8. SLOVAKIA

J. Balajka
Profing spol. s r.o.

8.1. Introduction

Since 1999, the International Atomic Energy Agency (IAEA) has been engaged in a cooperative project with the UN Department of Economic and Social Affairs (UNDESA) and other international research organizations to formulate a set of comprehensive indicators for sustainable energy development (ISED) and to implement and test them in a number of countries (IAEA/IEA, 2003).

8.1.1. Slovakian Case study

Slovakia is one of seven countries that participated in a three-year coordinated research project (CRP) conducted by the IAEA, and set out to define, test and implement the ISED set. Slovakia's participation has at least one unique attribute –Slovakia is a new European Union (EU) member and experienced a process of economic transformation which accompanied the EU accession. Therefore an analysis of recent development using the selected indicators can provide relevant information about this economic transformation of the whole economy and EU accession process, as well as a basis for additional energy and environmental policy formulation.

This chapter summarizes the main findings of the review process carried out in Slovakia under the IAEA project entitled: *"Historical Evolution of Indicators of Sustainable Energy Development (ISED) and the Use of this Information for Designing Guidelines for Future Energy Strategies in Conformity with the Objectives of Sustainable Development"*. Detailed analyses have focused primarily on the following issues:

- Identification of national energy policy priority areas.
- Review of the energy statistical data capability of the country, identification of data relevant to the priority issues, and determination of additional indicators that could be collected and recorded in the future.
- Compilation of data (including time series) needed to develop relevant ISED specific information for priority issues.
- Priority area and relevant ISED trend analyses, and historical data.
- Recommendations related to the main issues, and relevant ISED to improve development of national energy and environmental policies.

8.1.2. Approach and Scope of the Study

The Slovakian case study was conducted during the 2002-2005 period. This final report reflects the situation and national energy priorities at the time of its preparation (i.e., the time when the EU accession process was ending). In the year 2004, Slovakia became a member of the EU, and in that same year a new proposal of Energy Policy (Ministry of Economy of Slovakia (MES), 2004) was prepared by the Ministry of Economy, just at the time this final report was being prepared. Therefore, previous progress reports had to be rewritten in order to reflect as far as possible new issues included in this final version. Nonetheless, the main objectives of the material did not differ substantially, and the main difference lay in the fact that the EU accession process was finalised.

Data collected for this study are the result of a close co-operation of the research team with the Slovak government representatives, namely from the Ministry of Economy, the Ministry of Environment, the Hydrometeorological Institute and also from the Statistical Office of Slovakia.

8.2. Overview of the Energy Sector

The total energy balance can be roughly split into the following energy chains, moving from primary energy sources through final energy use (Statistical Office of Slovakia (SOS), 2005):

- Primary energy sources, including indigenous fuels and energy imports;
- Conversion of primary fuels, including oil refinery and coke and coal derived gas production;
- Generation of energy carriers, including electricity and heat;
- Final energy uses in industrial, commercial, services, and residential sectors.

The energy balance for Slovakia is presented in ANNEX 1.

8.2.1. Primary energy sources

Lignite and hydropower represent the only domestic energy resources to any considerable extent. Slovakia is very dependent on imported energy, and the country has a very low degree of energy source diversification. Slovakia imports 90% of its basic energy requirements (if the basic nuclear fuel is included). Almost all the imported resources come from Russia while the rest is satisfied with imports from the Czech Republic, Poland and Ukraine. Domestic sources cover only 10% of PES – 3% from hydro, 6% from lignite and 1% from natural gas and oil. Data in Table 8.1 shows the primary energy supply for Slovakia for 2000.

TABLE 8.1 BALANCE OF TOTAL PRIMARY ENERGY SUPPLY (TPES), 2000 (TJ)

	Solid [1]	Liquid	Gaseous	Fuel total	Heat [2]	Electricity [3]	Total
Domestic	45,600	2,436	5,620	53,656	211,523	18,101	283,280
Import	145,321	231,362	242,613	619,296	0	3,424	622,720
Export	1,709	119,599	23	121,331	0	13,129	134,460
Stockpile change	-6,890	3,659	-18,215	-21,446	-	-	-21,446
Other sources	-675	2,851	15,479	17,655	0	0	17,655
TPES in total	181,647	120,709	245,474	547,830	211,523	8,396	767,749

1 Biomass is included in solid fuels

2 Nuclear primary heat released in primary circuit of nuclear power plant

3 Domestic sources represent electricity generated in hydropower and nuclear plants

8.2.2. Conversion of primary fuels

There are two crude oil refineries operating in Slovakia, one large and one very small. The Slovnaft, a.s., refinery in Bratislava is the only major one in Slovakia. It processes imported crude oil and produces motor fuels, fuel oils, lubricants and petrochemical products (plastics). The second one, a small refinery unit, is Petrochema's Dubová plant, which processes domestic low-sulphur crude oil of higher quality to produce medical oils and similar, high quality products. Motor and heating fuels are by-products. Technology for deep crude oil processing was installed in Slovnaft, a.s. in past years to increase the share of light products (gasoline, diesel) and decrease the share of heavy fuel oils.

The other process for fuel conversion is applied in a steel mill in the US Steel, a.s. facility at Košice. Coking coal is converted into coke and coking gases. Other gases are generated in the blast furnace

and converter, and all of these gases are used for heating in technology applications as well as in industrial combined heat and power (CHP).

8.2.3. Heat and electricity production

8.2.3.1. Public Power plants

The former Slovak electricity system consisted of four public utilities, which were the dominant producers and suppliers, and also a small number of independent power producers (in the industrial sector or some small hydropower producers). This public system included the electricity generation and transmission company Slovenské elektrárne, a.s. (SE) and three regional distribution companies that mainly supplied electricity (and heat) to the end-user.

The three regional distribution companies were privatised in 2001 into:

- Západoslovenská energetika, a.s. (west) – owned 49% by Deutsche E.ON Energie;
- Stredoslovenská energetika, a.s. (central) – owned 49% by Electricité de France;
- Východoslovenská energetika, a.s.(east) – owned 49% by Deutsche RWE Plus.

The Západoslovenská energetika, a.s and Stredoslovenská energetika, a.s. have their own CHP facilities, generating 2% of the total electricity.

SE owned and operated 86% of the installed capacity of power plants in Slovakia and produced 76% of the domestic supplies. The company was split in 2002 into a generation part and an electricity transmission part as follows:

- Slovenské elektrárne, a.s. – which owns 90% of the property from the previous SE, (nuclear, thermal and large scale hydro power plants), and is now privatized and owned by the company ENEL of Italy).
- Slovenská elektrizačná prenosová sústava, a.s. (Slovak electricity transmission system, a.s.) – which owns the transmission network (220 and 400 kV), transformer stations and the central dispatch centre in Žilina.
- Tepláreň Košice, a.s. – CHP to supply electricity and heat.

The SE owns and operates the following power plants:

1. The nuclear power plants (NPP) JEV1 and JEV2 located in Jaslovské Bohunice 70 km northwest of Bratislava. Each plant has two units with an installed capacity of 2 x 440 MWe (VVER type), for a total of 1,760 MWe. The old units in JEV1 were planned to be retired in 2006 and 2008, respectively, according to the Resolution of Slovakian Government No. 801/1999. The other nuclear power plant, JEV2, is located in Mochovce. Two units each of 440 MWe (VVER type) were put into operation in 2000, and two other units of the same capacity are currently about 60% completed. The future of these two units is not clear now, and will strongly depend upon both the transformation and privatisation processes, as well as on the developments following EU accession.

