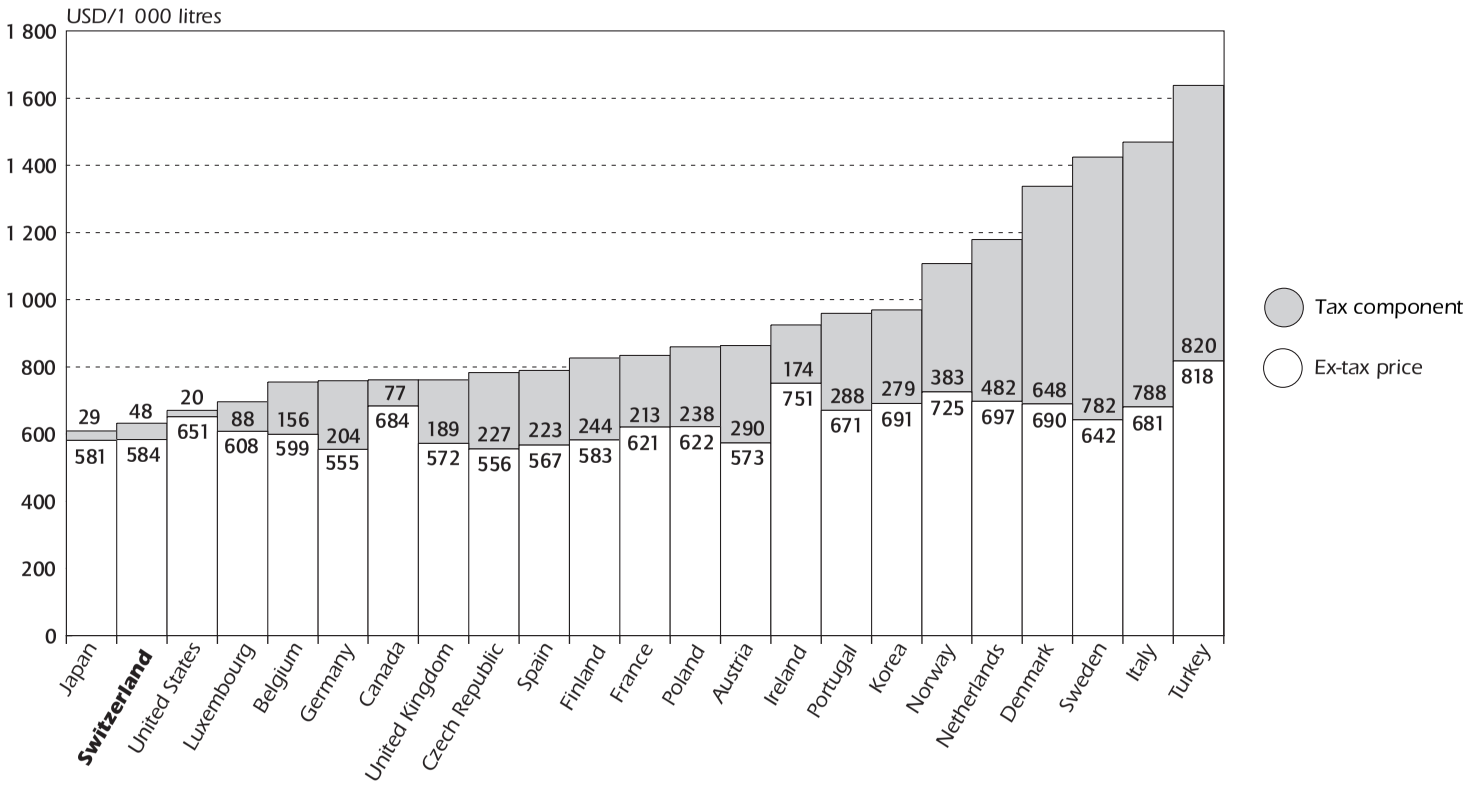
Heating oil is inexpensive in Switzerland. In the second quarter of 2007, it was the cheapest after Japan in a comparison of 23 OECD countries (see Figure 11). Taxes were 7.6% of the retail price, third-lowest in the OECD comparison. The CO_2 tax, which comes into force on 1 January 2008 and amounts to CHF 12 per t CO_2, will raise heating oil prices by roughly CHF 0.03 per litre, equal to about 5% of the retail price in early 2007.

Gasoline prices, too, are relatively low (see Figure 12). In the first quarter of 2007, gasoline cost 19.4% less than in France, 20.9% less than in Italy and 23.5% less than in Germany. This is explained by differences in tax rates. In Switzerland, taxes accounted for 54.4% of the retail price, whereas in Italy the share was 63.1%, in France 66.9% and in Germany 68.1%. Low prices in Switzerland lead to fuel tourism from these neighbouring countries. The government estimates that annual sales to foreigners account for about 10% of domestic consumption.

Diesel costs more than gasoline in only five OECD countries. In Switzerland, the price difference between the two is the highest: 8.6% in the first quarter of 2007. This is mostly explained by excise taxes, which are CHF 0.731 per litre on gasoline and CHF 0.759 per litre on diesel. The government has set the excise tax on diesel higher to internalise the external costs from air pollution caused by diesel engines. In recent years, improvements in diesel technology have produced cleaner and more fuel-efficient cars. This and the concerns over climate change have motivated the government to change its policy. The fuel tax reform is expected to come into force on 1 January 2008.

Figure 11

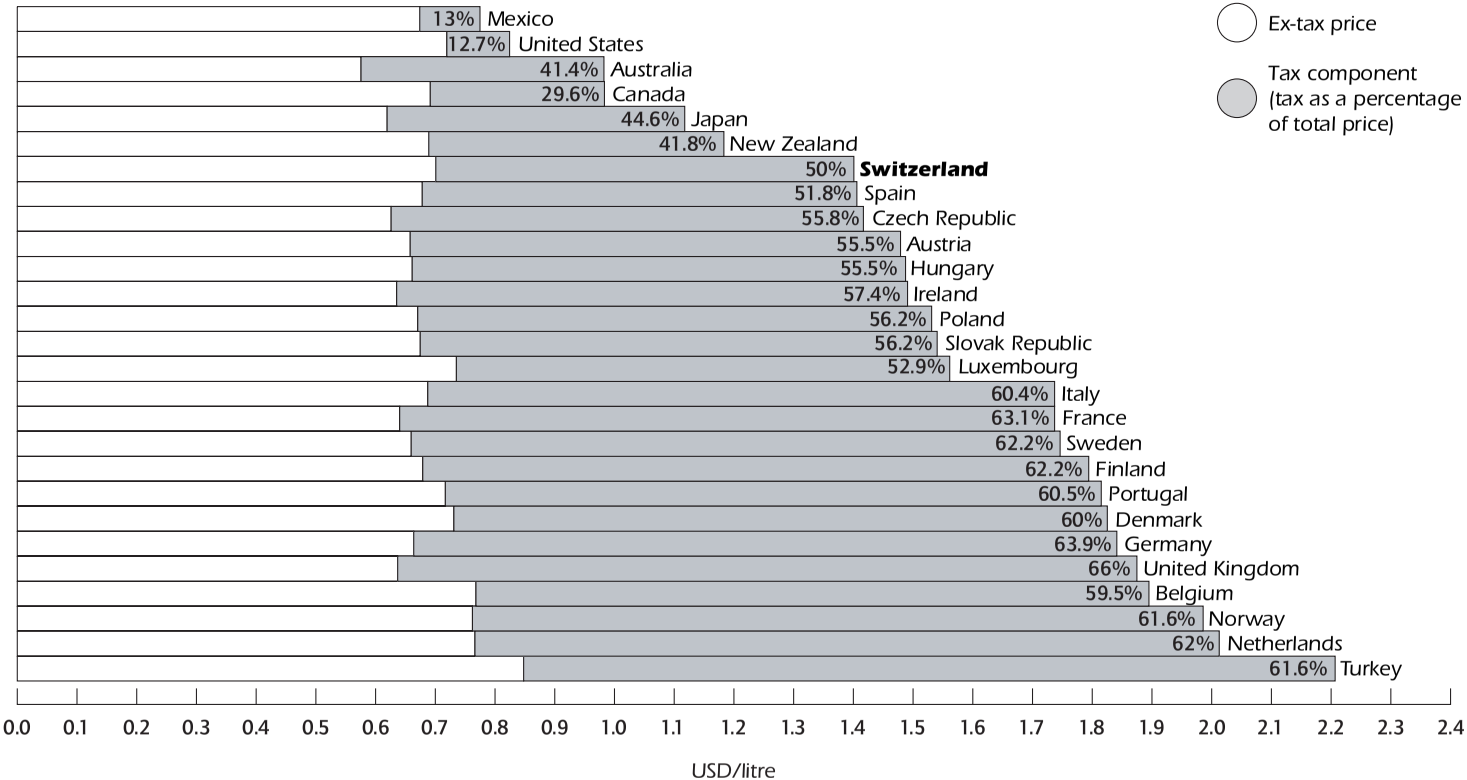
OECD Light Fuel Oil Prices and Taxes, Second Quarter 2007



Note: data not available for Australia, Greece, Hungary, Mexico, New Zealand and the Slovak Republic.
Source: *Energy Prices and Taxes*, IEA/OECD Paris, 2007.

Figure 12

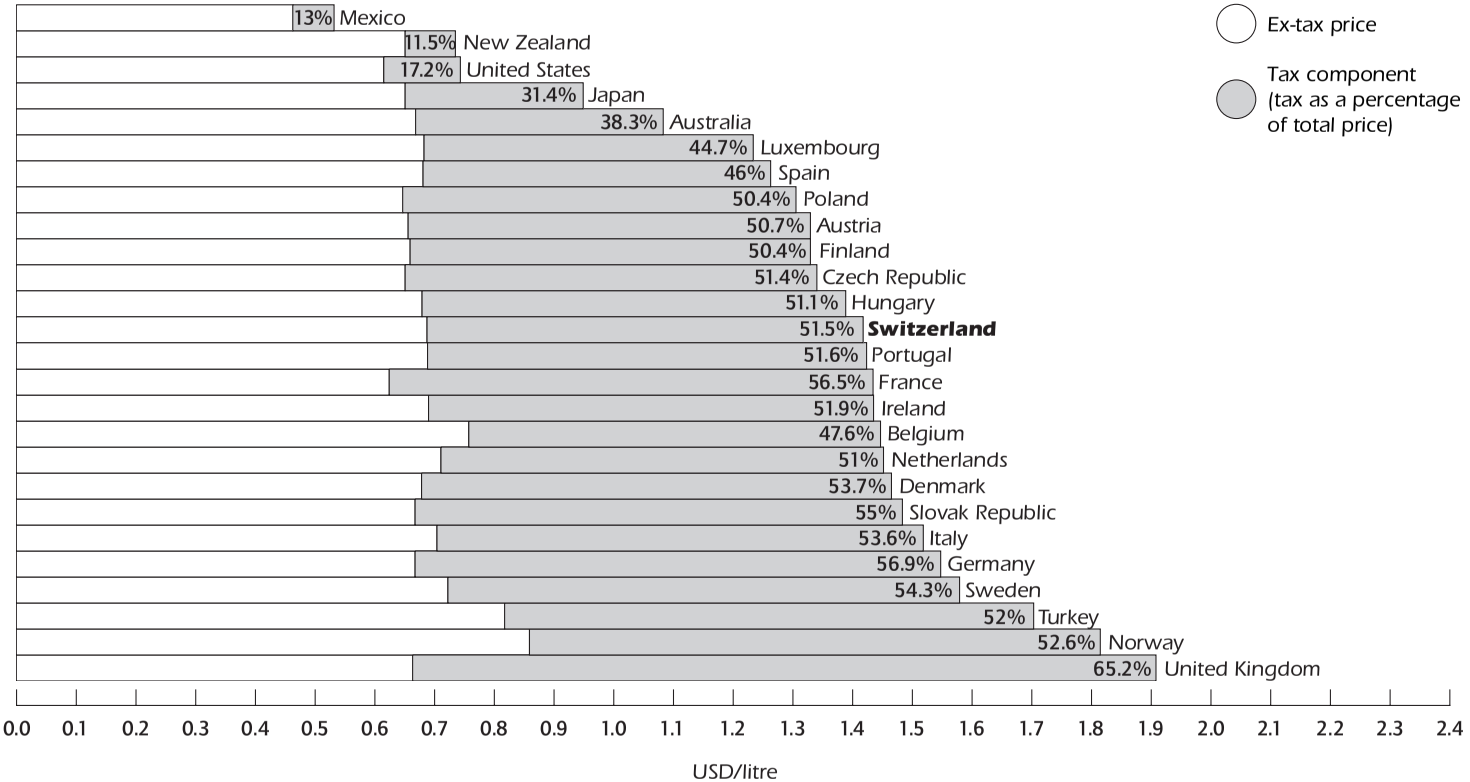
OECD Unleaded Gasoline Prices and Taxes, Second Quarter 2007



Note: data not available for Greece and Korea.
Source: *Energy Prices and Taxes*, IEA/OECD Paris, 2007.

Figure 13

OECD Automotive Diesel Prices and Taxes, Second Quarter 2007



Note: data not available for Canada, Greece and Korea.
Source: *Energy Prices and Taxes*, IEA/OECD Paris, 2007.

EMERGENCY RESPONSE SYSTEM

Companies importing more than 3 000 m^3 of oil per year are obliged to apply for an import licence. For the licence, the importer must sign a contract with the Federal Office for National Economic Supply (FONES) to hold a quantity of stocks in relation to its domestic market share. Although compulsory stocks remain in the ownership of the importer, they are controlled by the Swiss authorities, who can dispose of them, if necessary.

The minimum levels of compulsory stocks are set by a directive of the Federal Department of Economic Affairs. The levels are product-specific and stated in months of average imports of the previous three years. The current levels are four-and-a-half months for motor gasoline, diesel and heating oil, and three months for jet fuel. Swiss compulsory stock policy provides to cover more than the 90-day net imports required under Article 2 of the IEP Agreement.

During the IEA Collective Response Action to the 2005 Katrina and Rita hurricanes, Switzerland was able to make oil available to the market without lowering compulsory stock levels below 90 days. However, as there was no domestic demand for additional oil products, stocks were not released to the market. During the IEA Emergency Response Review of Switzerland, in September 2006, the review team recommended that during an international supply disruption, Switzerland should make domestic stocks available to the market by lowering compulsory stockholding levels and urging companies to use compulsory stocks, instead of using shipments scheduled for delivery into Switzerland. In this way, Switzerland could improve the supply of oil on the global market and contribute directly to an IEA collective response action.

NATURAL GAS

SUPPLY AND DEMAND

All natural gas used in Switzerland is imported. In 2006, the imports amounted to 2.8 Mtoe, providing 10% of TPES. In 2005, the latest year for which country data are available, the imports came from Germany (51% of the total), the Netherlands (22%), Russia (11%), France (11%) and Italy (5%)[6].

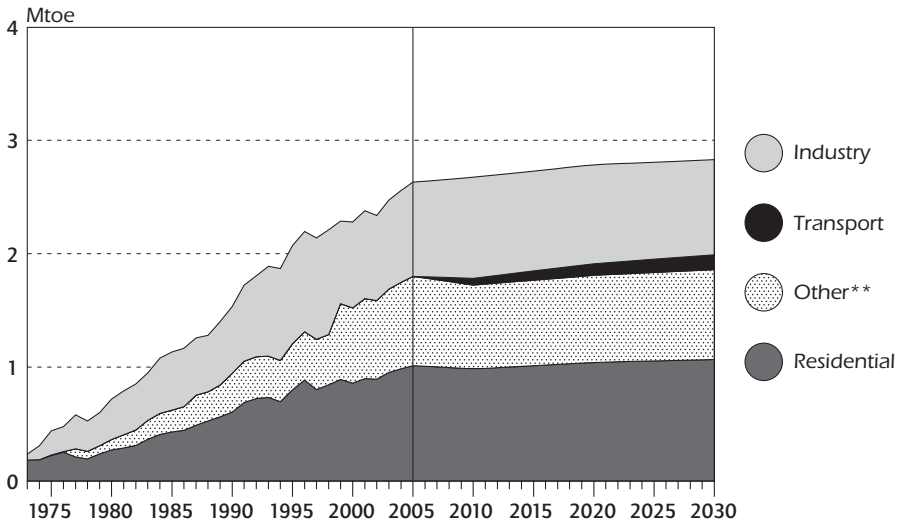
From 1990 to 2005, end-use of natural gas increased by 71%, from 1.5 Mtoe to a record of 2.6 Mtoe. At the same time, its share of TFC grew from 8% to 12%. In 2005, the largest user was the residential sector (39% of the total), followed by industry (31%), services (25%) and other sectors (5%). Reflecting the use for heating purposes, natural gas consumption is strongly concentrated in winter months. In 2003-2005, 72% of the total was consumed in October-March.

6. The figures refer to contractual, not physical volumes.

In the projections until 2030, the government expects gas demand to grow by some 7%, assuming no gas-fired power generation capacity is built (see Figure 14). The CO_2 tax on heating and process fuels, in place from 1 January 2008, would prompt investments in carbon-free technologies in residential heating. As a result of the fuel tax reform, use in transport would increase, though from a near-zero level. Owing to the small size of the Swiss gas market, constructing gas-fired power plants would change the demand outlook substantially.

Figure 14

Final Consumption of Natural Gas by Sector, 1973 to 2030*



* excluding possible future use for power generation in new installations.

** includes commercial, public service, agricultural, fishing and other non-specified sectors.

Sources: *Energy Balances of OECD Countries*, IEA/OECD Paris, 2007 and country submission.

LEGAL FRAMEWORK

Switzerland's gas market is open to competition for the largest consumers that are directly connected to the high-pressure grid. Many of the institutions fundamental to a well-functioning market are still to be established and the legal base for market opening is thin. The gas market is partly regulated by the 1963 Pipeline Law. The law is complemented by the 2003 Branch Agreement of the gas industry, which is legally binding to its parties. Having recently succeeded in introducing legislation to open the electricity market, the government is now turning its attention back to the gas market.

Article 13 of the Pipeline Law allows for open third-party access (TPA) to the high-pressure grid, including cross-border transit. The law entrusts the SFOE with the responsibility for settling disputes over grid access and compensation for grid use. By summer 2007, no gas had been supplied on this basis on the Swiss market.

Following the rejection of electricity market liberalisation in the 2002 referendum, the government decided to shelve the plans to open the gas market and to focus on relaunching efforts to liberalise the electricity market. For several reasons, reforming the gas sector was not considered a matter of urgency. First, benefits to end-users from market opening were estimated lower than in the case of electricity, owing to smaller price differences with the neighbouring countries. Second, as a heating fuel, gas was already subject to competition from other energy sources. Third, under the Pipeline Law, TPA to the high-pressure grid already existed.

In 2003, anticipating the EU gas market liberalisation, the Swiss gas industry voluntarily agreed to standardise procedures for TPA to the regional high-pressure network. It also agreed to set rules for defining grid use tariffs and to establish a transmission co-ordinator for TPA (*Koordinationsstelle Durchleitung* – KSDL). Until summer 2007, only a few requests for TPA had been made and no gas had been supplied in the framework of the agreement.

Since the beginning of 2007, the gas industry is also following self-imposed rules for negotiated TPA to the distribution network. The rules concern calculating the grid fees to allow for non-discriminatory access to third parties. The grid fees must reflect costs and the utilities must separate the accounts for distribution activities from their other activities. The government is monitoring the effect of these voluntary agreements on the gas market.

Special regulations apply to the construction and operation of the high-pressure gas network. Ensuring that they are duly observed is the responsibility of the SFOE, the Federal Pipelines Inspectorate and the Federal Office for the Environment.

INDUSTRY STRUCTURE

Switzerland has approximately 100 gas utilities, which are akin to the electricity utilities, and are typically local monopolies owned by the cantons and municipalities. They are also often involved in other activities, such as supplying electricity, heat or water. The utilities vary greatly in size. In 2006, the seven biggest, those of the largest cities, sold half of the gas, whereas the 42 smallest utilities accounted for only 10% of the total sales.

Vertical integration in gas transmission and distribution is strong. For purchasing gas, the local monopolies, together with a few industrial customers, have set up four regional associations: Gasverbund Mittelland AG, Erdgas Ostschweiz AG, Gaznat SA and Erdgas Zentralschweiz AG (EGZ). Each association operates its

own high-pressure grid and supplies gas to its owners at cost. The associations, in turn, obtain most of the gas at cost through Swissgas AG, the gas industry's vehicle for imports (see Table 13). Except for EGZ, the associations also have direct imports contracts with foreign suppliers. In 2006, Swissgas supplied 80% of total imports, GVM 7.1%, EGO 5.8%, Gaznat 4.2%, AIL[7] 2.1% and others 0.8%.

Table 13

Shareholders of Swissgas, 2006

Shareholder	*Ownership, %*
Erdgas Ostschweiz AG, Zurich (EGO)	25.98
Gasverbund Mittelland AG, Arlesheim (GVM)	25.98
Gaznat SA, Lausanne/Vevey	25.98
Swiss Gas Association, Zurich	16.45
Erdgas Zentralschweiz AG, Lucerne (EGZ)	5.61

Source: Swissgas.

Apart from being the main Swiss gas company, Swissgas is also responsible for handling questions of common interest to the gas industry, such as supply and infrastructure, and representing the Swiss gas industry abroad. Swissgas operates its own high-pressure transmission grid and, through its stake in Transitgas AG, is involved in gas transit (see section below).

INFRASTRUCTURE

Switzerland's gas transmission and distribution network measures some 16 700 km. It includes 2 190 km of high-pressure grid (>5 bar). The length of the 1 to 5 bar grid is 3 164 km, while the <1 bar grid is 11 284 km. The grid area is home to 68% of Switzerland's population.

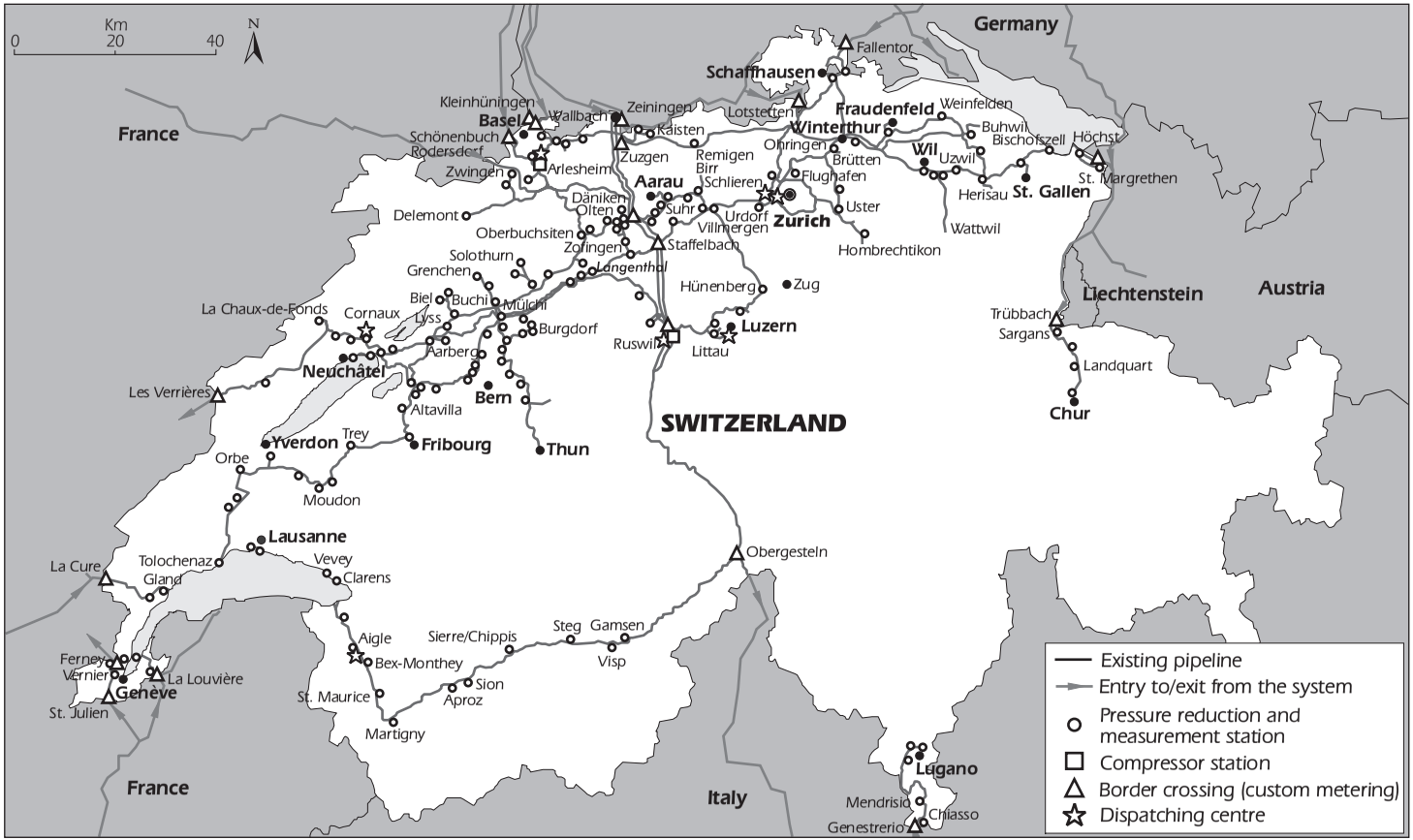
Switzerland has eleven cross-border feeding points into the European network. In 2006, nearly 85% of the gas supply came from or through Germany (*i.e.* gas from Germany, the Netherlands and Russia). On a company basis, E.On Ruhrgas supplied half of the gas consumed in Switzerland. The rest came from GDF, ENI and Gasunie.

Gas storage in Switzerland is limited to minor facilities of local significance that allow for daily balancing of the gas supply. Swiss companies, however, co-own and use storage in France. Security of gas supply is enhanced through interruptible contracts, which cover more than 40% of gas consumption.

7. AIL *(Azienda Industriale di Lugano)* imports gas from Italy to the Lugano area in the canton of Ticino.

Figure 15

Map of the Swiss Natural Gas System



The boundaries and names shown and the designations used on this map do not imply official endorsement or acceptance by the IEA.
Source: *Natural Gas Information* 2006, IEA/OECD Paris, 2007.

Consumers with dual- and multi-powered plants are obliged to hold compulsory heating oil stocks equalling 4.5 months' consumption. During a shortage (normally seasonal), households have priority, which leads the big industrial users to switch from gas to fuel oil.

Gas transit over Switzerland – from Germany and France to Italy – makes use of the Transitgas system. Crossing Switzerland from north to south, it is part of the high-pressure pipeline system connecting northern Europe to Italy. The annual transit volume amounts to some 16 billion m^3, more than four times the Swiss gas consumption.

The Transitgas system is operated by Transitgas AG, which is owned by Swissgas (51% of shares), ENI (46%) and E.On Ruhrgas (3%). The transport capacity of the system is owned by ENI (89% of the total) and Swissgas (11%). Since 2001, access to foreign suppliers is granted to the system. Free capacity is auctioned. Swissgas auctioned capacity for the gas year beginning on 1 October 2007 in May 2007. At the auction, it sold ten lots of 3 074 Nm^3 per hour each, equalling 0.27 billion m^3. ENI, too, held an auction in May, with prices ranging from EUR 3.0 to EUR 3.5 per MWh.

Anticipating growing demand for non-oil transport fuels, the Swiss gas industry is expanding its network of filling stations. At the end of 2006, there were more than 70 filling stations and natural gas was used in some 3 500 vehicles. By the end of 2007, the industry expects the number of filling stations to reach 100. Under an agreement between the gas industry and biogas producers, the filling stations are admixing biogas, in the volume of up to 10% of natural gas sales.

PRICES AND TAXES

Prices of gas imports are based on long-term contracts and linked to the price of oil. Prices paid by all utilities are practically the same, because they obtain the gas through Swissgas and the regional associations at cost. End-use prices, in turn, vary somewhat between utilities. This is largely explained by the local differences in the level of competition from other energy sources.

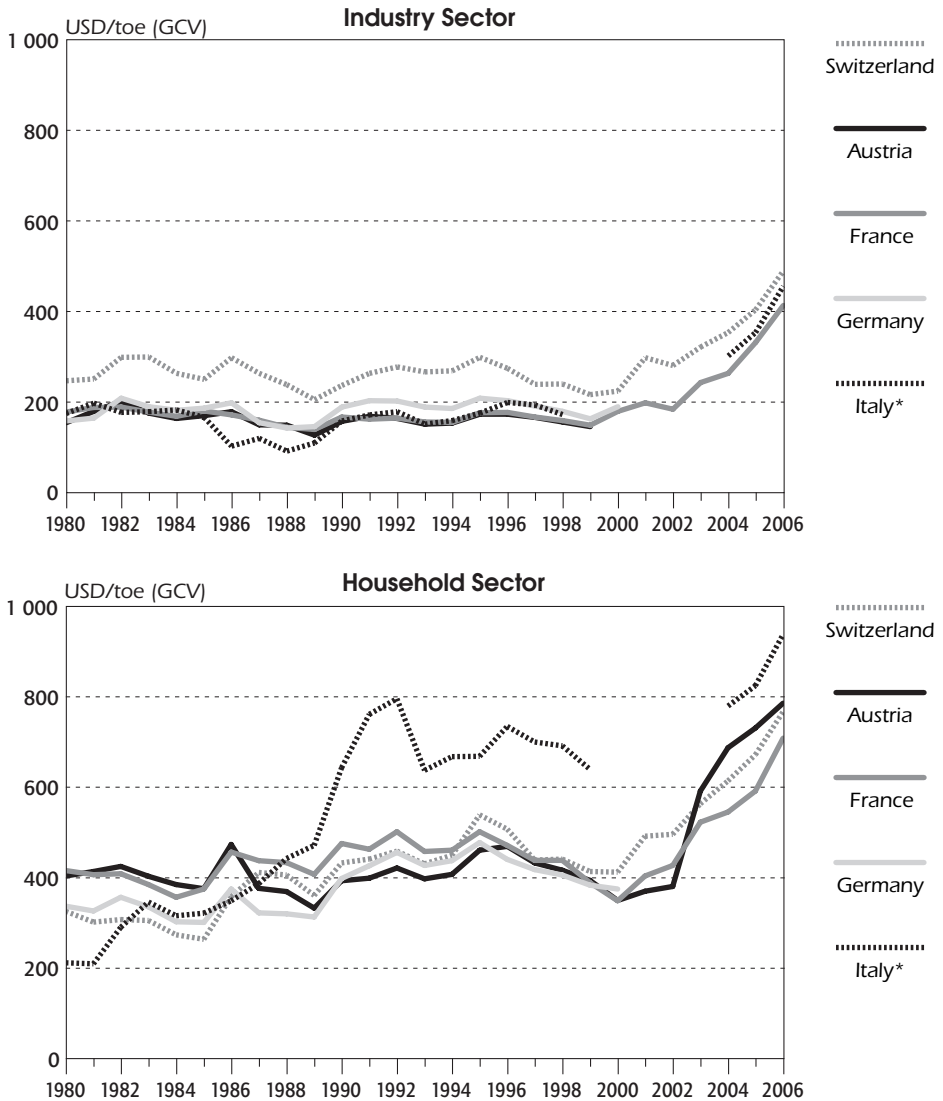
In addition to the 7.6% VAT, which is refundable to businesses, end-users are subject to an excise tax, and a special tax used for holding emergency stocks of light fuel oil. In 2006, the excise tax and the special tax equalled 0.7% of industry prices and 0.4% of household prices. From 1 January 2008, gas as a heating and process fuel will be levied a CO_2 tax of CHF 12 per t CO_2.

For the past several years, gas prices have been increasing, reflecting growing demand and the impact of rising oil prices (see Figure 16). By international comparison, prices in Switzerland are high for industry and slightly more than average for households (see Figure 17). This is mostly because transport

distances from sources are long, distribution companies tend to be small, and large consumers are few. In addition, the gas market is small, implying that the fixed costs of the gas infrastructure, already high in a mountainous country, are spread among fewer customers than in many other countries.

Figure 16

Gas Prices in Switzerland and in Other Selected IEA Countries, 1980 to 2006

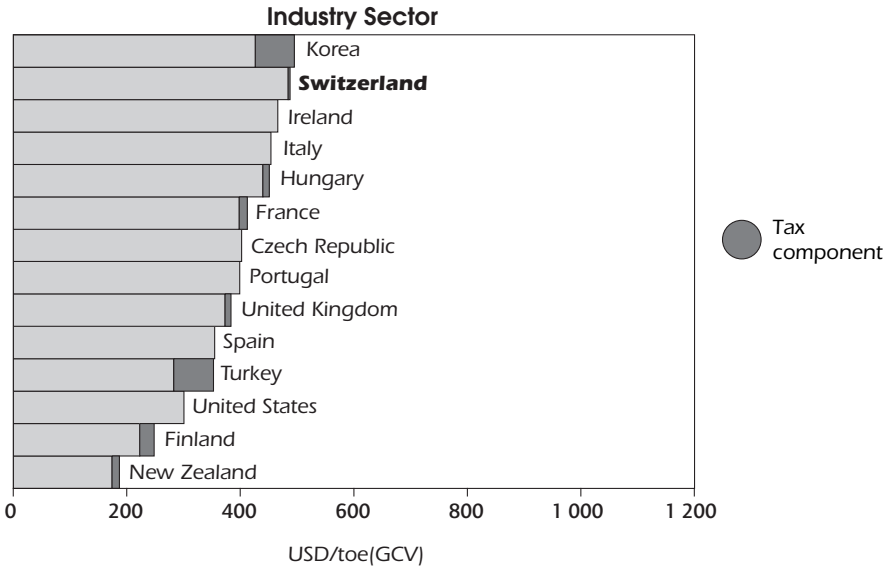


* data not available for Italy from 1999 to 2003 in the industry sector and from 2000 to 2003 in the household sector.

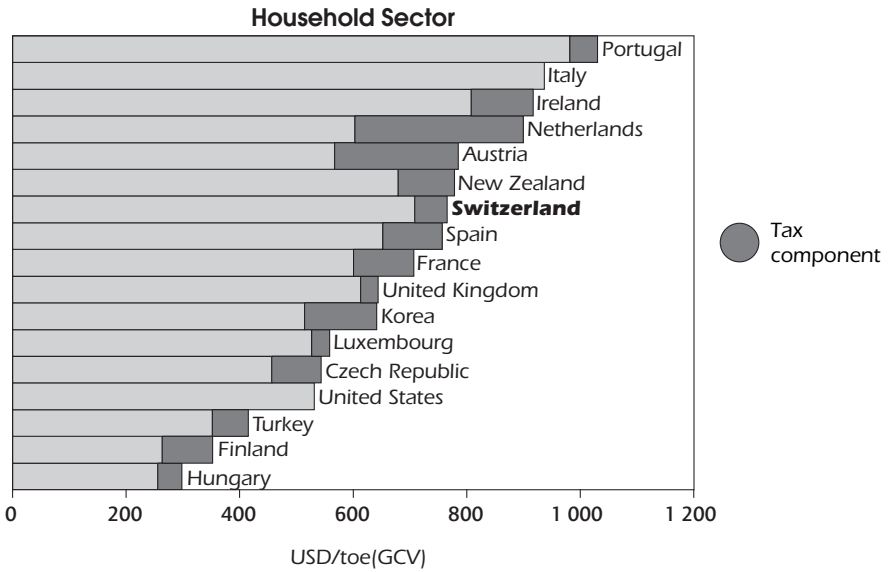
Source: *Energy Prices and Taxes*, IEA/OECD Paris, 2007.

Figure 17

Gas Prices in IEA Countries, 2006



Note: Tax information not available for the United States. Data not available for Australia, Austria, Belgium, Canada, Denmark, Germany, Greece, Japan, Luxembourg, the Netherlands, Norway and Sweden.