2. The thermal power plant ENO. This power plant uses domestic coal and is located in Zemianske Kostoľany (in the upper Nitra valley), close to the underground lignite mines. Currently the following units are installed:

- 2 x 110 MWe units with dry bottom boilers equipped with flue gas desulphurization (FGD)/wet scrubber technology;
- 2x 110 MWe units with dry bottom boilers without FGD, that do not comply with adopted environmental legislation (SO_2 stack concentration limit); their retirement by 2006 was under consideration;

- ENO A units, 28 + 32 MWe with dry bottom boiler without FGD, and 24.4 MWe with fluidized bed combustion boiler. The power plant supplies electricity as well as heat for the industrial and residential sectors.

3. The thermal power plant EVO1. This power plant has an installed capacity of 6 x 110 MWe, burning hard coal in wet bottom boilers. Two boilers were retrofitted with FGD, two others were repowered with fluidized bed combustion boilers, and the other two without FGD will be retired.

4. The thermal power plant EVO 2. This power plant has installed capacity of 6 x 110 MWe units with combustion of natural gas (NG) and/or heavy fuel oils. It covers the peak demand together with pumped storage hydropower plants (HPP).

5. The hydropower plant Gabčíkovo. On the Danube river, this has a total capacity of 746.5 MWe.

6. The hydropower plant Trenčin. Based on a dam cascade on the Váh river, it has a total capacity of 1,649 MW including pumped storage.

7. The hydropower plant Dobšiná. It has total capacity of 141 MWe including pumped storage.

8.2.3.2. Public CHP

Three regional distribution companies are responsible for about 2 % of the total electricity production, but their main role is to distribute and supply electricity and heat on a regional level. They own and operate the transmission lines of less than 220 kV and the local distribution networks. The CHP and heat plants (HP) in the cities of Bratislava and Trnava are fuelled by NG; CHP and HP in middle Slovakia (Žilina, Zvolen, Martin) are fuelled by a fuel mix of brown coal (lignite) and NG. The new established plant in Košice is fuelled by a fuel mix of hard coal and NG.

8.2.3.3. Local Heating Plants

District heat supply is assured from the boiler houses located in city districts close to the heat consumers. District heat is supplied for consumers in the residential, industrial, commercial and service sectors. In some cities, an integrated hot water supply system was built, and heat could be supplied from local heating plants (HP) and public and industrial CHP. In recent years, some consumers in the commercial and industrial sectors have shut down these connections and built their own heat sources. The aim of national policy is to sustain the share of district heat supplied by existing distribution networks.

The local HP typically use coal, biomass, oil and gas as fuel. Due to adopted environmental legislation for air quality protection, the share of NG has significantly increased since 1990.

8.2.4. Final energy uses

Table 8.2 outlines figures on final energy consumption by individual sectors in the year 2000.

TABLE 8.2 FINAL ENERGY CONSUMPTION BY SECTORS IN 2000 [TJ]

	Solid[1]	Liquid	Gaseous	Heat	Electricity
Forestry	61	704	114	101	138
Agriculture	346	5,825	2,034	2,120	2,585
Industry	47,411	8,597	87,338	36,356	100,046
Construction	82	2,800	1,398	479	873
Transport	801	8,792	396	3,474	4,553
Residential	2,066	15,330	60,814	19,508	35,759
Other	8,509	24,149	20,371	18,967	30,256
Final energy cons. in total	59,276	66,197	172,465	81,005	174,210

1 Biomass is included in solid fuels

8.3. Review of energy statistical data capability

Officially established institutions in Slovakia collect and provide data within a strictly defined legal framework. There are a wide range of activities, starting with data collection and recording; this is followed by reporting for official domestic and international statistics. These tasks can also be extended for other pre-defined purposes (e.g., estimating charges for air pollution, wastes, etc.). With regards to input data for ISED, the most important institutions were the Statistical Office of Slovakia and the Hydrometeorological Institute.

8.3.1. Statistical Office of Slovakia

The Statistical Office of the Slovakia performs statistical analyses to determine the demographic, economic and social developments in the country. The inputs are determined by the actual legislation framework, while outputs are issued periodically and presented primarily at four levels:

- basic indicators for long-term development;
- detailed indicators for short-term periods (i.e., from 1 to 5 years);
- brief indicators in regional classification mode;
- comparison of national and international data.

The Statistical Yearbook (SOS, 1995-2003) and Energy Statistics (SOS, 2005), published by this institute were the principal sources of ISED data for this study. Both of these were harmonised with EU and other international methodologies. The Statistical Office cooperates with EUROSTAT and other EU and international bodies, and also periodically issues other time series of specific selections of available data – for example, selected indicators of economic development, data on individual industries, etc. (SOS, 2002a), (SOS, 1997-2001).

The Statistical Office of Slovakia is the authority officially organizing and performing annual statistical analyses, and issuing related findings. The reporting duty to fill out statistical forms is issued by Act No. 322/1992 Coll. 27 on National Statistics, as amended. According to this Act, statistical determinations are also performed by relevant ministries and other central offices of the state administration. These determinations are advised by the Statistical Office as well, and regularly become integrated into the programme of state statistical findings.

8.3.2. Slovak Hydrometeorological Institute

The Slovak Hydrometeorological Institute ensures collection, recording and reporting of environmental data. Among others, it operates the database of individual sources of air pollution used for yearly balanced inventories of basic pollutants and greenhouse gas emissions. These data are covered by the National Emission Inventory System (NEIS) that covers not only emission data but also data addressing fuel consumption, thermal capacities of energy sources, etc. (MENV, 2000-2003). One new activity that is connected with environmental concerns is the National Allocation Plan for selected GHG emission sources, participating in the EU carbon dioxide emission trading scheme.

8.3.3. Other data sources

Other sources of data for ISED included the Ministry of Transport and Telecommunication, electric and gas utilities, the Energy Agency, and consultant offices in energy, environment and civil engineering fields. All of these data were also utilized in a previous national study of energy efficiency (World Bank/MES, 2002).

8.4. Implementation of ISED framework

The process of transition of the type of economy in Slovakia (similar to that in other Economies in Transition), does not allow the collection of a long time series of historical data, nor to use such time series as basis for energy development analyses under ISED. The situation in Slovakia is also complicated by the fact that it only became an independent country in 1993. This fact, together with ongoing changes of methodology in collecting and reporting statistical data, have had a negative impact on the availability of data over the entire period being considered. Energy Statistics (SOS, 2005) providing specific national energy data was first issued in 1997. Annually issued Statistical Yearbooks are continuously adjusted and updated for previous years due to the harmonisation of methodologies with the EU approaches. Another important concern arises from the fact that data are not expressed in the form or detail required for ISED calculation purposes.

A time series of selected ISED data have been developed for the period 1993–2000, with some additional data for 2002. This period begins in the year when Slovakia became an independent state. However, even for this relatively short period, data for the indicators have not always been available in consistent series. Statistical measures have been changed during the whole economic activity period. For example, the issuing of Energy Statistics in detail only started in 1997, and regularly issued Statistical Yearbooks have not covered all areas of interest in time series and/or in the type of data necessary for ISED. In order to obtain a full time series, some missing data have been extrapolated.