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

Source: *Energy Prices and Taxes*, IEA/OECD Paris, 2007.

COAL

Coal has little importance in Switzerland. All coal is imported and most of it is used in the cement industry. In 2006, coal consumption was 0.15 Mtoe, which accounted for 0.7% of TFC. Consumption is not expected to increase in the future.

CRITIQUE

OIL

Since the last in-depth review, Switzerland has continued to reduce its dependence on oil. In 2006, oil accounted for 47% of TPES, down from 50% in 2001. This is to be applauded, but more could be done. Oil remains the most important energy source in Switzerland and its share of TPES is still one of the highest among IEA countries. As all oil is imported, further reducing dependence on it would help both to secure energy supplies and to mitigate climate change.

Oil has long been the cheapest and the most popular energy source for space heating in Switzerland, owing to one of the lowest taxes in IEA countries. Gasoline taxes are also low by international comparison. As low prices tend to lead to inefficient use, Switzerland should consider raising fuel taxes as an option to increase fuel efficiency and reduce CO_2 emissions. The CO_2 tax is designed to work to this end, whereas the Climate Cent aims precisely in the opposite direction to divert the pressure away from curbing demand for transport fuels.

Oil use in the transport sector is the largest source of CO_2 emissions, and these emissions are growing. To address this issue, the government has plans to reform fuel taxation and raise gasoline taxes nearer to those on diesel. This is commendable, but it may not be enough. The government should consider further raising taxes on transport fuels or increasing the Climate Cent surcharge. Both can be done so as to minimise the impact on the income from fuel tourism. Gasoline prices in neighbouring France, Italy and Germany are so much higher than in Switzerland that taxes would have to be raised by some 40-50% to reach total price levels in those countries.

Switzerland has robust oil emergency legislation, measures and procedures. Its emergency reserves have consistently exceeded the level of 90 days' net imports required by the IEA. Import structures for both crude oil and oil products are geographically and logistically well diversified, which further enhances security of supply. The IEA finds this commendable.

Since the 2003 in-depth review, the government has focused its efforts for market reform on electricity. In the meanwhile, the gas industry has voluntarily moved to improve conditions for competition. Rules for TPA to the grid exist, but they have seldom been used, which implies lack of willingness or incentives to compete. The sector continues to be characterised by strong vertical integration, and supply is dominated by long-term contracts. Gas demand is rising, but the current framework does not encourage new entrants to the market.

The government knows that there is room for more work. To increase competition in the vertically integrated network businesses, an independent regulator and a transmission system operator are needed. After successfully introducing legislation to this effect in the electricity sector, it is encouraging that the government is now planning to move on to reform the gas sector.

The role for gas in solving Switzerland's electricity supply challenges remains open and depends, among other things, on the role of nuclear power and climate change policy. Producing 10 TWh of electricity from gas would increase total gas demand by more than 50%. Large investments would be needed in both the gas and electricity networks. By increasing incentives for timely investment in infrastructure, gas market reform would add to the flexibility required from the gas system to enable and accommodate such strong growth in demand.

Security of gas supply remains a key issue. As Switzerland's geology does not allow for large underground gas storage, the Swiss gas industry has for many years been using and co-owning storage in France. Interruptible contracts are the other main instrument of flexibility. Industry seems well protected against major supply disruptions, and the IEA commends Switzerland's policy to require interruptible consumers with dual- and multi-powered plants to hold large stocks of heating oil. Households, however, remain more vulnerable. To manage this risk, the government could consider increasing incentives for alternative heating systems.

The potential for strong growth in gas demand at home and Switzerland's role as a major transit country underline the importance of available cross-border capacity. As part of the European gas network, Switzerland should ensure that mechanisms to allocate cross-border capacity and procedures to manage congestion, including freely tradable capacity rights, are compatible with those of the neighbouring countries.

Gas is becoming an increasingly important energy source, and as all of it is imported, regulatory compatibility with the neighbouring countries would improve security of supply. At a time when gas supply in Europe is tight and European gas companies struggle to secure future supplies, a framework in

Switzerland similar to the EU rules could ease the conclusion of flexible spot and long-term contracts. The EU is also developing a common policy in case of a major supply disruption. Switzerland would do well to seek to increase co-ordination with the EU and neighbouring countries.

RECOMMENDATIONS

The government of Switzerland should:

Oil

- *Continue efforts to reduce dependence on oil, increase the efficiency of oil use and reduce CO_2 emissions from it.*
- *Monitor the effectiveness of the planned taxes on oil consumption and take stronger action, if needed.*

Natural Gas

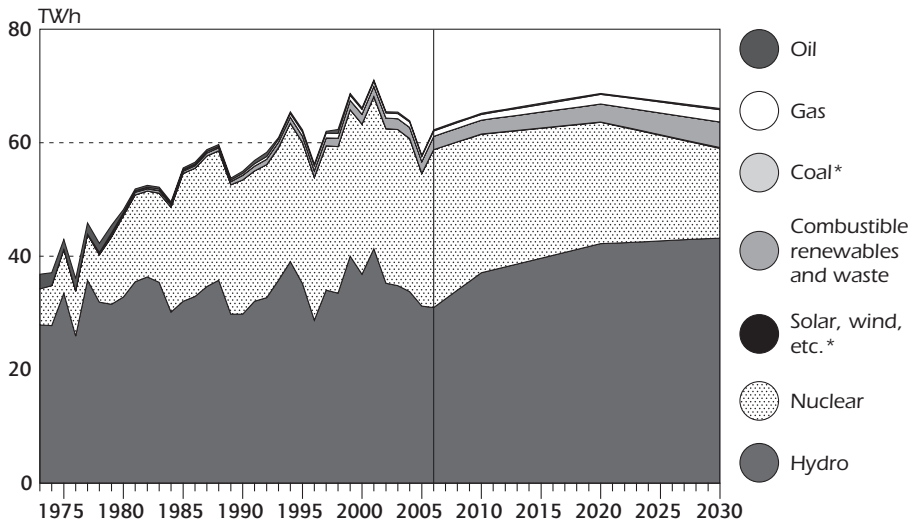
- *Reform the gas market to ensure long-term access to adequate supplies of gas, and give priority to establishing an independent regulator and an independent transmission system operator.*
- *Strengthen emergency response mechanisms, including in co-operation with the EU and the neighbouring countries, to protect end-users – especially households – from supply disruptions.*

SUPPLY AND DEMAND

Switzerland's electricity supply is dominated by hydro and nuclear power. Since 1990, hydro (53-60%) and nuclear power (37-45%) combined have accounted for 95-97% of the country's annual electricity generation. The rest is divided between biomass, waste, natural gas and oil (see Figure 18).

Figure 18

Electricity Generation by Source, 1973 to 2030



* negligible.

Sources: *Energy Balances of OECD Countries*, IEA/OECD Paris, 2007 and country submission.

From 1990 to 2006, electricity generation increased by roughly 13%, from 55.0 TWh to 62.3 TWh. Generation varies strongly from year to year, mostly owing to changes in rainfall. In 2000-2006, it averaged 64.6 TWh (ranging from 57 TWh in 2005 to 71 TWh in 2001). Hydropower generation varied from 31 TWh in 2005 to 41 TWh in 2001. Nuclear power was more stable at 26.5-27.8 TWh per year, with the exception of 2005, when a five-month standstill at the country's largest nuclear power plant reduced generation to 23.3 TWh. As mentioned in Chapter 2, the government projects total generation to remain more or less at today's levels. Figure 18 depicts a scenario in which the decrease in nuclear power generation is more than offset by increases in generation from hydropower, other renewables and

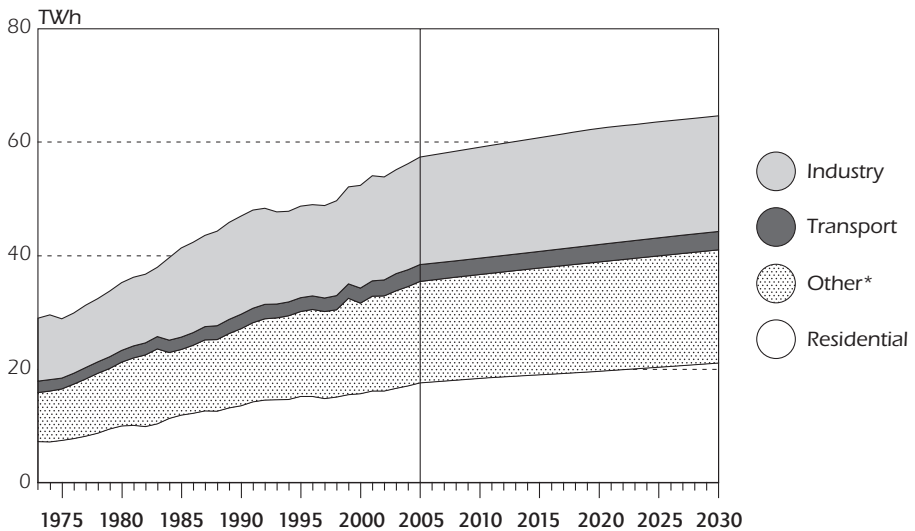
gas. However, on the basis of the government's decision of February 2007, all generation options remain open. Thus, decreases in nuclear power and increases in gas-fired generation are still hypothetical.

From 1990 to 2006, electricity demand increased by 23%, from 47.0 TWh to a record of 57.7 TWh. Consumption in 2006 was 10.3% higher than in 2000 and more than twice SwissEnergy's +5% cap for growth in electricity demand from 2000 to 2010. All sectors contributed to this increase. Consumption grew the fastest in the commercial and residential sectors, by roughly 30%, whereas in industry it rose by about 10%. In 2005, the breakdown of electricity end-use by sector was industry 33.0%; residential 30.8%; services 29.3%; transport 5.2%, and agriculture, forestry and fishing 1.8%. In the projections until 2030, the government expects demand to continue to grow, but at a much slower rate than in the past decades (see Figure 19).

In 2005 and 2006, Switzerland was a net importer of electricity. After decades as a net exporter, this could mark a turning point for the country. Since the 1990s, electricity demand is growing faster than generation. Demand has also shifted towards winter (October-March), when hydropower generation is lower than in summer; in six out of the last ten years, domestic generation has been insufficient to meet the demand in winter.

Figure 19

Final Consumption of Electricity by Sector, 1973 to 2030



* includes commercial, public service, agricultural, fishing and other non-specified sectors.
Sources: *Energy Balances of OECD Countries*, IEA/OECD Paris, 2007 and country submission.

Net maximum generating capacity[8], as measured on 31 December 2004, was 19 200 MW, practically unchanged since 2000. Construction and upgrades are expected to increase it by 300-400 MW by 2010. Major capacity additions are under way or planned at the Linth-Limmern (760 MW) and Emosson (630 MW) pumped-storage plants, and at the Grimsel hydro-complex (more than 1 GW in several phases). The planned conversion of the out-of-use Chavalon oil-fired plant into a 400 MW combined-cycle gas-turbine (CCGT) would be the first fossil-fired plant commissioned since the early 1990s. The Swiss electricity industry has plans for more CCGTs, but realising them is not likely under current CO_2 obligations and electricity prices, or without sufficient available capacity for gas imports. Adding to existing capacity is a major question for Switzerland, especially in light of growing demand (see Chapter 2).

LEGAL FRAMEWORK

Compared to its neighbours, Switzerland's electricity sector has long been lacking competition and many of the institutions fundamental to a well-functioning market. All this is set to change in 2008, when the Law on Electricity Supply (*Stromversorgungsgesetz*, LES) comes into force.

LAW ON ELECTRICITY SUPPLY

The LES will be a major step in reforming Switzerland's electricity market. It establishes an independent regulator and an independent transmission system operator (TSO). It stipulates open and non-discriminated access to the grid. It requires the utilities to separate the accounting of the distribution activities from the other activities. To accommodate concerns over security of supply, it also includes provisions for customer protection and public services obligations. The LES is largely based on the relevant EU legislation.

The LES will open the Swiss electricity market for competition in two phases. End-users with an annual consumption of more than 100 MWh are free to choose their supplier from 1 October 2008 and all end-users from 1 October 2013. Proceeding to the second phase, however, is subject to a facultative referendum. The first phase of market opening covers roughly 50% of electricity consumption in Switzerland.

The LES establishes a regulator, the Electricity Commission (ElCom). The ElCom will be responsible for ensuring compliance with the new law. In particular, it shall monitor grid access and conditions for grid use. The LES shall also control *ex post* both the level of grid and electricity tariffs, and the

8. Net maximum capacity = gross maximum capacity *minus* capacity for own use at the plant *minus* losses from transformation.

use of TSO revenues from cross-border capacity auctions. To prepare for the market opening, the LES articles on ElCom came into force already in July 2007. The LES also establishes a TSO for operating and supervising the national high-voltage transmission grid (220/380 kV). Utilities must legally unbundle the transmission grid from their other activities by 1 January 2009 and hand over their grid assets to the TSO by 1 January 2013 in a share swap.

BACKGROUND TO THE LES

The LES is the result of several years' work. The first attempt to reform the Swiss electricity market, the Electricity Market Law, was rejected in a referendum in September 2002. This forced the federal government to reconsider the pace and methodology for market reform. Assisted by an expert committee, DETEC prepared the draft bill in the course of 2003 and early 2004. It paid particular attention to the reasons for the rejection of the Electricity Market Law, mainly the concerns over security of supply.

Three other developments had an influence on the draft bill. First, in June 2003, the Federal Tribunal applied the 1995 Cartel Law to impose TPA to the grid[9]. In practice, this implied that the Cartel Law could be used to open the electricity market. But *ex post* regulation with neither a regulatory framework, nor a regulator, would have been far from an ideal solution. Regulatory approach would be simpler. Second, also in June 2003, the EU approved legislation to create an internal market for electricity: the second Electricity Market Directive (2003/54/EC) set the date for a full market opening by July 2007, and the regulation 1228/2003 stipulated conditions for network access for cross-border trade in electricity. Third, in September 2003, Italy suffered a major blackout, which originated in Switzerland. The blackout underlined the need to improve co-operation between TSOs. At the time, the Swiss transmission system consisted of five control areas and was operated in co-operation by the several utilities that owned the grid and were also involved in cross-border trade.

After a public consultation, the federal government submitted the LES Bill to the parliament in December 2004. It also submitted a revision to the 1998 Energy Law to promote renewable energy sources for electricity generation (see Chapter 5). The parliament approved both bills in March 2007.

OTHER FEDERAL LAWS RELEVANT TO ELECTRICITY

In addition to the LES, main federal laws relevant to the electricity sector are the 1902 Law on Electricity, the 1916 Law on the Use of Hydropower Resources, the 1998 Energy Law, and the 2003 Nuclear Energy Law (see Chapter 8).

9. Entreprises Electriques Fribourgeoises vs. Watt/Migros, ruling 129 II 497.

The 1902 Law on Electricity regulates the construction, operation and maintenance of networks and power plants. The focus of the 1916 Law on the Use of Hydropower Resources is clear from the title. The law includes regulations on the royalty tax on water use, which is levied by the cantons.

The 1998 Energy Law guarantees independent producers access to the grid. Suppliers are obliged to purchase electricity from non-renewable sources at market prices and from renewable sources at a minimum price of CHF 0.15 per kWh. The feed-in tariff for renewables is considerably higher than the market price, which resulted in additional costs for suppliers and end-users in regions with a high level of feeds from independent producers. To distribute these costs more evenly among all end-users, they are financed by a surcharge on transmission grid use since 1 January 2005. The Energy Law was revised in spring 2007 to increase feed-in tariffs for generation from new installations. The revision will take effect in 2008.

The 1995 Cartel Law is also highly relevant to the electricity sector. It stipulates that a dominant position may exist if an enterprise has a position of strength on the market relative to its competitors, especially if the other enterprises are dependent on it for structural reasons. Compliance with the Cartel Law is monitored by the Competition Commission.

SUB-FEDERAL REGULATION

Cantons and municipalities have their own regulations on market entry, end-user prices and quality and conditions of service. Traditionally, cantonal legislation has focused on energy efficiency, promoting renewable energy sources, and technical and safety issues. Competition has not been a priority.

Cantons issue licences for power plant use. The exceptions are hydropower plants on the Swiss border and nuclear power plants, which require licences from the federal government. Cantons also issue licences for water use at hydropower plants. Furthermore, cantons and municipalities decide how to organise electricity distribution in their territory. Typically, distribution has been entrusted to a monopoly utility, often owned by the canton or municipality itself. Competition has been very limited, but the LES is expected to gradually change this.

INDUSTRY STRUCTURE

Switzerland has about 900 utilities. In annual sales volume, they range from 100 MWh to more than 10 TWh. Most of them, some 800, are small local distributors and suppliers, operating at the municipal level as a local monopoly. On average, each distribution company supplies about 6 000 people.

Electricity generation comes mostly from the five large vertically integrated groups: ATEL, AXPO, BKW, EOS and EWZ[10]. They account for roughly 80% of generation in Switzerland and are the main suppliers for the distribution companies. They own the Swiss high-voltage transmission grid and are also major distributors. The big five groups have mutual access agreements to each other's grids and jointly own many of the largest power plants. They all, except for EWZ, operate at the supra-cantonal level and are heavily involved in international electricity trading, as is evident from the sales volumes in Table 14.