8.4.1. ISED implemented in the Slovakian case study

According to the IAEA methodology, the ISED considers four dimensions: social, environmental, economic and institutional.

Data were structured according to the framework proposed by the IAEA, and the total ISED time series for the 1993-2002 period are summarized in ANNEX B. Table 8.3 provides a summary of ISED that were fully or partly elaborated using available data for Slovakia.

TABLE 8.3 LIST OF ISED INDICATORS WITH ECONOMIC AND ENVIRONMENTAL DIMENSIONS

Indirect driving force	
ISED #1	Population
ISED #2	GDP per capita
ISED #3	End-use energy prices with and without tax/subsidy
ISED #4	Shares of sectors in GDP value added
ISED #5	Distance travelled per capita by passengers
ISED #6	Freight transport activity
ISED #7	Floor area per capita
ISED #8	Manufacturing value added by selected energy intensive industries
Indirect driving force within energy sector	
ISED #9	Energy intensities
ISED #10	Final energy intensity of production
ISED #11	Energy mix
ISED #12	Energy supply efficiency
ISED #13	Status of deployment of pollution abatement technologies
Direct driving force within energy sector	
ISED #14	Energy use per unit of GDP
State ISED	

ISED #16	Energy consumption per capita
ISED #17	Indigenous energy production
ISED #18	Energy net imports dependency
Direct driving force	
ISED #23	Quantities of air pollutant emissions
ISED #26	Quantities of greenhouse gas emissions from energy related activities
ISED #27	Radionuclides in atmospheric radioactive discharges
ISED #28	Discharges into water basin associated with energy activity
State ISED	
ISED #24	Ambient concentration of pollutants in urban areas
ISED #31	Generation of radioactive waste from fuel cycle chains of nuclear power generation
ISED #34	Fatalities due to accidents

8.4.2. Social dimension

Two main indicators of the social dimension are: energy disparities, and energy affordability and accessibility. These parameters are not critical in Slovakia's case, since there is a high degree of accessibility, and even small villages are fully connected to the electricity grid. The share of availability for the supply of natural gas increased in 2004 to more than 80% of all inhabitants. The social situation resulting from the relationship between energy prices and incomes does not appear to be critical, even though during the ongoing process of economic reforms subsidies for heat and electricity have already been fully removed and higher tariffs have been implemented (including in the residential sector, for gas and electricity prices).

As a specific critical social issue within Slovakia, the impact of the on-going economic transformation process, together with the impact of new environmental requirements on employment rates in the mining sector, have to be considered.

8.4.3. Environmental dimension

To evaluate the environmental dimension of sustainability according to the IAEA methodology, the following issues were addressed:

- Global climate change
- Air pollution
- Water pollution
- Wastes
- Energy resource depletion
- Land use
- Accident risks
- Deforestation

In view of impacts on the energy sector, global climate issues as well as air pollution by basic pollutant within regional, national and EU-region impacts must be considered.

8.4.3.1. *Global climate change*

The energy system is responsible for the bulk of GHG emissions in Slovakia, in that the energy related CO_2 emissions represent more than 80% of the total GHG balance. Slovakia ratified both the UNFCCC and the Kyoto Protocol (MENV, 1999), (Transport Research Institute, 2000). According to actual data of annual GHG emissions and their projections, Slovakia has a chance to participate within the GHG emission trading framework of the Kyoto Protocol's flexibility mechanisms and the EU emissions trading scheme (ETS). Both the Joint Implementation (JI) and the ETS can bring additional financial resources needed for a broader updating of existing equipment, and/or implementation of brand new energy conversion technologies.

8.4.3.2. *Air pollution*

The total amount of basic pollutant emissions from energy and industrial sources decreased during the period of economic transformation. It was primarily due to the impact of restructuring in industry, accompanied by a decrease in energy demand. It was also due to adopted environmental legislation, which directly motivates sources to implement abatement technologies. On-going adjustments of the Air Protection Act as well as harmonization of the existing environmental legislation framework with the EU will bring further decreases in levels of pollution. Specific applications of air quality legislation in Slovakia include emission quotas and trading for SO_2 emissions (already adopted), as well as a scheme for a CO_2 cap and trading system that is under development now. Slovakia should be able to benefit from the practical emissions trading experiences gained directly at the stakeholder level in potential international trading schemes, too.

8.4.4. Economic dimension

To qualify and quantify the economic dimension of sustainability, the following themes were considered:

- Economic activity levels
- Energy production, supply and consumption
- Energy pricing, taxation and subsidies
- End-use energy intensities
- Energy supply efficiency
- Energy security

8.4.5. Main problems implementing ISED in Slovakia

In order to utilize ISED for sustainable energy development a long time series of indicators is preferred. In such a case, consistent statistical input data should be available. The methodology of data collection and handling should not be dramatically changed during the period under consideration. Unfortunately, this is not the case for countries with Economies in Transition. Slovakia was established in 1993, and the methodology of data collection and processing has been changing due to both the period of transformation and the EU accession process. Therefore, the complete time series need for the implementation of the ISED was not available, and "jumps" can be observed in some of the available time series. These were caused mainly by the following issues:

- The process of privatization brought about changes in the classification of economic entities in economic sectors and industrial branches. It also caused some inconsistent changes in value added (VA) structures.
- The methodology for energy statistics changed in the year 2002, and reported energy data for the years 2001 and 2002 are based on the new methodology.

8.5. Identification of major energy priority areas and its relation to applied ISED

The 2000 issue of Energy Policy of Slovakia (MES, 2000) was used as the basis for the selection of major energy priorities. This document defined priorities at a relatively general level reflecting the main political targets of economic transformation and the EU accession process. The main objectives defined in the 2000 Energy Policy were:

- preparation of integration into the European Union internal market;
- security of energy supply;
- sustainable development.

The latest proposal of Energy Policy (IEA, 2005), (MES, 2004), which was issued in December 2004, strictly defined the following priorities of future energy policy:

Priority 1: Reliable, environmentally acceptable and economically effective energy supply

Priority 2: Involvement in international electricity and gas markets

Priority 3: Lower dependency on fossil fuel imports

Comparing the priorities selected on the basis of the previous Energy Policy issue and the most recent Energy Policy proposal, the same set of ISED with economic and environmental dimensions can be applied. The main differences between the last Energy Policy and its new proposal lies in the fact that, in year 2004, Slovakia became a member of the EU and all accession processes are now finalised. Nevertheless, the time series for ISED can illustrate the impact of economic transformation and the EU accession process on the energy sector, as well as make clear whether Slovakia is prepared to achieve the priorities defined by the new Energy Policy proposal.

Considering the objectives of the previous Energy Policy as well as the defined priorities of the new Energy Policy proposal, the following issues were analysed, using the ISED time series:

ISED related to the EU accession process

- Macroeconomic indicators
- Final energy prices
- Share of sectors for GDP value added
- Value added shares of industrial branches

ISED related to security of energy supply.