Table 14

Largest Electricity Companies Based in Switzerland, 2006

Company	*Sales, TWh*	*Sales, CHF bn*	*Generation in Switzerland, TWh*	*Main shareholders*
ATEL	115.6	11.3	8.0 (2.2 hydro, 5.8 nuclear)	Private/public ownership. Motor Columbus 59.1%[1], EBM 14.9%, EBL 7.9%, AEM Milano 5.8%
AXPO[2]	112.2[3]	9.4[3]	30.8[3] (7.3 hydro, 23.5 nuclear[4])	Public-sector ownership. Several cantons and cantonal utilities 100%.
EOS	58.2	1.9[5]	3.1 (2.6 hydro, 0.5 nuclear)	Public-sector ownership. Romande Energie SA 28.72%, Services Industriels de Genève 23.02%, Groupe E 22.33%, city of Lausanne 20.06%, FMV SA 5.87%.
BKW	18.9	2.4	7.7 (3.5 hydro, 4.2 nuclear)	Private/public ownership. Canton of Berne 52.5%, E.On 21%.
EWZ	5.5	0.7	3.8 (1.6 hydro, 2.2 nuclear)	Public-sector ownership. City of Zurich 100%

1. Main shareholders of Motor Columbus are EDF (36.9%) and EOS Holding (31.5%).
2. Parent company of large utilities CKW, EGL and NOK.
3. Figures are for business year 10/2005-9/2006.
4. Includes generation under drawing rights from French NPPs.
5. For trading operations, includes net result, not sales.

Sources: Annual reports and company web sites.

10. Aare-Tessin AG für Elektrizität (ATEL), AXPO Holding, BKW-FMB Energie (BKW), Energie Ouest Suisse (EOS) and Elektrizitätswerk der Stadt Zürich (EWZ). AXPO is the holding company for Elektrizitäts-Gesellschaft Laufenburg (EGL), Centralschweizerische Kraftwerke (CKW) and Nordostschweizerische Kraftwerke (NOK).

Most Swiss electricity companies are partly or wholly owned by the public sector. According to the SFOE's annual electricity statistics, in 2005, 81% of the electricity sector was publicly owned (50% by the cantons, 31% by municipalities).[11] Foreign owners held 8.4% of the shares, among them EDF, E.On and EnBW. Three of the five largest companies are 100% public-sector owned (AXPO, EOS and EWZ) and the other two (ATEL and BKW) are in mixed ownership.

The number of Swiss electricity companies has decreased from some 1 200 in the mid-1990s to some 900 in 2006. Market liberalisation is expected to lead to further consolidation. Among the big five, ATEL's merger with EOS and the Swiss activities of EDF is planned to be finalised in 2007-2008.

The Swiss electricity industry is represented by several overlapping associations. The most important ones are the VSE (Verband Schweizerischer Elektrizitätsunternehmen – Swiss Association of Electricity Companies) and Swisselectric. VSE represents the interests of some 460 electricity companies, which supply 90% of the electricity. Swisselectric represents the big five.

TRANSMISSION AND DISTRIBUTION

TRANSMISSION NETWORK

Switzerland has some 6 700 km of high-voltage (220/380 kV) transmission lines. They are owned by the largest electricity companies (see Table 15). Through ownership in these companies, the cantons and municipalities control about 75% of the grid. In addition to the industry-owned high-voltage transmission grid, there is a 132-kV transmission grid, owned and operated by the Swiss Federal Railways. Switzerland also has significant cross-border transmission capacity (see Table 16).

Table 15

Shareholders of Swissgrid, 2007

	NOK	*ATEL*	*EOS*	*EWZ*	*EGL*	*BKW*	*CKW*	*Rätia Energie*[1]
Share, %	24.2	18.9	13.7	12.6	12.3	11.2	5.2	1.9

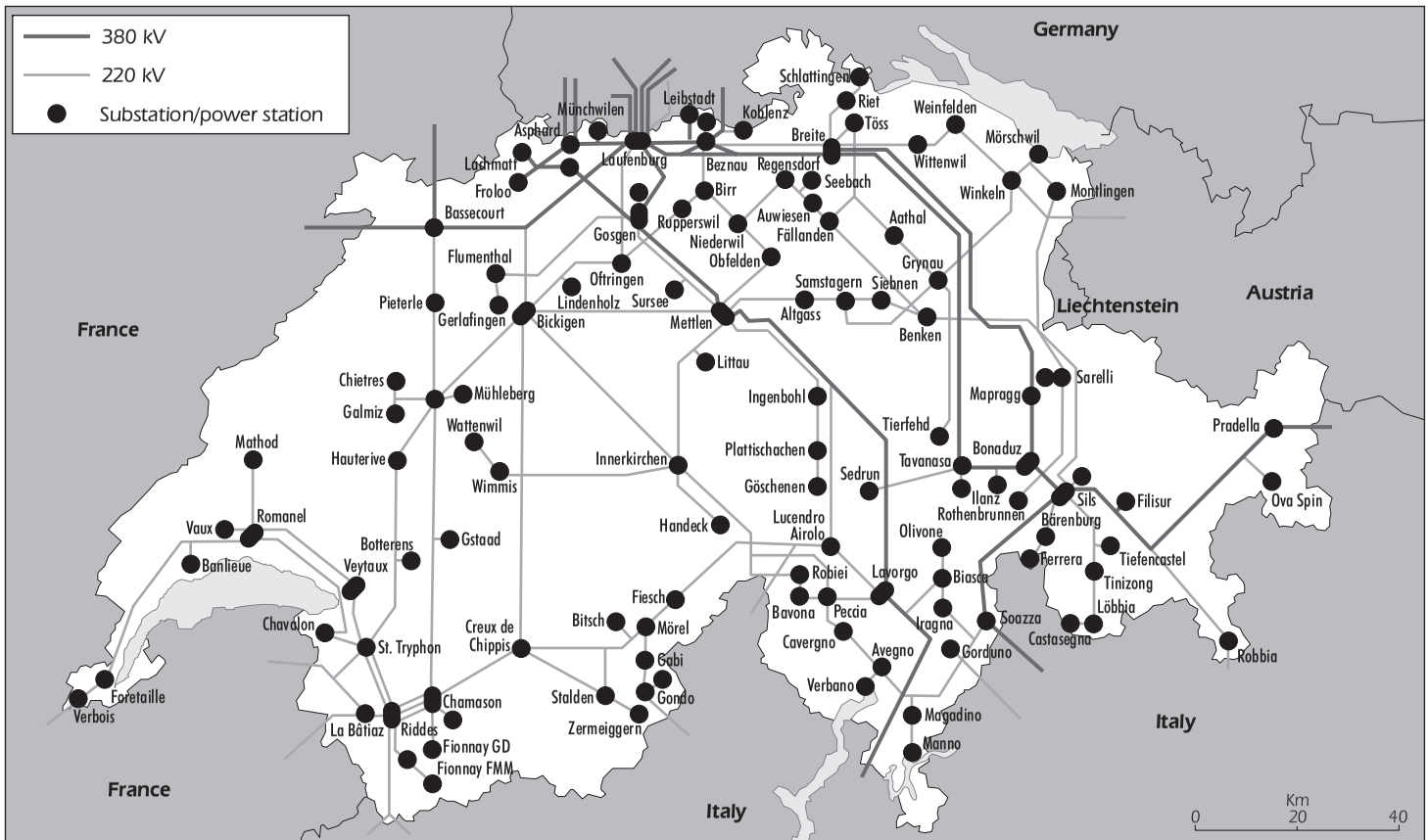
1. Largest owners of Rätia Energie are the canton of Graubunden (46%), ATEL (24.6%) and EGL (21.4%).

Source: Swissgrid.

11. The statistics cover 183 utilities, which account for 95% of electricity generation in Switzerland.

Figure 20

Map of the Swiss High-Voltage Electricity Grid



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

Source: *Electricity Information 2006*, IEA/OECD Paris, 2007.

The SFOE and the Swiss Federal Office for Area Planning are jointly responsible for overseeing the development of the transmission grid. For this purpose, they maintain a Transmission Lines Plan *(Sachplan Übertragungsleitungen)*, which includes all planned projects for capacity expansion. The plan is part of the formal licensing process and is binding to all parties. The plan seeks to determine the most suitable corridor for construction projects of transmission lines and optimise Switzerland's existing transmission network, before any detailed planning takes place. The current plan is valid until 2010 and updated regularly.

Improvements to the transmission grid were recently recommended by a working group (*Arbeitsgruppe Leitungen und Versorgungssicherheit* – Transmission Lines and Security of Supply). DETEC had set up the group in November 2005 as a response to concerns over security of electricity supply. The working group had members from the cantons, railway companies, electricity industry, environmental groups and the federal government. In its final report in March 2007, it considered the transmission grid strained and outlined 38 projects for improving the 220/380-kV lines. By 2015, total investments of CHF 1.2-1.4 billion will be needed for these projects. The working group also recommended streamlining the planning and consent procedures for new transmission lines. The recommendations are yet to be implemented.

TRANSMISSION SYSTEM OPERATION

Since December 2006, Switzerland's transmission system is operated by Swissgrid, a company set up in 2004 by the grid-owning utilities (see Table 15). Swissgrid was preceded by Etrans, a system co-ordinator the utilities had formed in 2000. After the 2003 blackouts, the utilities decided to replace Etrans with a legally separate company, as it had become evident that Etrans lacked the formal powers needed for effective grid management and a strong interface with other system operators in Europe. Swissgrid is a member of ETSO (European Transmission System Operators) and the UCTE (Union for the Co-ordination of Transmission of Electricity).

The legal base for an independent Swiss transmission system operator (TSO) is the LES. From 1 January 2008, Swissgrid will assume overall responsibility for operating the Swiss high-voltage grid and will gradually gain independence from the grid-owning utilities. By 1 January 2009, the utilities must legally unbundle transmission grid operation from their other activities and by 1 January 2013, they must hand over their grid assets to the TSO in a share swap.

The LES demands transparent and non-discriminatory procedures for transmission system operation. It calls for open TPA to the grid. The TSO must publish tariffs and other conditions of network access and use. The ElCom will

monitor the level and use of its revenues. The TSO must be an independent company based in Switzerland and majority-owned by cantons and municipalities. It shall not be active in energy production or distribution, nor have ownership in companies in the sector. The majority of the board members (including the chairman) must be independent of the utilities.

Anticipating the LES, Swissgrid introduced the schedule balance group (SBG) system in late 2005 to provide a framework for electricity exchange within Switzerland and, in particular, for international transits and cross-border electricity exchange. It is now setting up the balance management system, which comprises schedule management (based on the SBG system), meter data management and balance settlement management. The LES requires that the balance management system be operational by 1 October 2008.

DISTRIBUTION NETWORK

Switzerland's electricity distribution network (400 V to 160 kV) covers roughly 69 000 km. It is mostly owned by the cantonal and municipal utilities, which have traditionally had a monopoly status in their supply area. The LES will open distribution networks to non-discriminatory TPA and impose unbundling, at the accounting level, of distribution activities from all other activities of the utilities. The ElCom will monitor distribution operations, including cost accounting and the level of profit, and will decide over any possible disputes. In the event of congestion, priority must be given to deliveries to households and to electricity from renewable sources. The requirements of the LES will be specified in separate ordinances. At the time of writing, these were still being drafted.

CROSS-BORDER CAPACITY

In the UCTE area, Switzerland has 20% of the cross-border capacity, though it only accounts for 3% of electricity consumption. Rapid growth of cross-border trade in electricity in recent years is a challenge to Switzerland's transmission grid. Transalpine lines are particularly congested and the interconnection between Switzerland and Italy is a major bottleneck. The federal government has approved projects to increase cross-border capacity. The latest projects approved are the 380-kV Mendrisio-Cagno line (450 MW, approved in June 2004 and now under construction) and the 400-kV Sils-i.D.-Verderio line (1 100 MW, approved in March 2006, proceedings for planning approval now under way).

Methods for allocating cross-border capacity between Switzerland and its neighbours vary by country. Since 2006, capacity with Germany and Austria is allocated by explicit auction. Swissgrid is planning to start auctions with Italy in 2008. Capacity with France is reserved for incumbents with long-term contracts, while excess capacity is planned to be auctioned.

Table 16

Net Transfer Capacities between Switzerland and its Neighbours, Winter 2006/07 and Summer 2007

Country	*To Switzerland, MW*		*From Switzerland, MW*	
	Winter 2006/07	*Summer 2007*	*Winter 2006/07*	*Summer 2007*
Austria	600	540	1 200	1 000
France	3 200	3 000	2 300	1 400
Germany	2 400	2 060	4 000	4 400
Italy	1 460	1 140	3 890	3 160
Total	**7 660**	**6 740**	**11 390**	**9 960**

Note: Net transfer capacity = total transfer capacity *minus* transmission reliability margin.

Source: ETSO, available from http://www.etso-net.org/NTC_Info/map/e_default.asp.

The LES entrusts the TSO with the responsibility for cross-border congestion management. It states that available transmission capacity can be allocated through market procedures, such as auctions. Priority for capacity use is given to supplies to domestic end-users and, after them, to deliveries under international contracts that were concluded before 31 October 2002[12]. ElCom will monitor the use of revenues from capacity use.

INTERNATIONAL TRADE

Switzerland is a major player in electricity transit and cross-border trade. It is favourably located in the centre of Europe and has ample hydropower capacity that it can use to optimise production. For decades, it was a major exporter, but more recently, electricity demand has outpaced production. As a result, the export surplus is gone and the country is currently a net importer (see Table 17).

Imports come mainly from Germany and France. In 2000-2006, total imports were 24-38 TWh per year. Germany provided 42-48% of the annual total, France supplied a stable 10-12 TWh per year, equalling 28-41% of the total, while Austria accounted for the rest.

Switzerland exports mostly to Italy. In 2000-2006, total exports were 28-35 TWh per year, of which Italy accounted for 70-80%. Swiss electricity exports are crucial for Italy, covering roughly half of the country's electricity imports and 6-8% of its total electricity supply. Switzerland's role is all the more important to Italy owing to the lack of available grid capacity for additional imports from other countries.

12. In November 2002, the Florence Forum of the EU electricity regulators decided to recommend moving to a market-based allocation of the EU cross-border capacity.

Switzerland is an important peak electricity producer. The country's water storage capacity, equivalent to 8 500 GWh, provides the operational flexibility to meet demand both at home and abroad during peaking periods. Water is accumulated in the reservoirs during off-peak hours, and then used for power production during peak hours. Adding to this peak capacity, pumped-storage plants account for some 3% of total production.

Exports are mostly based on short-term and spot contracts. In 2006, long-term contracts (duration of more than two years) accounted for 13% of the total, down from 19% in 2001. Half of the imports are based on long-term drawing rights (duration of more than five years), mainly from the 2 455 MW available at French nuclear power plants.

Table 17

Switzerland's Electricity Trade by Country, 2000 to 2006 (physical flows)

Imports, GWh							
From	***2000***	***2001***	***2002***	***2003***	***2004***	***2005***	***2006***
Germany	10 450	10 395	12 272	13 681	12 212	18 467	14 193
France	9 613	9 930	11 236	12 265	10 317	10 448	11 733
Italy	78	134	75	78	76	186	447
Austria	4 189	3 637	4 217	4 060	4 451	9 245	7 430
Total	**24 330**	**24 096**	**27 800**	**30 084**	**27 056**	**38 346**	**33 803**
Contractual flows	*39 920*	*57 963*	*47 112*	*42 352*	*37 690*	*47 084*	*48 788*
Exports, GWh							
To	***2000***	***2001***	***2002***	***2003***	***2004***	***2005***	***2006***
Germany	6 560	7 787	5 035	4 208	4 042	2 720	4 092
France	2 068	1 998	1 500	1 873	2 684	3 044	2 558
Italy	22 337	23 799	25 284	26 473	20 450	25 882	24 064
Austria	213	726	251	372	307	64	82
Liechtenstein	222	230	238	270	276	286	304
Total	**31 400**	**34 540**	**32 308**	**33 196**	**27 759**	**31 996**	**31 100**
Contractual flows	*46 690*	*68 407*	*51 620*	*45 464*	*38 393*	*40 734*	*46 085*
Net exports	**7 070**	**10 444**	**4 508**	**3 112**	**703**	**–6 350**	**–2 703**

Sources: *Schweizerische Eletrizitätsstatistik 2006*. Berne 2007; *Ermittlung des Stromgrosshandelspreises im Schweizer Strommarkt*. May 2007.

In 2000-2006, annual combined exports and imports varied between 91% and 114% of the country's generation. Reflecting active trading, contractual electricity flows were on the average 54% higher than the physical ones (see Table 17). According to the Swiss electricity statistics, in the same period, revenues from cross-border electricity sales per kWh were 37% higher than spending on cross-border electricity purchases, resulting in annual profits of roughly CHF 1 billion.

PRICES AND TAXES

WHOLESALE PRICES

Wholesale electricity prices for Switzerland are available through the Swiss Electricity Price Index (SWEP) and the Swiss Electricity Index (Swissix). SWEP provides price indication for over-the-counter electricity trading. It is the volume-weighted average for deliveries at the 380-kV Laufenburg hub between 11h00 and 12h00 the following day. SWEP was initiated by ATEL and EGL, and launched in March 1998. Swissix is, in turn, the average price at the European Energy Exchange (EEX) in Leipzig for next-day deliveries within the Swissgrid control area. Swissix has indices for both base and peak loads. It was launched in December 2006. However, SWEP and Swissix account for merely some 10% of the Swiss market; the remaining 90% is traded over-the-counter and is largely subject to public service obligations – and therefore likely to be below the referenced market prices.

SWEP and Swissix correlate strongly with spot price movements in Germany, Austria and France, but at a higher level. From July 2004 to December 2006, average spot prices were EUR 49 per MWh for France and EUR 50 per MWh for both Germany and Austria, whereas the SWEP price for Switzerland was EUR 63 per MWh. In 2006, the average import price[13] to Switzerland was EUR 53 per MWh, while the average SWEP price was EUR 72 per MWh. For Italy, the annual average IPEX spot price was EUR 59 per MWh in 2005 and EUR 75 per MWh in 2006.

The same trend continued in January-April 2007, as SWEP and Swissix prices were about 25% higher than spot prices for France and Germany. Gradually, market opening should reduce price differences. It should also lead to increasing trading volumes.

13. The import price is the volume-weighted average of spot prices in France (Powernext), Germany (EEX) and Austria (EXAA), plus the auction price for cross-border grid use.

RETAIL PRICES

Retail prices for electricity have been decreasing for the past several years. In 2005, the average retail price was CHF 0.149 per kWh, down from CHF 0.158 per kWh in 2001[14]. Retail prices vary strongly according to supply area. For households, average prices between cantons vary by more than 50%. Within individual cantons, price differences can be even bigger, mainly because some mountain municipalities offer hydropower to locals at below-market prices. For industry, price differences are smaller, but still represent tens of percentage points. By international comparison, the Swiss end-users currently pay mid-range prices. Still, compared to countries with a similar low-carbon generation profile, prices remain high. This is especially true for industry (see Figures 21 and 22).

TAXES

At the federal level, the only tax on electricity is the 7.6% VAT, which is refundable to industry. However, the cantons and municipalities can levy taxes on generation, transmission and distribution. The level of these taxes varies, but the most important ones are the royalty taxes and concession fees on water use for hydropower production. The maximum annual tax rate is CHF 80 per kW of net capacity. In 2006, this amounted to CHF 450 million, equalling CHF 13.8 per MWh of hydropower.

PRICE SUPERVISION

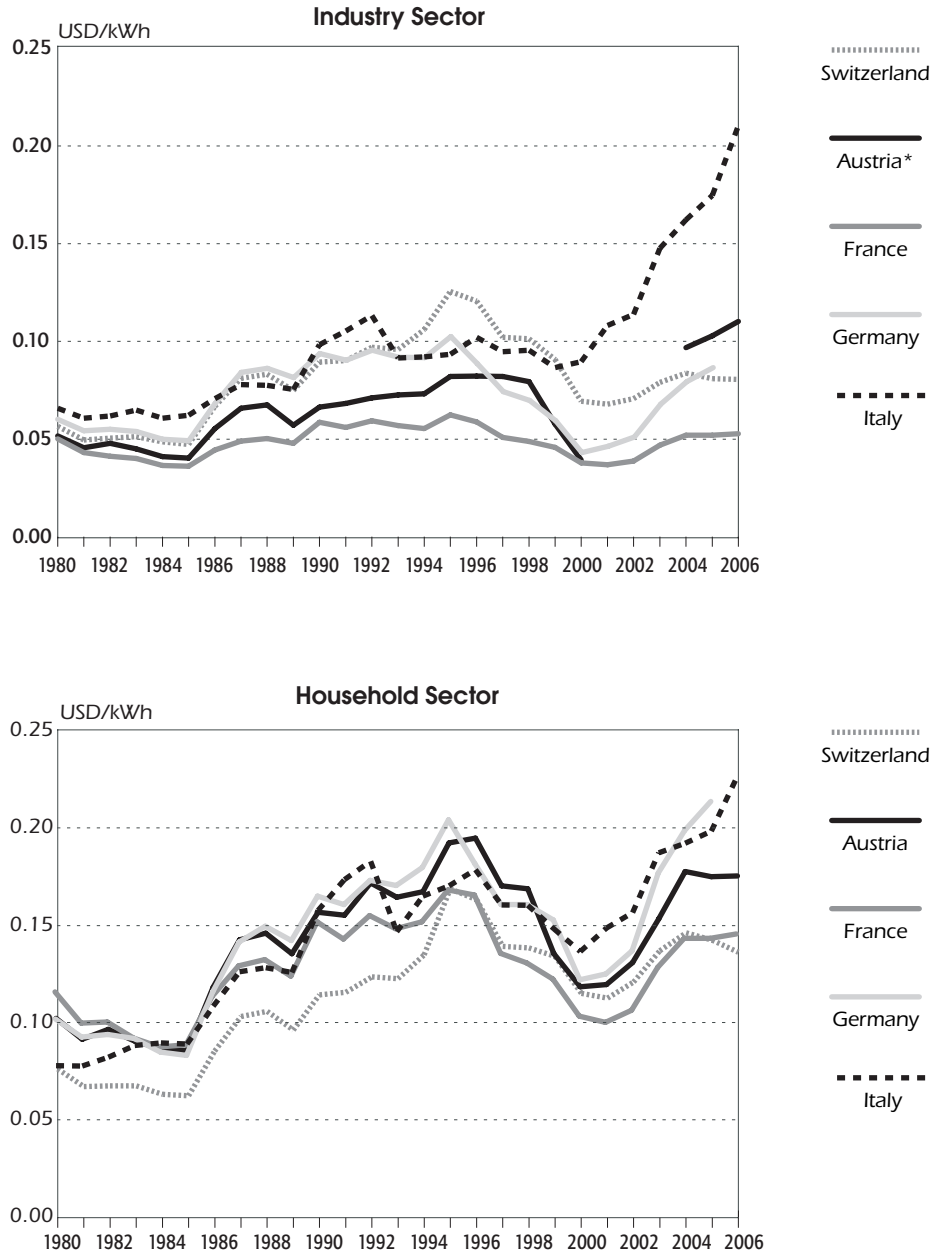
Price Supervision (PSU) is in charge of ensuring non-abusive electricity pricing until 2008, when ElCom will take over this responsibility. Under the Law on Price Control, the PSU monitors the level of electricity prices and grid fees and the use of proceeds from cross-border capacity auctions.

Consumers can complain to the PSU about abusive prices. If prices are set by a company without prior approval from a public authority, the PSU can forbid any price increases or decide on a price reduction. If a public authority decides on or has to approve a price increase (the case for most electricity prices), the PSU can issue recommendations. The utilities, however, are not legally obliged to follow these recommendations. In recent years, the PSU has managed to lower prices in several cases of excess pricing. On its Internet site, PSU publishes intra- and cross-cantonal data on electricity prices for 14 consumer profiles.

14. The average retail price is calculated from annual data representing 62-66% of end-use.

Figure 21

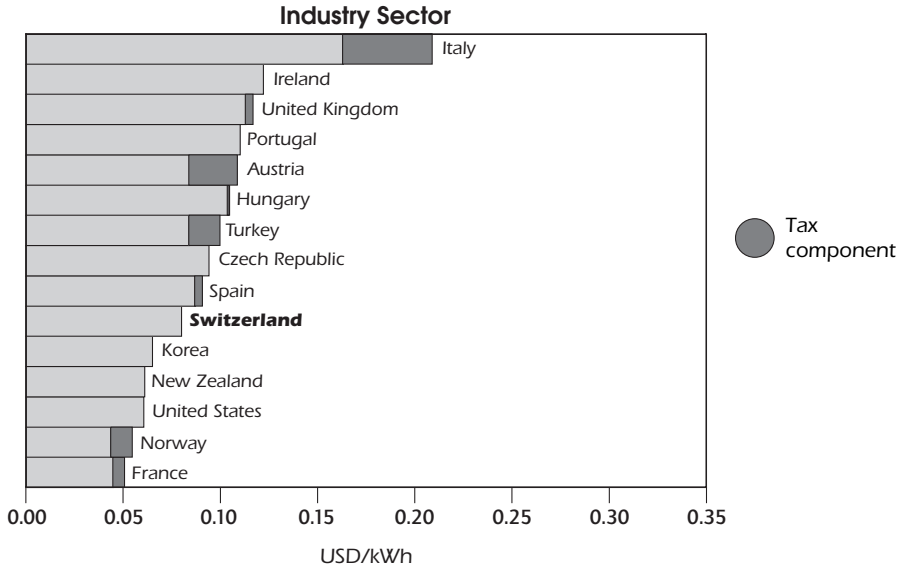
Electricity Prices in Switzerland and in Other Selected IEA Countries, 1980 to 2006



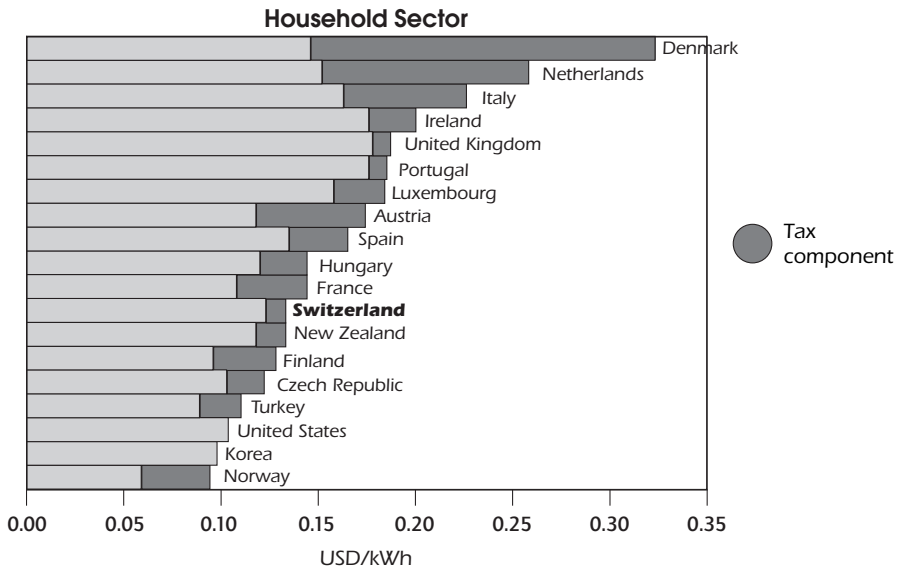
* data not available for Austria from 2001 to 2003 in the industry sector.
Source: *Energy Prices and Taxes*, IEA/OECD Paris, 2007.

Figure 22

Electricity Prices in IEA Countries, 2006



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



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, 2007.

CRITIQUE

Since the last in-depth review, the government has worked hard to relaunch the liberalisation of the Swiss electricity market. As a result, the Law on Electricity Supply comes into force in 2008, partly from 1 January 2008 and fully from 1 October 2013. The law contains the necessary elements for effective market liberalisation: an independent regulator, an independent transmission system operator, regulated third-party grid access, and freedom to choose the supplier. It is set to open the Swiss electricity market in full by 2013. The law is a major step forward for the electricity sector, and the IEA applauds Switzerland for it.

Market opening and increased competition are good news for end-users. Opening the market in full well before October 2013 would enable all customers to benefit faster from more competition. Therefore, the IEA urges Switzerland to consider accelerating the reform process.

The electricity sector will go through fundamental changes over the next years. It is vital that the regulator, the ElCom, is there from the beginning both to oversee the process and to develop expertise. The decision to set up the ElCom in July 2007 is a very positive sign of Switzerland's commitment to the reform. Furthermore, a strong regulator gives confidence to potential new entrants that the market will be operated fairly, thereby encouraging them to enter the market. Though *ex post* regulation is foreseen, the government should consider instituting *ex ante* regulation, as it provides greater regulatory certainty and is less cumbersome. In all cases, the government should provide the regulator with the sufficient resources.

Open and non-discriminatory access to the grid is essential for competition. To increase transparency, the LES unbundles the network activities from the utilities' other activities at the accounting level. Legal unbundling is said to be too burdensome for most utilities given their small size. However, more effective unbundling would benefit customers and there should be room for it with the big utilities. Strong public-sector ownership in the utilities implies that on many occasions, directly or indirectly, the majority shareholder would have to decide to unbundle the companies. This could prove challenging, but it should be helpful to underline that liberalisation is not the same as privatisation and that legal unbundling has been successful in several IEA countries. In any case, the government should monitor market development and, to increase competition, consider requiring legal unbundling of network operations, starting with the largest utilities.

The LES imposes a legally unbundled owner and operator of the transmission network. With the TSO, Switzerland will move from five control areas to just one. This is a great improvement to security of supply at home and internationally, and the IEA commends the Swiss government for it.

Switzerland is part of the UCTE system, which is serving some 450 million end-users. To function reliably, the system requires strong technical rules and co-operation between national system operators. To contribute to this, the TSO should set up the balance management system without delay.

By the beginning of 2013, the TSO will gain full ownership of the transmission grid. Until then, the grid will remain in the ownership of the largest utilities. However, even after the 2013 deadline, the cantons and municipalities will continue to own the majority of the TSO and the transmission grid. With this ownership structure, the ElCom should closely monitor the TSO performance. In particular, the TSO should have strong incentives to maximise the amount of cross-border capacity made available to the market.

Cross-border flows of electricity to and from Switzerland have increased considerably in recent years. Managing these flows effectively is crucial for security of supply both in Switzerland and in the neighbouring countries. This sets requirements for the availability and allocation of cross-border capacity.

A large part of Switzerland's cross-border capacity with France and Italy is reserved, under long-term contracts, for Swiss companies. Contracts with France cover the entire capacity and run until the late 2010s. Transmission lines with Italy have long been congested. All this is profitable for the incumbent companies, but unlikely to be so for Switzerland as a whole. Switzerland may remain a net importer of electricity for years to come, and therefore the capacity for imports from France will remain in full use when demand is high. If the capacity is insufficient, additional imports will have to be sourced elsewhere, presumably at a higher price. The prevalence of long-term contracts gives rise to a potential conflict with the EU. Under the EU law, long-term contracts for cross-border capacity use have no pre-emption rights. Encouragingly, plans to increase cross-border capacity do exist. The government should continue to monitor the implementation of these plans and use its powers to facilitate the implementation. The government should also proceed to streamline the licensing process for new transmission lines.

Capacity allocation on the Swiss borders is only partially based on market principles. The LES states that if the Swiss cross-border lines are congested, priority will be given to deliveries to domestic end-users and to deliveries based on international long-term contracts. This discriminates against spot and short-term deliveries to customers abroad. Switzerland's neighbours have a different approach, as the EU law stipulates non-discriminatory allocation of cross-border capacity. The other non-EU countries in the UCTE area are now adopting the EU rules as part of their obligations under the Energy Community Treaty. In line with these developments, Switzerland should move towards allocating all capacity according to market-based mechanisms.

Full opening of the electricity market by October 2013 is subject to a facultative referendum. Voters should base their judgement on an understanding of how the market functions and why prices may change. To facilitate this, the government should ensure that information on prices and tariffs is made readily available. Elements such as the grid levy for promoting renewables and energy efficiency will increase prices, and it is important that the voters understand the underlying reasons for these developments.

Since the 1990s, Switzerland's electricity demand is rising faster than domestic generation and this trend is likely to continue. For the past two years, Switzerland has been a net importer of electricity. Becoming a net importer is a fundamental change in the power sector, but its effects should not be exaggerated. Switzerland is favourably located in the centre of an ever-integrating European electricity market. The country has abundant cross-border capacity and consumes only 3% of the electricity in the UCTE area. The government should monitor these developments and adjust policy, when necessary

One detailed, yet important example of changes in the electricity sector is the development of automatic meter-reading (AMR). It is in use, for example, in the United States, Australia, Italy and the Nordic countries. Implementing already approved EU legislation will make it increasingly common in the EU member states[15]. The integration of AMR into system operations provides several advantages, including the ability to manage load levels. Switzerland already has a tradition of remote-controlled household appliances (*e.g.* washing machines that are not operable at mid-day). More advanced demand response solutions could be built on this experience.

RECOMMENDATIONS

The government of Switzerland should:

- *Ensure swift implementation of the Law on Electricity Supply and pay particular attention to providing the regulator with sufficient resources, establishing the independent transmission system operator, and ensuring open and non-discriminatory access to the grid.*
- *Consider accelerating market reform, for example by requiring legal unbundling of distribution activities, starting with the largest companies, and using market-based mechanisms to allocate the cross-border capacity.*
- *Consider* ex ante *regulation of network tariffs or of maximum network revenue.*
- *Improve market transparency by publishing the structure and trends in electricity prices and tariffs.*
- *Monitor closely generation and transmission capacity and demand, particularly the dependence on imported electricity.*
- *Investigate ways to increase demand response, such as through the expanded use of automatic meter-reading.*

15. Directive 2006/32/EC on energy end-use efficiency and energy services. The EU member states will have to comply with the Directive from 17 May 2008.

OVERVIEW

Switzerland has five nuclear power plants (NPPs), with a total capacity of 3 220 MW_e. Three of the NPPs are pressurised water reactors and two are boiling water reactors. The NPPs are located at four sites (see Table 18).

The first NPP in Switzerland (Beznau 1) began commercial operation in 1969, while the last plant (Leibstadt) was built in 1984. Owing to increasing opposition to nuclear power since the 1970s, two other nuclear projects, for which sites had already been approved, were not built.

The Swiss nuclear fleet currently provides about 40% of the country's electricity generation. This figure can reach 45% in winter, when hydropower production is lowest and electricity demand greatest. In 2006, Swiss NPPs generated some 26 TWh of electricity (net), 42% of the total in the country. Over the course of operations, the Swiss nuclear reactor fleet has generated 650 TWh of CO_2-free baseload electricity. The Beznau and Gösgen NPPs also supply district heat in addition to electricity.

The Swiss nuclear fleet has one of the highest capacity factors in the world. Average lifetime capacity factor is more than 85%, and in 2006, at 93.93%, Switzerland topped the list of capacity factors by nation.[16] All Swiss NPPs have had power uprates, in total adding about 500 MW_e (gross) of generating capacity. In the short term, additional uprates are likely to be small and result from applying advanced fuel technologies.

Table 18

Nuclear Power Plants in Operation in Switzerland, 2007

Name	*Type*	*Net capacity (MW_e)*	*Commissioning date*	*Electricity generation in 2006 (TWh)*
Beznau 1	PWR	365	1969	2.95
Beznau 2	PWR	365	1971	3.07
Mühleberg	BWR	355	1972	2.88
Gösgen	PWR	970	1979	8.10
Leibstadt	BWR	1 165	1984	9.37
Total		**3 220**		**26.37**

Source: International Atomic Energy Agency Power Reactor Information System.

16. *Platts Nucleonics Week*, February 15, 2007. The top five capacity factors by nation were Switzerland - 93.93%; Finland - 93.12%; South Korea - 92.51%; Mexico - 91.88%; and Romania - 91.06%.

Swiss NPPs are generally licensed to operate as long as safe operation is demonstrated. However, the practical lifetime of each reactor is expected to amount to no more than 50 to 55 years. As a result, the decommissioning of the three oldest facilities (Beznau 1 and 2 and Mühleberg) is expected to begin around 2020. These three reactors represent combined capacity of 1 085 MW_e: 35% of existing nuclear capacity and about 6% of the total Swiss generating capacity.