This issue is consistent with priority No. 3 of the new Energy Policy proposal - *lower dependency on fossil fuel imports*

ISED related to sustainable development

This issue is consistent with priority No. 1 of the new Energy Policy proposal - *Reliable, environmentally acceptable and economically effective energy supply*

8.5.1. EU accession process

The accession into the European Union, one of the objectives from the previous Energy Policy (MES, 2000), included several measures. It required a restructuring of the energy sector, new principles of regulation in the energy sector, price adjustments, and liberalisation and opening of the market. The main objective for integrating into the European internal market was to transform the energy sector to become a fully competitive sector of the economy, able and prepared to access the European market. From these EU priorities, only the price priority is related to the economic dimension of ISED. The

other priorities are related instead to the institutional dimension, and are not directly covered by ISED. Nevertheless, the impact of restructuring and privatisation of energy companies can be indirectly analysed by macroeconomic indicators used within ISED, such as GDP and its sectoral structure. Given the accession process for entering the EU, the comparison of ISED with other EU countries and/or the EU average is important for analyzing the transition process. Considering the list of ISED, the following were selected as most relevant to analyse the EU accession process:

Macroeconomic data, including population and GDP/capita (ISED # 1 and 2).

End-use energy prices, including automotive fuel, electricity, district heat, natural gas and light fuel oils. (ISED # 3).

Sectoral contribution to GDP (ISED # 4) and VA of manufacturing sectors (ISED # 8).

8.5.1.1. Macroeconomic data

The principal macroeconomic indicators are population and GDP growth rates, which are the driving force of the whole national economy and derived impacts (See Table 8.4).

TABLE 8.4 MACROECONOMIC DATA

ISED #	Indicator	Unit	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002
1.	Population											
1.1.	Total:	Million	5.336	5.356	5.368	5.379	5.388	5.393	5.399	5.403	5.379	5.379
2.	GDP											
2.1.	GDP c.p 95 USD/cap	$/cap	2,593	3,112	3,612	3,991	4,448	4,873	5,258	5,814	6,314	6,712
2.2.	GDP per capita (PPP):	$/cap	8,319	9,910	9,281	10,095	10,703	11,720	13,584	14,197	15,261	15,926

Figure 8.1 illustrates trends of GDP PPP/cap both for Slovakia and EU average (EUROSTAT, 2005) and the Slovakia/EU ratio of this ISED. Analyses of these trends help to assess Slovakia economic growth situation in relation to the EU countries average. While in the beginning of the period under consideration the Slovak GDP_{PPP}/cap curve lies below the $EU_{average}$ one, this trend was changed in 1998. That indicates that economic growth in Slovakia was higher than the EU_{av} after that year.

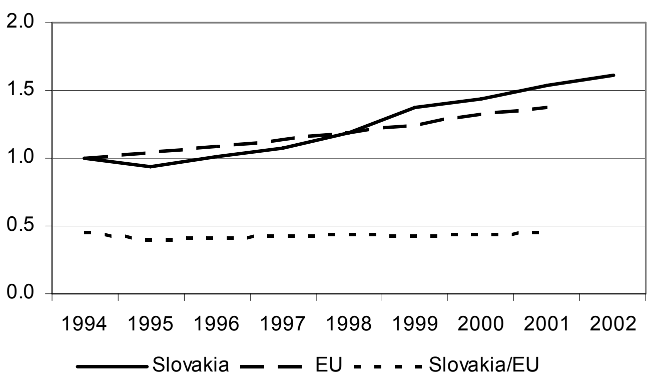


Figure 8.1 Indices of GDP_{PPP}/cap trends for Slovakia and EU $_{average}$ (1994 = 1.0)

8.5.1.2. End-use energy prices with and without tax/subsidy

For analyses of national priorities in connection with the EU accession process, the most important data and development trends concern the following end-use energy carriers:

- Automotive fuels
- Electricity

- District heat
- Natural gas
- Light fuel oil

Automotive fuels

TABLE 8.5 PRICES AND TAXES/SUBSIDIES OF AUTOMOTIVE FUELS (OECD/IEA, 2003)

ISED # 3.1.	Automotive fuel	Unit	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002
3.1.1.		Leaded gasoline 91										
3.1.1.1	With tax/subsidy	$/1,000 liter	664	671	653	711	742	713	856	1,114	1,057	1,110
3.1.1.2	Without tax/subsidy	$/1,000 liter	257	258	242	289	330	315	379	510	463	424
3.1.2.		Unleaded gasoline 95										
3.1.2.1	With tax/subsidy	$/1,000 liter	647	665	655	702	745	734	910	1,126	1,067	1,012
3.1.2.2	Without tax/subsidy	$/1,000 liter	280	286	272	315	354	332	397	519	471	425
3.1.3.		Automotive gasoline										
3.1.3.1	With tax/subsidy	$/1,000 liter	452	455	474	535	702	706	738	867	838	769
3.1.3.2	Without tax/subsidy	$/1,000 liter	197	200	206	252	317	292	342	462	424	392

Figure 8.2 compares prices of automotive fuels in Slovakia with those for Germany (GR) and Netherlands (NL), both EU members. The comparison (using exchange rates for SKK/EUR) indicates that for gasoline, the typical EU prices are higher than those of Slovakia throughout the whole period, despite quite expensive domestic price increases (i.e., 60% over the period 1993-2003). In the case of diesel fuel, there is a smaller difference.

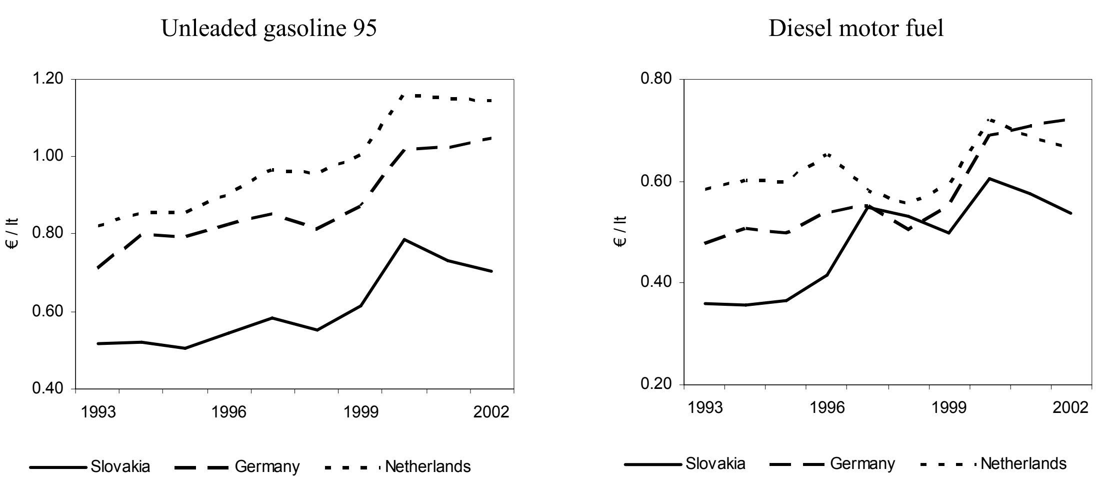


Figure 8.2. Comparison of automotive fuel prices

Slovakia successfully met a goal in 1993 by adopting a new tax system, which covered the same range of goods as the EU one. A comparison of the excise taxes for petroleum products for the EU and Slovakia in 2001 shows a high degree of similarity, even if the structure of the tax, as well as the manner of tax accounting and treatment, are still very different.