Swiss NPPs are owned by a mix of public and private partners. Beznau and Mühleberg are owned and operated by public utilities, whereas Gösgen and Leibstadt are owned by several electric utilities and public service companies. Significant stakes are owned by large companies, such as ATEL, AXPO Holding, BKW and EOS (see Table 19). Consolidation is ongoing (a merger between the ATEL Group and EOS was announced in 2006) and partnerships, as well as other forms of co-operation between the larger players, have been established. Some public shareholders, *e.g.* the canton of Berne, are actively planning to sell or have already sold stakes in electricity companies.

Table 19

Ownership of the Swiss Nuclear Power Plants, 2007

NPP	*Shareholders*	*Share, %*
Mühleberg	BKW	100
Beznau 1 and 2	NOK*	100
Gösgen	ATEL	40.0
	CKW*	12.5
	Energie Wasser Bern (EWB)	7.5
	NOK*	25.0
	City of Zurich (EWZ)	15.0
Leibstadt	ATEL	27.4
	AEW Energie*	5.4
	BKW	9.5
	CKW*	13.6
	EGL*	16.3
	EOS	5.0
	NOK*	22.8

* owned by AXPO Holding.

Source: Country submission.

Switzerland has no domestic nuclear fuel-cycle industry and the operators of Swiss NPPs source nuclear fuel and services outside the country. The safe handling and disposal of all radioactive wastes are the responsibility of the waste producers. Spent fuel is either stored in pools at reactor sites or at a centralised interim waste storage facility located on the site of the Paul Scherrer Institute in Würenlingen. Some used fuel has been sent to France and the United Kingdom for reprocessing.

LEGAL FRAMEWORK

In 1990, the Swiss population voted in favour of the further operation of the existing NPPs but imposed a ten-year moratorium on licensing new NPPs and other nuclear facilities. In May 2003, two popular initiatives were rejected in a national vote: 58.4% of voters opposed extending the moratorium on the licensing of new NPPs that lapsed in 2000 (Moratorium Plus initiative) and 66.3% of voters opposed phasing out nuclear altogether (Electricity Without Nuclear initiative).

After two years of parliamentary debate, a new Nuclear Energy Law (NEL) was adopted in March 2003 and entered into force in February 2005, along with a new main Nuclear Energy Ordinance (NEO). The NEL keeps the nuclear energy option open, addresses key issues related to radioactive waste management, including a ten-year moratorium on reprocessing spent fuel as of 1 July 2006, and empowers DETEC to authorise construction, operation and decommissioning of NPPs.

The permitting procedure for new NPPs set out in the NEL is estimated to take about 16 to 18 years from receiving a proposal to build to the end of construction. This process requires three licences. First, the federal government issues a general licence that determines the site and the main features of a nuclear facility, *i.e.* the reactor system, output category, and main cooling system, and any changes in their purpose or scope of activities. After this, DETEC issues technical licences for the construction and operation of nuclear facilities. The general licence shall be the subject of a national referendum. The technical licences are potentially subject to court appeal.

NUCLEAR SAFETY

Protecting individuals, society and the environment against radiological and other nuclear safety hazards is subject to the Swiss legislation on radiation protection and nuclear energy. Compliance with the legal requirements is verified and enforced by regulatory bodies, principally the Swiss Federal Nuclear Safety Inspectorate (HSK/DSN). Part of SFOE, HSK/DSN supervises reactor and radiation safety in Swiss nuclear installations, including NPPs, research reactors and intermediate radioactive waste storage facilities. HSK/DSN approves safety-relevant changes to nuclear installations, supervises the transport of nuclear materials and assesses the safety of proposed geological nuclear waste repositories. In June 2007, the parliament adopted a law, which will enable HSK/DSN to become a fully independent federal agency in January 2009.

No serious incidents were recorded in any of the five NPPs in Switzerland in 2006. HSK/DSN observed that nuclear safety, in terms of design and operation of facilities, was good throughout 2006: nine incidents were

registered, but all were classified as Level 0 on the International Nuclear Safety Event Scale, indicating that they had no safety significance. Releases of radioactivity to the environment through waste water and air were considerably less than the limits specified in the operating licences.

Conclusions in the 2006 assessment are generally applicable to the last several years of operating history. In all reviews since 1999, the annual collective doses for personnel in all NPPs were low and the release of radioactive material into the environment has been significantly below the limits established by regulators. The number of reportable incidents is generally low and none are considered to have represented a radiological hazard to workers or the environment. The number of reactor SCRAMS (unplanned shut-downs) has also been low.

The second Swiss Report to the Joint Convention on the Safety of Spent Fuel Management and on the Safety of Radioactive Waste Management concludes that the safety of spent fuel management and radioactive waste management in Switzerland is in compliance with the obligations of the Convention. The Joint Convention includes the obligation to establish and maintain a legislative and regulatory framework to govern the safety of spent fuel and radioactive waste management. It also includes the obligation to ensure that individuals, society and the environment are adequately protected against radiological and other hazards by appropriate siting, design and construction of facilities, and, by making provisions for ensuring the safety of facilities both during their operation and after their closure.

WASTE DISPOSAL AND DECOMMISSIONING

The key organisation in the field of nuclear waste disposal is the National Co-operative for the Disposal of Radioactive Waste (NAGRA). It was formed in 1972 by the nuclear power plant operators and the federal government to prepare and implement solutions for the management of radioactive waste from nuclear activities in medicine, industry and research.

In 2002, NAGRA completed a feasibility project for the disposal of high-level radioactive waste (Project Opalinous Clay). This study was reviewed by national nuclear regulatory authorities and the Nuclear Energy Agency (NEA) and approved by the federal government in 2006. Approval of NAGRA's feasibility study verifies the concept of a nuclear waste repository in Switzerland, one of the requirements that must be met prior to the licensing of replacement or new NPPs, as stipulated in the NEL.

In a response to a request from the Minister of Energy and Environment, NAGRA published a report in 2005 on alternative options for siting a high-level waste repository. In addition, NAGRA is preparing a new programme in support of the site selection process for a low- and intermediate-level waste repository. The programme will be submitted to the government for approval in 2007.

Nuclear legislation foresees several steps for the realisation of waste repositories; a site selection process will be defined as stipulated in the Law on Spatial Planning. Once approved, the process to identify at least two sites can begin. This step, which includes obtaining government approval and addressing objections raised, could take up to nine years. This would then lead to the second step, a phased licensing process that begins with the issuance of a general licence, which would take four years and likely be subject to a national referendum. Successive licensing for underground investigations, construction and operation would then follow, each taking a number of years to realise. Current estimates place the completion of these steps and the opening of the repositories in the 2030 (low- and intermediate-level waste) to 2040 (high-level waste) time frame.

In accordance with the polluter-pays principle, waste producers are required to fund the safe disposal of all nuclear waste. The costs, *e.g.* for reprocessing until 1 July 2006, NAGRA activities, investigations and interim storage facilities, are covered by waste producers. The surcharges are deposited into a decommissioning and a waste management funds. By 2005, the decommissioning fund stood at CHF 1.252 billion of the total estimated decommissioning cost for the five NPPs of CHF 1.9 billion. The waste management fund totalled CHF 2.762 billion of the estimated total waste disposal cost of CHF 12.1 billion.

CRITIQUE

Much has been accomplished since the 2003 in-depth review. Two national referendums that would have seen Switzerland turn its back on the nuclear option were defeated in 2003. In 2005, following two years of consultation, the NEL and Nuclear Energy Ordinance came into force. In 2006, the federal government approved a feasibility project for the disposal of high-level radioactive waste. Through these actions, Switzerland has retained the nuclear option and the federal government has set the stage for the construction of new NPPs.

In addition to this, the federal government is also developing a site selection process for low- and intermediate-level and high-level radioactive waste repositories. New legislation that will come into force at the beginning of 2009 will establish an independent federal nuclear regulator. Each one of these steps alone represents a major improvement in the political and regulatory environment for nuclear power generation in Switzerland.

However, more work remains if new NPPs are to be built. The process set out for the approval and licensing of new NPPs in the NEL is exceptionally long and uncertain. It is estimated that it will take 16 to 18 years from the submission of the proposal to power generation. Over this time, a national

referendum is likely to be held and court challenges are possible. Investors may be reluctant to commit the large amount of capital required to build a new plant, when many years must pass before returns are realised, if at all.

In addition to the challenges presented during the approval and licensing of NPPs, the process envisioned for realising the high-level radioactive waste disposal initiative is also very lengthy (almost 35 years). It may also be delayed by requirements to address repeated opportunities for objections and it, too, will likely be the subject of a national referendum. Despite the best efforts of the federal government to legally separate the two issues, it can be expected that the issue of a high-level nuclear waste repository will be raised during the approval and licensing process for new NPPs.

Political resolve over the long term will be necessary to move the high-level radioactive waste disposal initiative forward. The issues of NPP construction and waste disposal are intertwined in other countries and will no doubt be so in Switzerland, at least at the political level. Demonstrable progress on nuclear waste disposal will be vital to building public confidence in the construction of new NPPs.

Nuclear power is controversial in many countries. Building public confidence in the nuclear option will require clearer messages and more information on the impacts of all aspects of the nuclear fuel cycle and the generation of electricity in NPPs.

RECOMMENDATIONS

The government of Switzerland should:

- *Work within the framework of the Nuclear Energy Law to ensure that the approval and licensing process for the construction of new NPPs proceeds efficiently without unnecessary process delays.*
- *Maximise the flexibility available to hold a referendum on the prospect of new NPPs as early in the approval and licensing process as possible.*
- *Continue to show leadership in the siting and establishment of a high-level nuclear waste repository, including ensuring that the process proceeds efficiently without unnecessary delays.*
- *Continue to ensure that the general public is fully informed on the full range of effects and impacts associated with the construction and operation of new NPPs.*

RESEARCH AND DEVELOPMENT

OVERVIEW

Switzerland's energy research and development (R&D) policy aims to contribute to a secure and sustainable energy supply; continue the strong position of Switzerland as a market place for energy technology and ensure the high quality of its energy research. The long-term goal is to reduce annual energy needs per person to 2 000 W. Consistent with the government's overall energy policy objectives, R&D focuses on energy efficiency, renewable energy sources and large-scale power production. International co-operation and efficient implementation of research findings have a high priority.

Energy R&D policy is laid down in the four-year Federal Energy Research Master Plans. The federal government uses such master plans in all the 12 policy areas, in which it funds research directly. Master plans for energy research in 2004–2007 and 2008–2011 are discussed in more detail below.

The master plans include the objectives, means, focus areas and budget allocations for publicly-funded energy research in Switzerland. They are drafted by the Federal Energy Research Commission (CORE), a high-level advisory body to the federal government, consisting of 15 members from industry and academia. The draft master plan is subjected for comments at a National Energy Research Conference, held every four years and attended by the Swiss energy research community. On the basis of the conference feedback, CORE and the SFOE finalise the master plan and submit it to the federal government and parliament for approval.

The SFOE, in collaboration with CORE, is responsible for co-ordinating energy R&D policy and implementing the master plan. It is directly involved in some 90% of the publicly-funded energy R&D projects. These projects are managed under the SFOE's research programmes, currently 20 in total. The research programmes, in turn, fall into 14 subject areas that cover the whole energy R&D path: basic and applied research, pilot and demonstration projects, and market entry.

The SFOE programme leaders review the projects annually. The reviews as well as the final reports of individual projects are available on the SFOE Internet site. Every two years, the SFOE also conducts a comprehensive survey of all publicly-funded energy R&D projects *(Projektliste der Energieforschung des Bundes)*. The latest, for 2004–2005, includes close to 970 projects. Information on individual R&D and evaluation projects of the Swiss federal administration can also be found on the ARAMIS database (www.aramis.admin.ch).

FEDERAL ENERGY RESEARCH MASTER PLAN 2004–2007

The emphasis of the master plan is on applications-oriented research. It focuses on the following four thematic areas:

- Rational use of energy, particularly in buildings and transportation. Projects concentrate on optimising combustion processes and increasing the efficiency of storage and consumption of electricity. Also important are the optimal co-generation of heat and power, and the use of ambient heat (heat pumps).
- Renewable energy. Examples of project areas include solar thermal systems, photovoltaics and biomass (priority on wood). Other project areas include geothermal energy, wind power and small hydropower plants, as well as longer-term research on solar energy and hydrogen.
- Nuclear energy. Research on fission focuses mainly on the security and disposal of radioactive waste. Research on fusion concentrates primarily on plasma physics and heating methods.
- Energy policies and economics. Research focuses mostly on economic, ecological and societal consequences of energy technology developments.

FEDERAL ENERGY RESEARCH MASTER PLAN 2008–2011

For the years 2008–2011, the focus of public energy R&D is maintained on the same four areas as for 2004–2007: rational use of energy, renewables, nuclear energy, and energy policies and economics. Energy research continues to be guided by the vision of a 2 000 W per capita society, implying a need for major technological breakthroughs. Based on that vision, the plan sets the following four quantitative goals for 2050:

- Phasing out fossil fuels in space heating.
- Cutting energy use in buildings by half.
- Tripling the use of biomass for energy.
- Reducing average fuel consumption of the passenger car fleet to 3 litres per 100 km.

In 2008–2011, the focus will be on developing technologies that:

- Have the highest possible system effectiveness and lowest possible emissions in transport, buildings and electricity generation.
- Use ambient and solar heat as well as biomass.
- Use in the shorter term hydro and geothermal power.
- Reduce in the longer term dependence on fossil fuels (photovoltaics, hydrogen, fourth-generation nuclear reactors).

FUNDING

Most energy R&D in Switzerland is funded by industry. According to SFOE estimates, in 2005, the private sector accounted for some 80% of the country's total energy R&D spending of close to CHF 900 million. Four-fifths of the private-sector funding went into pilot and demonstration projects and product development, which were carried out half by a few multinational companies and half by SMEs.

According to the master plan for 2004–2007, some 85% of basic research is government-funded. Costs of applied research are divided 45%/55% between the public and private sectors, while the pilot and demonstration projects are 90% funded by the private sector. Market entry of new products is supported by the SwissEnergy programme.

Public funding for energy R&D in Switzerland comes through various channels, with individual projects often receiving funding from several sources. All this underlines the importance of the SFOE as a co-ordinator. It contributes to the funding of roughly 70% of the public R&D projects and is involved in an additional 20% of the projects through its membership in advisory boards.

In 2005, half of the public-sector funding for energy R&D came from the Board of the Swiss Federal Institutes of Technology (FIT-Board, see Figure 23). It funds basic research within its sphere, namely the Paul Scherrer Institute (PSI), the Federal Institutes of Technology at Zurich and Lausanne and the Materials Science and Technology Institute (EMPA).

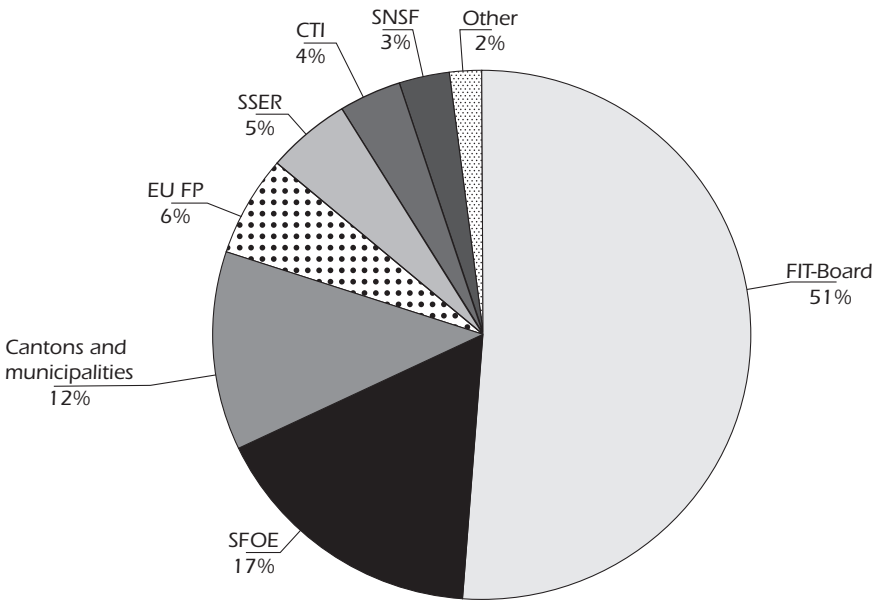
Cantons and municipalities supported applied research at universities of applied sciences *(Fachhochschulen)*, as well as pilot and demonstration projects.

The bulk of the funding from the European Union's Framework Programme for Research and Technological Development (EU FP) went into nuclear fusion research. Part of the EU money was channelled through the State Secretariat for Education and Research (SSER) to participants in a range of R&D projects.

The Swiss Innovation Promotion Agency (CTI) funded universities in public-private joint projects aiming to commercialise innovations. In each project, CTI funding had to be matched by industry. The Swiss National Science Foundation (SNSF) supported basic research at universities and provided grants to junior scientists. Other public-sector funding comprised federal offices other than the SFOE with energy-related research activities (agriculture, environment, spatial development).

Figure 23

Distribution of Public Energy R&D Spending by Source, 2005



Source: *Projektliste der Energieforschung des Bundes*. SFOE, 2007.