Prices of end-use energy carriers

TABLE 8.6 PRICES OF ELECTRICITY, DISTRICT HEAT AND NG FOR THE INDUSTRY AND HOUSEHOLD SECTORS

ISED #		Unit	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002
3.2	**Industry**											
3.2.1.	**Electricity**											
3.2.1.1	with tax/subsidy	$/MWh	48.9	48.6	48.6	50.8	55.1	57.7	57.5	65.7	70.1	72.2
3.2.1.2	without tax/subsidy	$/MWh	48.9	48.6	48.6	50.8	55.1	57.5	57.1	65.0	69.4	71.9
3.2.2	**Heat**											
3.2.2.1	with tax/subsidy	$/GJ	6.22	7.26	7.80	8.07	8.54	8.98	9.69	9.75		
3.2.3.	**Natural gas:**											
3.2.3.1	with tax/subsidy	$/GJ $_{GCV}$	2.8	2.9	3.1	3.1	3.2	3.5	3.6	3.8	4.2	4.9
3.2.3.2	without tax/subsidy	$/GJ $_{GCV}$	2.8	2.9	3.1	3.1	3.2	3.5	3.6	3.8	4.2	4.9
3.2.4.	**Light fuel oil**											
3.2.4.1	with tax/subsidy	$/1,000lt	176	145	133	147	155	150	167	240	324	350
3.2.4.2	without tax/subsidy	$/1,000lt	176	145	133	147	155	150	167	240	324	350
3.3.	**Households**											
3.3.1.	**Electricity:**											
3.3.1.1	with tax/subsidy	$/MWh	31	31	31	32	33	33	48	78	102	102
3.3.1.2	without tax/subsidy	$/MWh	30	30	30	31	31	31	44	70	92	92
3.3.2.	**Heat:**											
3.3.2.1	with tax/subsidy	$/GJ	4.04	4.37	4.71	4.71	4.88	5.55	8.24	11.77		
3.3.3.	**Natural gas:**											
3.3.3.1	with tax/subsidy	$/GJ $_{GCV}$	1.87	1.87	1.95	1.98	2.04	2.08	2.60	4.04	4.50	4.60
3.3.3.2	without tax/subsidy	$/GJ $_{GCV}$	1.77	1.76	1.84	1.87	1.92	1.96	2.40	3.67	4.09	4.18
3.2.4.	**Light fuel oil**											
3.2.4.1	with tax/subsidy	$/1,000lt	176	145	133	147	155	150	167	240	324	350
3.2.4.2	without tax/subsidy	$/1,000lt	10	9	300	301	308	317	327	344	352	45

Data sources: electricity and NG (OECD/IEA, 2003) district heat (World Bank/MES, 2002)

Data on electricity and NG end-use prices (Table 8.6) were derived from IEA Statistics [12]. Comparison of data on electricity and NG prices among individual countries is possible due to the identical methodology for reporting. A different situation exists for price data about district heating, which were not available from international statistical reviews and therefore not available for inter-country comparisons.

To assess national pricing policies within countries, prices for electricity and NG in selected EU countries (Germany and Netherlands were employed as the reference cases) were obtained in the industry and household sectors.

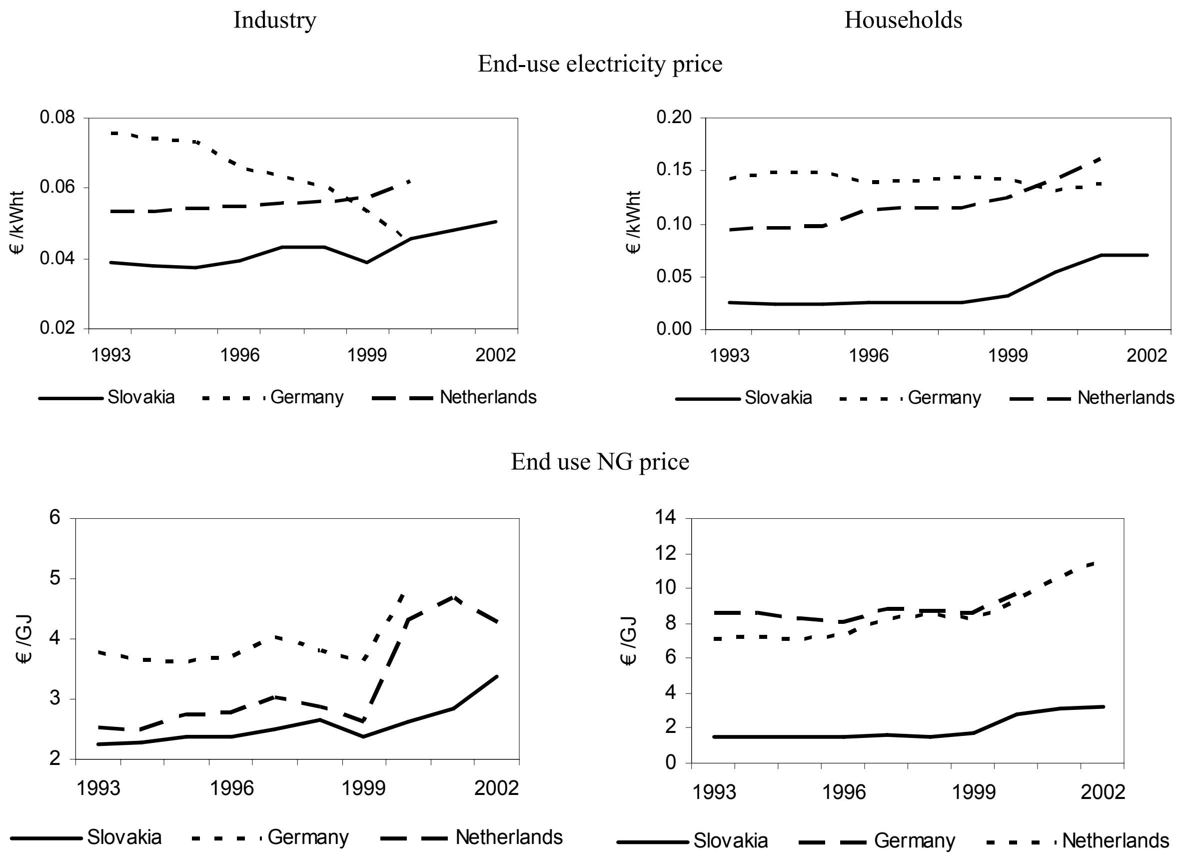


Figure 8.3. Comparison of end-use energy prices

The differences in end-use energy prices between Slovakia and EU representative countries are higher for the household sector than those for industry (Figure 8.3). Even though it is possible to identify continuously increasing end-use prices in Slovakia since 1999, during the whole period under consideration they remained lower than those for the EU representative countries, except for the price of electricity in Germany in the year 2000.

When tariff policies reflect production and distribution costs, then the end-use prices for households are higher than those for industry. This is usually the case for countries with a developed market economy. In former socialist countries, cross-sector subsidies were applied and the end-use energy prices for households were lower, balanced by higher energy prices in industry. Removing all types of subsidies is declared to be one of the main goals in existing national energy policy (MES, 2000). The time schedule for this process was defined in this policy in agreement with the harmonisation process with EU legislation. In Figure 8.4 the ratio of industry/households end-use prices for electricity and NG are compared.