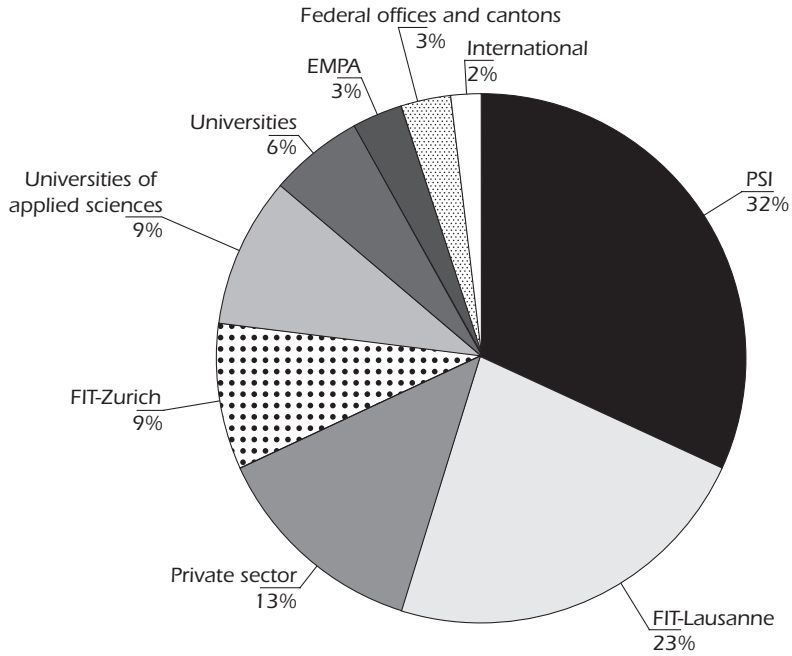
In 2005, public R&D funding was divided between the four thematic research areas of the master plan as follows: 35% to rational use of energy, 31% to nuclear energy, 27% to renewables and 7% to energy policies and economics.

The biggest receiver of public funding was the domain of the Swiss Federal Institutes of Technology (FIT, see Figure 24). The Paul Scherrer Institute had activities on nuclear energy and the FIT-Zurich on photovoltaics. They both also focused on combustion, batteries, energy economy and solar chemistry/hydrogen. The FIT-Lausanne conducted projects primarily on nuclear fusion, hydropower, fuel cells, photovoltaics and electricity networks. EMPA focused on buildings, fuel cells and thermoelectricity.

Private enterprises received funding for pilot and demonstration projects in all non-nuclear sectors. At universities of applied sciences, the emphasis was on solar thermal systems, ambient heat, buildings, combustion, transportation and photovoltaics. Universities, in turn, focused on photovoltaics, supra-conductivity and hydrogen. Small amounts were spent by the federal offices and cantons on a wide array of internal research. International co-operation comprised mainly activities within the IEA and the EURATOM.

Figure 24

Distribution of Public Energy R&D Spending by Recipient, 2005



Source: *Projektliste der Energieforschung des Bundes*. SFOE, 2007.

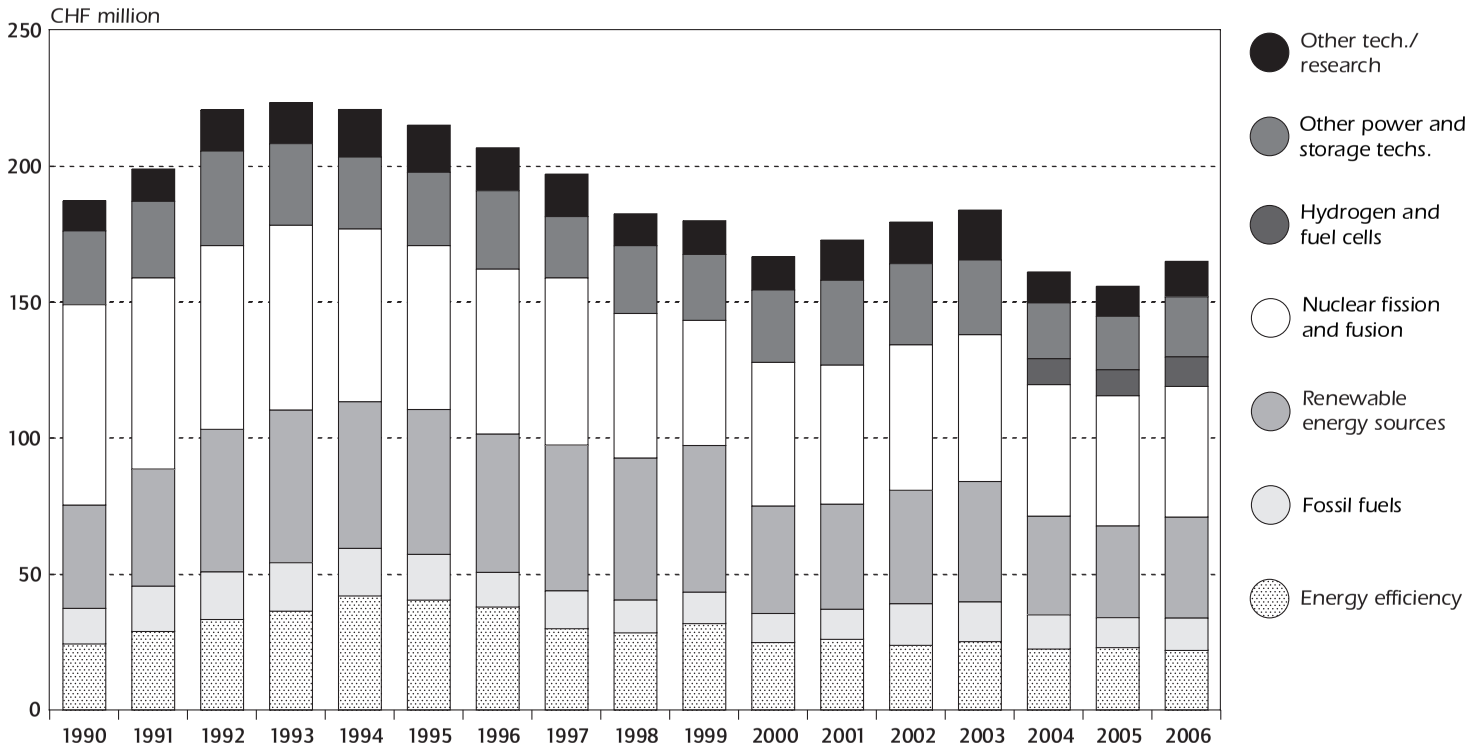
Public funding for energy R&D has been on a downward trend after reaching its peak in the early 1990s (see Figure 25). According to the master plan, the budget was to gradually increase from CHF 184 million in 2003 to CHF 213 million in 2007. However, owing to the federal government's overall spending cuts, public funding in 2005 fell to a multi-decade low of CHF 156 million. Funding for pilot and demonstration projects was nearly completely abandoned in 2004. In spite of these cuts, Swiss public spending on energy R&D per capita was one of the highest among the IEA countries in 2006 (see Figure 26).

The master plan for 2008–2011 proposes to increase funding by 25% from CHF 156 million in 2005 to CHF 200 million in 2011. The increases would be highest for energy efficiency and renewables projects, their shares reaching about 35% of the total. Funding for pilot and demonstration projects would be relaunched. In 2011, 60% of energy R&D would go to applied research, 20% to pilot and demonstration projects and 20% to basic research.

Figure 25

Public Spending on Energy R&D by Sector, 1990 to 2006*

(nominal values)

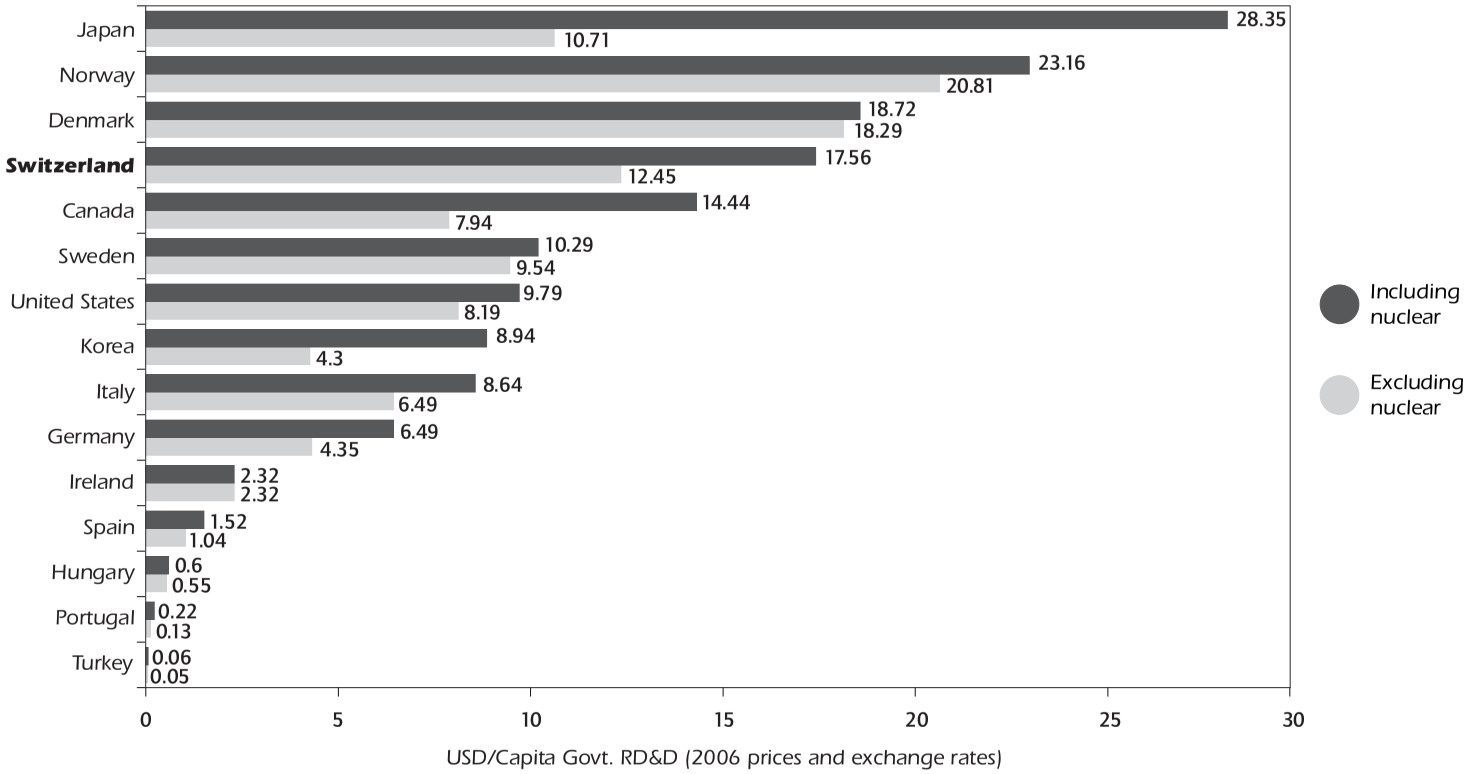


* 2006 = estimates.

Source: Country submission.

Figure 26

Government Spending on Energy R&D per Capita in IEA Countries, 2006*



* estimates.

Note: data not available for Australia, Austria, Belgium, the Czech Republic, Finland, France, Greece, Luxembourg, the Netherlands, New Zealand and the United Kingdom.

Sources: Country submissions and *National Accounts of OECD Countries*, OECD Paris, 2007.

INTERNATIONAL COLLABORATION

Swiss energy research is closely tied to the international energy research community and much of the national funding is directly linked with international projects, mainly within the IEA and the EU. Since 2004, under a bilateral treaty with the EU, Swiss research has been eligible for EU funding. Switzerland participates in 25 IEA Implementing Agreements and about 200 EU energy research projects. However, Switzerland is not actively participating in multilateral technology development efforts to advance cleaner technologies such as carbon sequestration or methane emissions reductions.

CRITIQUE

Energy R&D has a high priority in Switzerland. By international comparison, it is well funded and firmly integrated into the national energy and climate policies. Energy R&D comprehensively covers the whole innovation system: basic research, application-oriented R&D, pilot and demonstration projects, and market entry. This is also reflected in the Federal Energy Research Master Plan for 2008–2011, which should be recognised for its balanced approach and ambitious goals. The IEA commends the SFOE and CORE for their efforts to strengthen Switzerland's leading role in energy R&D.

Switzerland's policy on energy R&D is guided by an ambitious vision of reducing energy needs per person from 5 300 W in 2005 to 2 000 W in the second half of this century. The intermediate target is 4 200 W by 2050 (2 400 W renewables, 1 800 W fossil and nuclear). As this intermediate target lies still more than four decades away, the government might find explicit medium-term targets useful in assessing progress towards it. It is crucial to ensure that the short- and medium-term policy goals support this long-term objective. In particular, basic research should be closely connected to applied energy research.

If overall public spending in Switzerland were to remain constrained in the long term, the government would do well to consider focusing its funding even more strongly on the areas of the greatest importance to the country, and to complement public money even more with private funding. Co-operation between the public sector, with its longer-term approach, and the private sector, with its shorter-term focus, is essential. The private sector should be encouraged to participate more at the universities, with a focus on technology transfer and commercialisation of products.

Government support for bringing research results onto the market comes through pilot and demonstration projects and the SwissEnergy programme. Public funding for pilot and demonstration projects has been used to motivate industry to contribute to the transfer and market uptake of new energy

technologies. In this, the IEA sees a continuing role for the government and welcomes the plans to revive funding for pilot and demonstration projects in 2008–2011.

Additional funding will not be sufficient to reach the 2050 quantitative goals and, therefore, tax incentives and standards should also be considered. In the wider context of innovation policy, reaping the benefits from energy R&D spending depends also on the demand side and on the success in commercialising the products. Here, the OECD's message from 2006[17] is still relevant: the government should pay more attention to the general framework conditions conducive to innovation, such as competition and trade policy, reducing administrative burden, encouraging entrepreneurship and improving access to finance.

Switzerland's focus on international research co-operation is to be commended. Developing technologies is becoming increasingly complex, so pooling resources in international activities makes sense, especially for small countries. The IEA also commends Switzerland's active participation in the IEA Implementing Agreements and welcomes its plans to increase participation in the projects under the EU's 7th Framework Programme on Research and Development. Swiss stakeholders could benefit from even stronger participation in the EU work through the European Research Area Networks (ERA-NETs) and technology platforms.

RECOMMENDATIONS

The government of Switzerland should:

- *Ensure consistency of short- and medium-term policy with the four quantitative goals for 2050 (fossil fuels in heating, energy use in buildings, use of biomass, and fuel consumption of passenger cars).*
- *Strengthen the links between basic research and applied energy research.*
- *Consider focusing more on technologies with the highest potential to lead to specific marketable products, and encourage this by reviving the pilot and demonstration scheme.*
- *Pay close attention to the general framework conditions conducive to energy technology innovations.*
- *Increase Swiss participation in international R&D programmes, such as those of the EU and multilateral efforts.*

17. *OECD Economic Surveys – Switzerland*. Paris, 2006.

ORGANISATION OF THE REVIEW

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 Agency. The *Shared Goals* are set out in Annex C.

REVIEW TEAM

The in-depth review team visited Switzerland from 26 to 30 March 2007. 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. The team wishes to thank in particular Mr. Jean-Christophe Füeg from the SFOE for the professionalism displayed throughout the review.

The members of the team were:

Stein Øvstebø
Ministry of Petroleum and Energy, Norway (Team Leader)

Carlos Lopes
Swedish Energy Agency, Sweden

Fabrice Noilhan
Ministry of Industry, France

Timo Ritonummi
Ministry of Trade and Industry, Finland

Hans-Günther Schwarz
Ministry of Transport, Innovation and Technology, Austria

Robert Vance
Nuclear Energy Agency

Jolanka Fisher
International Energy Agency

Hisashi Yoshikawa
International Energy Agency

Miika Tommila
International Energy Agency

Miika Tommila managed the review and drafted the report with the exception of the chapters on renewables, drafted by Jolanka Fisher, and nuclear energy, drafted by Robert Vance. Monica Petit and Bertrand Sadin prepared the figures. Sandra Martin provided editorial assistance.