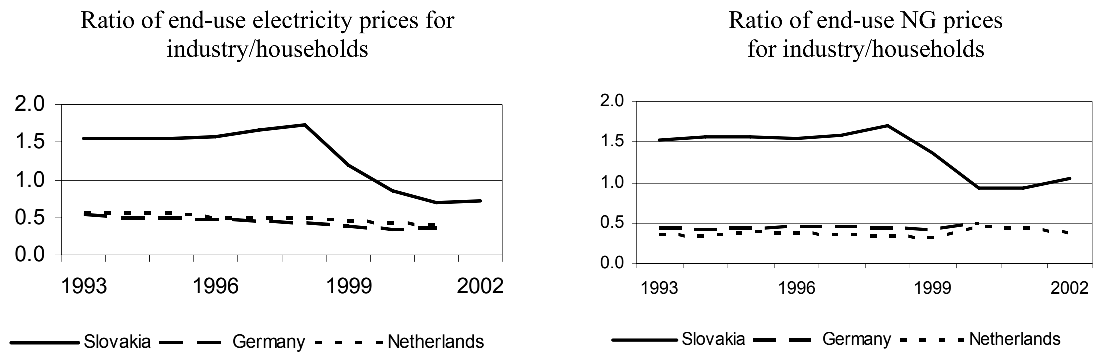


Figure 8.4 Ratio of end-use energy prices for the industry and households

As can be seen from the trends in Figure 8.4, the ratio of industry/household prices has been decreasing since 1999 as a result of national energy pricing policy. In spite of this, the price level of selected EU countries is still lower. Although the comparison among countries was not made for prices of district heating, a similar trend as that for electricity and NG could be assumed.

8.5.1.3. Sectoral contribution to GDP

This indicator quantifies the share of important economic sectors in total economic production. Figure 8.5 shows the value added and the ratio of individual sectors' contribution to the total GDP, expressed in current prices recalculated by the constant exchange rate of SKK/USD_{1995}. The part of the bar identified as industry represents the aggregation of industrial and construction sectors. There was a lack of consistent time series for individual industrial branches. The solid line indicates the share of manufacturing industries in industry and construction as a whole.

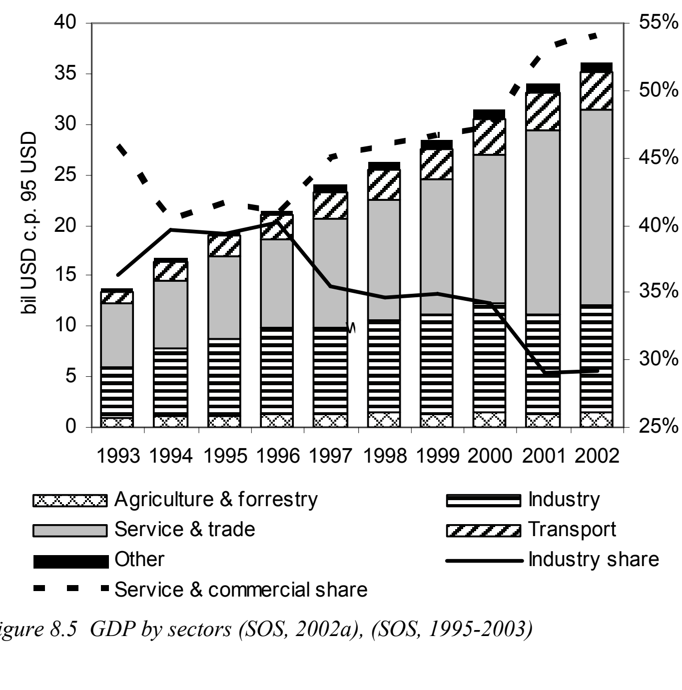


Figure 8.5 GDP by sectors (SOS, 2002a), (SOS, 1995-2003)

TABLE 8.7 SHARES OF ECONOMIC SECTORS IN TOTAL GDP (SOS, 2002A), (SOS, 1995-2003)

No	Indicator	Unit	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002
4.1.	Industry and construction	%	36.4	39.6	39.3	40.2	35.4	34.6	34.9	34.2	29.0	29.2
4.2.	Agriculture & forestry:	%	6.3	6.9	6.1	5.7	5.7	5.4	4.7	4.7	4.1	4.2
4.3.	Commercial & public services:	%	46.0	40.4	41.6	40.8	44.9	46.0	46.6	47.2	53.2	54.0
4.4.	Transportation:	%	8.6	11.0	10.8	11.1	11.0	11.1	10.9	11.0	11.2	10.2
4.5	Other	%	2.7	2.1	2.2	2.2	2.9	2.9	2.9	2.9	2.5	2.5

Table 8.7 shows a decrease in the contribution of industry and construction versus an increase in the share of services (commercial & public services, hotels, restaurants, post and telecommunications, real estate, etc.) on total GDP. The impact of the restructuring process on industrial activity should be quantified by using an index of relative increase, as well as its share of the national GDP. These indicators are compared in Figure 8.6, similar to the case of end-use energy prices, with the same parameters for two typical EU countries – Germany and Netherlands (SOS, 2002a), (SOS, 1995-2003).

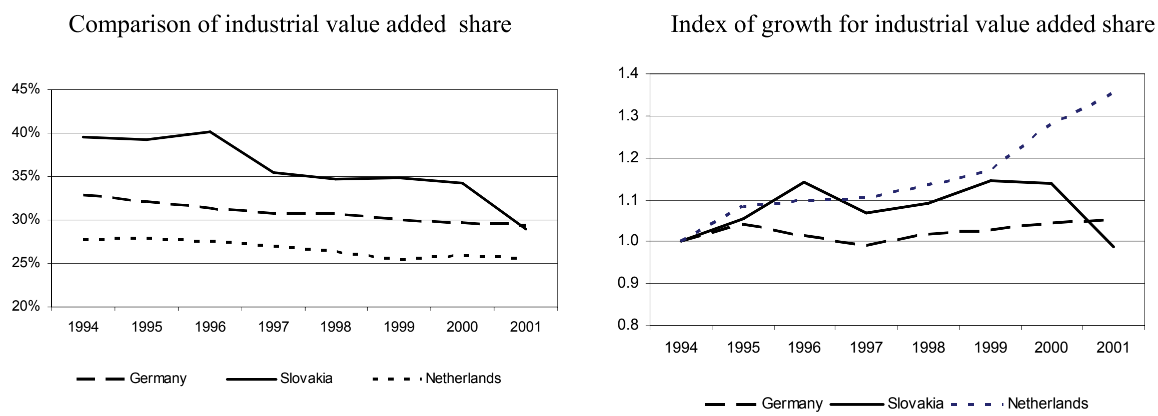


Figure 8.6 Share of industry in GDP, index of growth – comparison of data for Slovakia and EU representatives

At the beginning of the period, the contribution of industry to total GDP in Slovakia was higher than that in EU representative countries (GR, NL). This tendency was typical for a country formerly utilizing a central planning system, which stressed industrial activity development to a much larger extent than the commercial sector and services. After 1999, this parameter became much closer to the one for Germany. On the other hand, values for an index of growth for industry share in GDP were closer to those in the compared countries. A comparison of this parameter for the Netherlands and Slovakia shows similar values until 1999; after this year the NL curve shows higher growth. During the whole period, this index for Slovakia was higher than that of Germany. A more detailed assessment shows that the decrease in the industrial share in GDP for Slovakia is not the result of a decline in industrial activity, but rather the result of structural changes in GDP creation. This is an indication of progress in economic restructuring, and of positive changes enhancing less energy intensive sectors in the national economy (i.e., one of the country's policy priorities). The structural changes in the period were characterised by the decrease of industrial GDP, but also by changes in the VA of manufacturing branches. Based on the availability of data, required ISED information was developed for the following industry groups (see Table 8.8 and Figure 8.7):

- Iron and steel
- Non-ferrous metals
- Chemicals

- Petroleum refining
- Non-metallic minerals
- Paper and pulp

TABLE 8.8 VALUE ADDED SHARES OF INDUSTRIAL BRANCHES IN INDUSTRIAL SECTOR [%]

8.	VA shares of branches for ISED	1995	1996	1997	1998	1999	2000	2001	2002
8.	Iron and steel	12.2	12.4	12.2	10.7	9.5	13.8	15.9	13.7
8.2.	Machinery	15.7	15.6	17.6	18.7	20.1	22.5	24.6	26.0
8.3.	Chemicals	10.8	10.9	10.3	9.3	7.9	8.9	8.9	8.4
8.4.	Petroleum refining and coke production	4.1	3.8	5.1	3.9	3.2	6.4	4.6	4.1
8.5.	Non-metallic minerals	4.4	4.6	4.6	5.0	4.8	5.7	5.9	5.9
8.5.1.	Paper and pulp	4.6	3.5	3.5	4.0	3.8	4.5	5.8	5.4

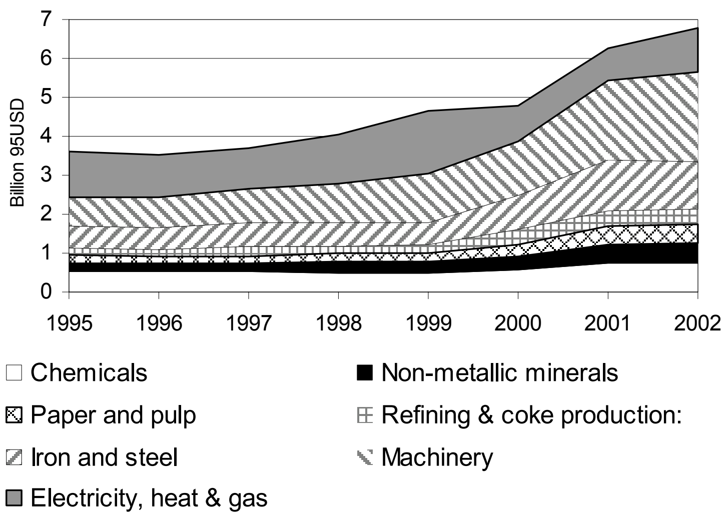


Figure 8.7 Value added for industrial branches

For energy intensive industries, machinery shows the largest increase in its VA share. Considering the new foreign investment in this branch (e.g., Peugeot, Kia, etc.), the share of the machinery industry should increase even further.

8.5.1.4. Conclusion of ISED related to EU accession process

- Even through the GDP/cap growth rate in the considered period was higher than the EU average, GDP per capita is still considerably lower than the average value for the EU.
- The growth rate of motor fuel consumption has a similar trend as that of selected countries in the EU (Germany, Netherlands), but the absolute level was still lower at the end of period. The analysis did not include development during and after 2005, when the situation in motor fuel prices was drastically changed.
- The cross-sectoral subsidies in Slovakia were gradually removed in the case of end-use energy prices (i.e., NG, electricity and district heat) during the transition period. Despite this development, the absolute price level was lower and the ratios of industrial/residential end-use prices of NG and electricity were still higher than in Netherlands and Germany.

- The economic transformation is characterized by the decrease of industrial sector share of the GDP VA, and the increase of the service and commercial sector share. This trend is typical for an economic transformation from the central planning system to an open market economy. In 2000, the industrial GDP share was at the same level as that in Germany, but still higher than in the Netherlands. The manufacturing VA structure is characterized by an increase of the machinery VA share. Due to the increase of foreign investment in this sector, the present period will reinforce this trend.

8.5.2. ISED related to security of energy supply

This issue is consistent with priority No.3, from the new proposal of energy policy - *Lowering dependency on fossil fuel imports*. The ISED listed below can be used to analyze the following strategies for this priority:

Strategy 1: To use the nuclear energy industry as a diversified, cost-effective and environmentally acceptable option for power generation

ISED 11.1 - Final energy mix

ISED 11.2 - Electricity generation mix by fuel types

ISED 11.3 - Total primary energy supply mix

Strategy 2: To increase the use of domestic primary energy sources

ISED 17- Indigenous energy production

ISED 18- Energy net imports dependency

Strategy 3: To increase the utilization of renewable energy sources

Included in principle 1 by ISED

ISED 11.3.7. - Non-combustible renewable:

ISED 11.3.8. - Renewable and wastes:

Strategy 4: To Support the utilization of sources with combined heat and power generation

ISED 12.6. Electricity supplies from CHP plants as percentage of total electricity generation

8.5.2.1. ISED related to strategy 1 - Final and Primary energy mix

Table 8.9 and Figure 8.8 present the final energy mix.

TABLE 8.9 FINAL ENERGY MIX

11.1	Final energy mix		1993	1994	1995	1996	1997	1998	1999	2000	2001	2002
11.1.1.	Coal	%	18.6	17.9	15.7	16.1	15.5	13.8	12.8	12.5	9.5	11.2
11.1.2.	Petroleum products	%	12.0	16.5	15.1	11.2	12.2	12.3	14.3	14.0	22.8	26.7
11.1.3.	Gas	%	29.3	30.3	31.6	34.4	31.6	37.3	36.6	36.5	38.1	33.2
11.1.4.	Electricity	%	13.4	14.4	15.3	16.3	16.9	15.5	16.7	17.2	17.8	17.6
11.1.5.	Heat	%	26.8	20.9	22.2	22.1	23.8	21.0	19.6	19.7	9.3	9.2
11.1.7.	Renewable & wastes	%	0.03	0.04	0.03	0.04	0.04	0.05	0.02	0.01	2.41	2.04

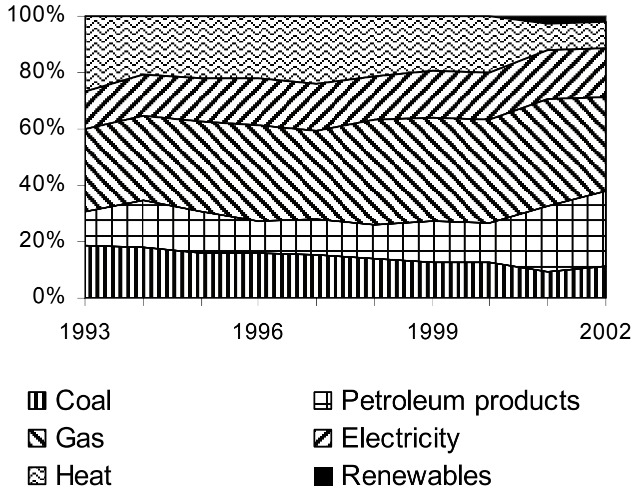


Figure 8.8 Final energy mix

Figure 8.9 shows the trends of energy mix.