ORGANISATIONS VISITED

- Agency of Renewable Energies and Energy Efficiency (AEE)
- Association for Environmentally Sound Electricity (VUE)
- Association of Swiss Distribution System Operators (DSV)
- Canton of Aargau
- Canton of Basle (City)
- Canton of Uri
- Canton of Zurich
- City of Zurich
- Climate Cent Foundation
- Competition Commission
- EconomieSuisse
- Energieforum Schweiz (energy NGO)
- Energy Agency for the Economy (EAEc)
- Federal Department of Economic Affairs
- Federal Department of Finance
- Federal Energy Research Commission (CORE)
- Federal Office for Spatial Development
- Federal Office for the Environment
- Minergie
- Nuclear Repository Site Investigation Agency (NAGRA)
- Oil Industry Union (EV)
- Price Supervision
- Swisselectric
- Swissgrid (TSO)
- Swissmem
- Swiss Agency for Efficient Energy Use (SAFE)
- Swiss Agency for Electric Appliances (EAE)
- Swiss Association of Electricity Companies (VSE)
- Swiss Association of Engineers and Architects (SIA)
- Swiss Energy Foundation (SES, an environmental NGO)
- Swiss Federal Nuclear Safety Inspectorate (HSK)
- Swiss Federal Office of Energy (SFOE)
- Swiss Federation of Trade Unions (SGB)
- Swiss Gas Association (VSG)
- Swiss Nuclear Forum
- WWF Switzerland
- Zurich Municipal Electric Utility (EWZ)

ENERGY BALANCES AND KEY STATISTICAL DATA

Unit: Mtoe

SUPPLY

		1973	1990	2004	2005	2010	2020	2030
TOTAL PRODUCTION		**4.28**	**9.72**	**11.82**	**10.88**	**12.01**	**12.16**	**11.44**
Coal		–	–	–	–	–	–	–
Oil		–	–	–	–	–	–	–
Gas		–	0.00	–	–	–	–	–
Comb. Renewables & Waste[1]		0.24	0.90	1.72	1.92	2.20	2.58	3.15
Nuclear		1.64	6.18	7.05	6.11	6.36	5.58	4.12
Hydro		2.40	2.56	2.90	2.69	3.19	3.63	3.72
Geothermal		–	0.06	0.12	0.14	0.22	0.32	0.39
Solar/Wind/Other		–	0.01	0.03	0.03	0.04	0.06	0.07
TOTAL NET IMPORTS[2]		**15.23**	**15.16**	**15.34**	**16.42**	**15.19**	**14.75**	**14.41**
Coal[1]	Exports	0.02	0.01	–	–	–	–	–
	Imports	0.24	0.35	0.13	0.10	0.14	0.13	0.13
	Net Imports	0.22	0.34	0.13	0.10	0.14	0.13	0.13
Oil	Exports	0.23	0.16	0.60	0.48	–	–	–
	Imports	15.38	13.54	13.16	13.49	12.24	11.18	10.31
	Bunkers	–	0.02	0.01	0.01	–	–	–
	Net Imports	15.16	13.36	12.56	12.99	12.24	11.18	10.31
Gas	Exports	–	–	–	–	–	–	–
	Imports	0.15	1.63	2.71	2.78	2.81	2.99	3.09
	Net Imports	0.15	1.63	2.71	2.78	2.81	2.99	3.09
Electricity	Exports	0.90	1.97	2.39	2.75	1.48	0.67	0.57
	Imports	0.60	1.79	2.33	3.30	1.48	1.12	1.45
	Net Imports	-0.30	-0.18	-0.06	0.55	–	0.45	0.88
TOTAL STOCK CHANGES		**0.22**	**0.12**	**-0.03**	**-0.15**	**–**	**–**	**–**
TOTAL SUPPLY (TPES)		**19.72**	**24.99**	**27.13**	**27.15**	**27.20**	**26.91**	**25.85**
Coal		0.33	0.36	0.13	0.16	0.14	0.13	0.13
Oil		15.26	13.46	12.53	12.79	12.24	11.18	10.31
Gas		0.15	1.63	2.71	2.78	2.81	2.99	3.09
Comb. Renewables & Waste[1]		0.24	0.92	1.71	1.92	2.20	2.58	3.15
Nuclear		1.64	6.18	7.05	6.11	6.36	5.58	4.12
Hydro		2.40	2.56	2.90	2.69	3.19	3.63	3.72
Geothermal		–	0.06	0.12	0.14	0.22	0.32	0.39
Solar/Wind/Other		–	0.01	0.03	0.03	0.04	0.06	0.07
Electricity Trade[3]		-0.30	-0.18	-0.06	0.55	–	0.45	0.88
Shares (%)								
Coal		*1.7*	*1.4*	*0.5*	*0.6*	*0.5*	*0.5*	*0.5*
Oil		*77.4*	*53.8*	*46.2*	*47.1*	*45.0*	*41.5*	*39.9*
Gas		*0.8*	*6.5*	*10.0*	*10.2*	*10.3*	*11.1*	*12.0*
Comb. Renewables & Waste		*1.2*	*3.7*	*6.3*	*7.1*	*8.1*	*9.6*	*12.2*
Nuclear		*8.3*	*24.7*	*26.0*	*22.5*	*23.4*	*20.7*	*15.9*
Hydro		*12.2*	*10.3*	*10.7*	*9.9*	*11.7*	*13.5*	*14.4*
Geothermal		*–*	*0.2*	*0.5*	*0.5*	*0.8*	*1.2*	*1.5*
Solar/Wind/Other		*–*	*–*	*0.1*	*0.1*	*0.2*	*0.2*	*0.3*
Electricity Trade		*-1.5*	*-0.7*	*-0.2*	*2.0*	*–*	*1.7*	*3.4*

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

Unit: Mtoe

DEMAND

FINAL CONSUMPTION BY SECTOR

	1973	1990	2004	2005	2010	2020	2030
TFC	**17.57**	**19.70**	**22.04**	**22.52**	**21.69**	**21.30**	**20.82**
Coal	0.29	0.35	0.13	0.16	0.14	0.13	0.13
Oil	14.30	12.85	12.84	12.89	11.91	10.87	10.02
Gas	0.24	1.54	2.56	2.64	2.68	2.79	2.83
Comb. Renewables & Waste[1]	0.24	0.61	1.16	1.36	1.25	1.37	1.40
Geothermal	–	0.06	0.12	0.14	0.22	0.32	0.39
Solar/Wind/Other	–	0.01	0.02	0.03	0.04	0.05	0.05
Electricity	2.50	4.04	4.83	4.93	5.08	5.37	5.56
Heat	–	0.25	0.37	0.38	0.38	0.41	0.43
Shares (%)							
Coal	*1.6*	*1.8*	*0.6*	*0.7*	*0.6*	*0.6*	*0.6*
Oil	*81.4*	*65.2*	*58.2*	*57.2*	*54.9*	*51.0*	*48.1*
Gas	*1.3*	*7.8*	*11.6*	*11.7*	*12.3*	*13.1*	*13.6*
Comb. Renewables & Waste	*1.4*	*3.1*	*5.3*	*6.0*	*5.8*	*6.4*	*6.7*
Geothermal	–	*0.3*	*0.6*	*0.6*	*1.0*	*1.5*	*1.9*
Solar/Wind/Other	–	–	*0.1*	*0.1*	*0.2*	*0.2*	*0.3*
Electricity	*14.2*	*20.5*	*21.9*	*21.9*	*23.4*	*25.2*	*26.7*
Heat	–	*1.3*	*1.7*	*1.7*	*1.8*	*1.9*	*2.0*
TOTAL INDUSTRY[4]	**4.78**	**3.92**	**4.59**	**4.67**	**4.57**	**4.59**	**4.49**
Coal	0.08	0.33	0.13	0.13	0.13	0.12	0.13
Oil	3.70	1.31	1.45	1.42	1.21	1.16	1.11
Gas	0.05	0.59	0.81	0.83	0.89	0.87	0.84
Comb. Renewables & Waste[1]	–	0.16	0.45	0.50	0.49	0.50	0.49
Geothermal	–	–	0.01	0.01	0.02	0.02	0.03
Solar/Wind/Other	–	–	–	–	0.00	0.00	0.00
Electricity	0.95	1.48	1.60	1.63	1.68	1.76	1.75
Heat	–	0.05	0.14	0.15	0.14	0.15	0.15
Shares (%)							
Coal	*1.6*	*8.4*	*2.8*	*2.8*	*2.8*	*2.7*	*2.8*
Oil	*77.4*	*33.5*	*31.7*	*30.4*	*26.5*	*25.3*	*24.6*
Gas	*1.1*	*15.0*	*17.6*	*17.8*	*19.5*	*19.0*	*18.7*
Comb. Renewables & Waste	–	*4.0*	*9.8*	*10.6*	*10.8*	*10.9*	*11.0*
Geothermal	–	–	*0.2*	*0.2*	*0.4*	*0.5*	*0.6*
Solar/Wind/Other	–	–	–	–	–	–	–
Electricity	*19.9*	*37.8*	*34.9*	*34.8*	*36.8*	*38.3*	*39.0*
Heat	–	*1.2*	*3.0*	*3.3*	*3.1*	*3.3*	*3.3*
TRANSPORT	**4.29**	**6.29**	**7.10**	**7.15**	**7.19**	**7.01**	**6.83**
TOTAL OTHER SECTORS[5]	**8.49**	**9.49**	**10.35**	**10.70**	**9.94**	**9.70**	**9.51**
Coal	0.21	0.02	0.01	0.02	0.01	0.01	0.01
Oil	6.48	5.47	4.54	4.58	3.92	3.28	2.76
Gas	0.19	0.95	1.75	1.81	1.73	1.81	1.86
Comb. Renewables & Waste[1]	0.24	0.46	0.71	0.86	0.65	0.65	0.65
Geothermal	–	0.06	0.12	0.13	0.20	0.29	0.37
Solar/Wind/Other	–	0.01	0.02	0.02	0.04	0.05	0.05
Electricity	1.37	2.34	2.98	3.05	3.16	3.35	3.53
Heat	–	0.20	0.23	0.23	0.24	0.26	0.28
Shares (%)							
Coal	*2.5*	*0.2*	*0.1*	*0.2*	*0.1*	*0.1*	*0.1*
Oil	*76.3*	*57.6*	*43.9*	*42.8*	*39.4*	*33.8*	*29.1*
Gas	*2.2*	*10.0*	*16.9*	*16.9*	*17.4*	*18.7*	*19.6*
Comb. Renewables & Waste	*2.8*	*4.8*	*6.8*	*8.0*	*6.5*	*6.7*	*6.8*
Geothermal	–	*0.6*	*1.1*	*1.2*	*2.0*	*3.0*	*3.9*
Solar/Wind/Other	–	*0.1*	*0.2*	*0.2*	*0.4*	*0.5*	*0.6*
Electricity	*16.1*	*24.6*	*28.7*	*28.5*	*31.8*	*34.5*	*37.1*
Heat	–	*2.1*	*2.2*	*2.2*	*2.4*	*2.7*	*2.9*

Unit: Mtoe

DEMAND

ENERGY TRANSFORMATION AND LOSSES

	1973	1990	2004	2005	2010	2020	2030
ELECTRICITY GENERATION[6]							
INPUT (Mtoe)	**4.48**	**9.25**	**10.67**	**9.51**	**10.64**	**10.63**	**9.84**
OUTPUT (Mtoe)	**3.17**	**4.73**	**5.49**	**4.97**	**5.61**	**5.91**	**5.68**
(TWh gross)	36.82	54.99	63.88	57.75	65.19	68.70	66.04
Output Shares (%)							
Coal	–	*0.1*	–	–	–	–	–
Oil	*7.1*	*0.7*	*0.3*	*0.3*	*0.3*	*0.3*	*0.3*
Gas	–	*0.6*	*1.5*	*1.5*	*1.5*	*2.5*	*3.3*
Comb. Renewables & Waste	–	*1.5*	*3.1*	*3.6*	*3.8*	*4.6*	*6.8*
Nuclear	*17.1*	*43.0*	*42.2*	*40.4*	*37.4*	*31.1*	*23.9*
Hydro	*75.8*	*54.2*	*52.8*	*54.1*	*56.9*	*61.4*	*65.4*
Geothermal	–	–	–	–	–	–	–
Solar/Wind/Other	–	*0.0*	*0.0*	*0.0*	*0.1*	*0.1*	*0.2*
TOTAL LOSSES	**2.17**	**4.95**	**5.74**	**5.09**	**5.50**	**5.60**	**5.02**
of which:							
Electricity and Heat Generation[7]	1.32	4.25	4.78	4.13	4.76	4.78	4.21
Other Transformation	0.14	0.01	–0.03	–0.02	–	–	–
Own Use and Losses[8]	**0.72**	**0.69**	**0.99**	**0.97**	**0.75**	**0.82**	**0.81**
Statistical Differences	**–0.02**	**0.34**	**–0.64**	**–0.46**	**–**	**–**	**–**

INDICATORS

	1973	1990	2004	2005	2010	2020	2030
GDP (billion 2000 USD)	174.28	221.69	254.66	259.57	289.32	329.21	374.60
Population (millions)	6.44	6.80	7.45	7.50	7.50	7.40	7.40
TPES/GDP[9]	0.11	0.11	0.11	0.10	0.09	0.08	0.07
Energy Production/TPES	0.22	0.39	0.44	0.40	0.44	0.45	0.44
Per Capita TPES[10]	3.06	3.68	3.64	3.62	3.63	3.64	3.49
Oil Supply/GDP[9]	0.09	0.06	0.05	0.05	0.04	0.03	0.03
TFC/GDP[9]	0.10	0.09	0.09	0.09	0.07	0.06	0.06
Per Capita TFC[10]	2.73	2.90	2.96	3.00	2.89	2.88	2.81
Energy-related emissions (Mt CO_2)[11]	43.6	41.3	44.5	45.0	42.2	39.5	37.2
CO_2 Emissions from Bunkers (Mt CO_2)	2.1	3.2	3.6	3.7	4.0	4.6	5.2

GROWTH RATES (% per year)

	73-79	79-90	90-04	04-05	05-10	10-20	20-30
TPES	0.2	2.1	0.6	0.1	0.0	–0.1	–0.4
Coal	–6.3	4.5	–6.8	15.7	–2.2	–0.6	0.2
Oil	–2.2	0.1	–0.5	2.1	–0.9	–0.9	–0.8
Gas	31.0	7.2	3.7	2.7	0.2	0.6	0.3
Comb. Renewables & Waste	11.2	6.6	4.6	12.2	2.7	1.6	2.0
Nuclear	11.0	6.5	0.9	–13.4	0.8	–1.3	–3.0
Hydro	2.1	–0.5	0.9	–7.5	3.5	1.3	0.2
Geothermal	–	–	5.2	10.5	9.4	4.0	2.2
Solar/Wind/Other	–	–	8.8	3.8	9.8	2.5	1.7
TFC	–0.6	1.4	0.8	2.2	–0.7	–0.2	–0.2
Electricity Consumption	2.6	3.0	1.3	2.0	0.6	0.6	0.3
Energy Production	6.5	4.1	1.4	–8.0	2.0	0.1	–0.6
Net Oil Imports	–1.6	–0.3	–0.4	3.5	–1.2	–0.9	–0.8
GDP	–0.4	2.4	1.0	1.9	2.2	1.3	1.3
Growth in the TPES/GDP Ratio	0.6	–0.4	–0.4	–1.8	–2.1	–1.4	–1.7
Growth in the TFC/GDP Ratio	–0.3	–1.0	–0.2	0.2	–2.9	–1.5	–1.5

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, industrial waste and municipal waste. Data are often based on partial surveys and may not be comparable between countries.

2. Total net imports include combustible renewables and waste and trade of heat.

3. Total supply of electricity represents net trade. A negative number in the share of TPES indicates that exports are greater than imports.

4. Industry includes non-energy use.

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

6. Inputs to electricity generation include inputs to electricity, CHP and heat plants. Output refers only to electricity generation.

7. 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 33% for nuclear and 100% for hydro and photovoltaic.

8. Data on "losses" for forecast years often include large statistical differences covering differences between expected supply and demand and mostly do not reflect real expectations on transformation gains and losses.

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

10. Toe per person.

11. "Energy-related CO_2 emissions" have been estimated using the IPCC Tier I Sectoral Approach. 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 2005 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 26 member countries* of the International Energy Agency (IEA) seek to create conditions in which the energy sectors of their economies can make the fullest possible contribution to sustainable economic development and to 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, member countries therefore aim to create a policy framework consistent with the following goals:

1. **Diversity, efficiency and flexibility within the energy sector** are basic conditions for longer-term energy security: the fuels used within and across sectors and the sources of those fuels should be as diverse as practicable. Non-fossil fuels, particularly nuclear and hydro power, make a substantial contribution to the energy supply diversity of IEA countries as a group.

2. Energy systems should have **the ability to respond promptly and flexibly to energy emergencies.** In some cases this requires collective mechanisms and action: IEA countries co-operate through the Agency in responding jointly to oil supply emergencies.

3. **The environmentally sustainable provision and use of energy** are 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 respect the Polluter Pays Principle where practicable.

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 member

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

countries wish to retain and improve 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 encourages 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 subsequently abbreviated, this glossary provides a quick and central reference for many of the abbreviations used.

AMR	automatic meter-reading.
BAU	business as usual.
b/d	barrels per day.
bcm	billion cubic metres.
CCGT	combined-cycle gas turbine.
CHP	combined production of heat and power; sometimes when referring to industrial CHP, the term "co-generation" is used.
CH_4	methane.
CLRTAP	UNECE Convention on Long-Range Transboundary Air Pollution.
CO_2	carbon dioxide.
CO_2 Law	1999 Federal Law on the Reduction of CO_2.
CORE	Federal Energy Research Commission.
CTI	Swiss Innovation Promotion Agency.
DETEC	Department (Ministry) of the Environment, Transport, Energy and Communications.
DHM	deep heating mining.
EAEc	Energy Agency for the Economy.
EEX	European Energy Exchange.
ElCom	Electricity Commission.
EU	European Union.
EU-ETS	EU Emissions Trading Scheme.
FIT	Swiss Federal Institutes of Technology.
FOEN	Federal Office for the Environment.
FONES	Federal Office for National Economic Supply.

GCV	gross calorific value.
GDP	gross domestic product.
GHG	greenhouse gas.
GW	gigawatt, or 1 watt × 10^9.
GWh	gigawatt-hour = 1 gigawatt × 1 hour.
HSK/DSN	Swiss Federal Nuclear Safety Inspectorate.
IEA	International Energy Agency.
IEP	International Energy Program (one of the founding documents of the IEA).
IT	information technology.
kcal	kilocalorie, or 1 cal × 10^3.
km^2	square kilometre.
kt	kilotonne.
ktoe	thousand tonnes of oil equivalent; see toe.
kW	kilowatt, or 1 watt × 10^3.
kWh	kilowatt-hour = 1 kilowatt × one hour.
LES	Law on Electricity Supply.
LNG	liquefied natural gas.
LPG	liquefied petroleum gas.
m	metre.
m^2	square metre.
m^3	cubic metre.
mboe	million barrels of oil equivalent.
mcm	million cubic metres.
MEPS	minimum energy performance standards.
Mt	million tonnes.
Mt CO_2-eq	million tonnes of CO_2 equivalent.
Mtoe	million tonnes of oil equivalent; see toe.
MW	megawatt, or 1 watt x 10^6.
MWh	megawatt-hour = 1 megawatt x one hour.
NAGRA	National Co-operative for the Disposal of Radioactive Waste.

NEL	Nuclear Energy Law.
NGO	non-governmental organisation.
NMVOC	non-methane volatile organic compound.
Nm^3	normal cubic metre.
NO_x	nitrogen oxide.
NPP	nuclear power plant.
OECD	Organisation for Economic Co-operation and Development.
PM	particulate matter.
PSU	Price Supervision.
PV	photovoltaics.
R&D	research and development, especially in energy technology; may include the demonstration and dissemination phases as well.
SAFE	Swiss Agency for Efficient Energy Use.
SBG	schedule balance group.
SFOE	Swiss Federal Office of Energy.
SME	small and medium-sized enterprises.
SO_2	sulphur dioxide.
SWEP	Swiss Electricity Price Index.
Swissix	Swiss Electricity Index.
TFC	total final consumption of energy.
TJ	terajoule.
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 × 10^{12}.
TWh	terawatt-hour =1 terawatt × 1 hour.
UCTE	Union for the Co-ordination of Transmission of Electricity.
UNFCCC	United Nations Framework Convention on Climate Change.
VAT	value-added tax.
VOC	volatile organic compound.
W	watt.

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