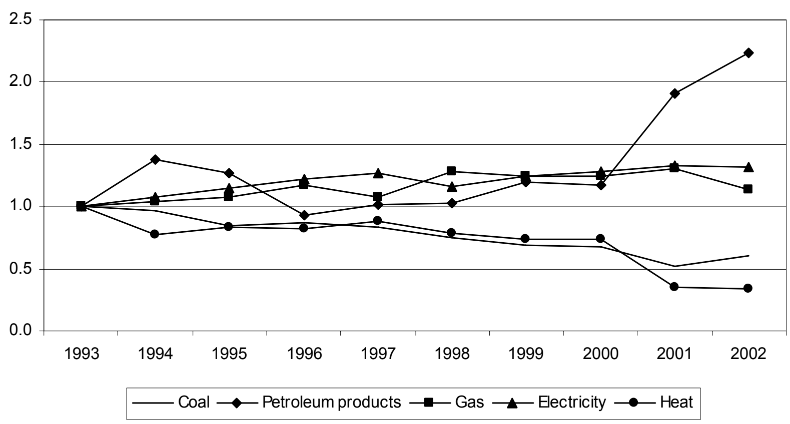


Figure 8.9 Trends of energy mix (1993 = 100%)

While electricity and gas show an increased share of the final energy mix, centralized district heating and coal consumption indicate a decreased share. This is closely related to the total economic and industrial restructuring. An increase of commercial and service activity growth, and the increasing share of machinery cause the increase for electricity. New investment in these branches of the industry will strengthen this trend. The decrease of coal and the increase of the NG share is a result of new environmental legislation, as well as the very aggressive policies of the gas utility which in the past year has expanded its national distribution network even in small villages. The district heating share decrease has many reasons, one of them being that some consumers have unplugged from the public hot water distribution network and applied their own heating sources, using gas as fuel.

Considering the later and future trends of electricity demand increases, the ISED No. 11.2 *Electricity generation mix by fuel types* will have an important impact on the security of energy supply. According to the definition, the electricity generation mix reflects the share of electricity produced by different types of electric power plants. Due to the fact that some Slovak power plants simultaneously use more than one fuel type, data for thermal power plants were roughly estimated. The figures for the electricity generation mix in Table 8.10 and Figure 8.10 show an increase in the nuclear power share (included in the energy balance as nuclear primary heat).

TABLE 8.10 ELECTRICITY GENERATION MIX

11.2.	Electricity generation mix	Unit	1997	1998	1999	2000	2001	2002
11.2.1.	Coal	%	26.48	25.53	22.66	18.34	20.17	20.27
11.2.2.	Oil products	%	4.97	6.16	3.21	2.42	0.73	1.153
11.2.3.	Gas based	%	6.87	6.32	8.53	7.77	8.14	9.825
11.2.4.	Nuclear power	%	51.33	51.55	55.66	62.46	64.54	62.39
11.2.5.	Hydro power	%	6.67	6.69	6.39	6.07	5.99	5.7
11.2.7.	Renewables & wastes	%	3.69	3.74	3.53	2.95	0.43	0.661

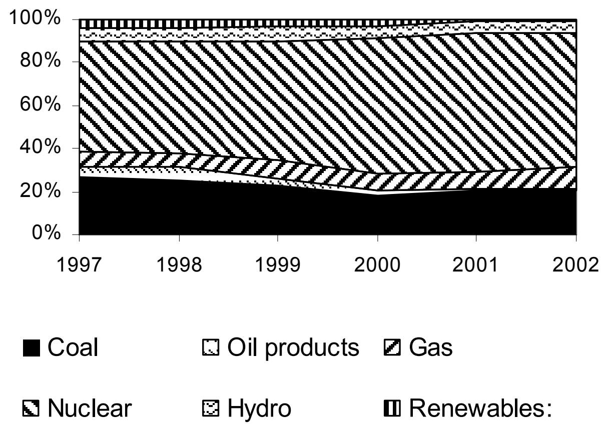


Figure 8.10 Electricity generation mix

The increasing share of nuclear was caused by the installation of two units (2 x 440 MWe) at the nuclear power plant Mochovce.

Table 8.11 shows total primary energy supply mix (ISED 11.3).

TABLE 8.11 TOTAL PRIMARY ENERGY SUPPLY MIX

11.3.	Total primary energy supply mix	Unit	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002
11.3.1.	Coal	%	33.9	30.7	29.4	28.7	27.8	25.9	25.0	23.3	22.8	22.4
11.3.2.	Oil	%	16.4	18.1	19.0	18.4	18.2	19.3	17.3	15.7	15.4	17.8
11.3.3.	Gas	%	27.4	26.7	28.6	29.7	30.8	31.7	32.0	32.0	32.2	31.0
11.3.4.	Nuclear power	%	18.7	21.2	19.6	19.0	18.7	19.8	22.8	27.6	28.4	26.5
11.3.5.	Hydro power	%	1.7	2.1	2.3	2.1	2.1	2.2	2.3	2.4	2.3	2.5
11.3.6.	Electricity net import	%	0.9	0.2	0.6	1.6	1.9	0.6	0.3	-1.3	-1.6	-1.9
11.3.8.	Renewables & wastes	%	0.9	1.0	0.4	0.4	0.5	0.4	0.4	0.3	0.5	1.6

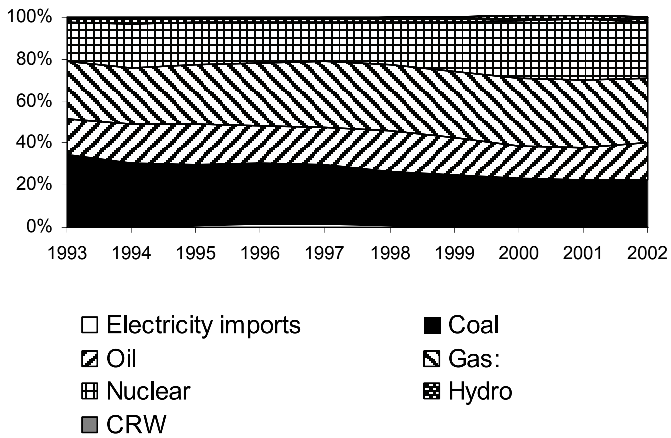


Figure. 8.11 Total primary energy supply mix

Table 8.11 and Figure 8.11 illustrate the increase of nuclear and NG share in the primary fuel mix. This is related to the change of final energy mix and the impact of environmental requirements. Nevertheless, this time series did not include the next stage of development, which is likely to be influenced by the retirement of old nuclear units and increasing NG prices on the world market.

8.5.2.2. ISED related to strategy No. 2 - To increase the use of domestic primary energy sources

Slovakia is dependent on energy imports, but the role of dependency nevertheless decreased from 72% in 1993 to 64% in 2001. The new nuclear power plant installation has had significant and positive impacts on this process.

The only domestic fuel to play some role in the total energy balance of Slovakia is brown coal/lignite from underground mining. This coal is directly used for electricity generation in thermal power plants located close to the mine site. The quality of the coal is low, with high sulphur content per thermal units. Adopted environmental legislation, as well as accepted international commitments (MENV, 1999), decrease the competitiveness of this coal in relation to imported ones from the Czech Republic and Poland. The Resolution of the Slovak Government No. 559/2000 stipulates the preferred purchasing of electricity generated from locally extracted PES (lignite), and this will play an important role for extraction and use of domestic coal until 2010.

Table 8.12 provides figures on the total amount of indigenous fuel as well as the share of individual energy types in the total indigenous primary energy supply.

TABLE 8.12 INDIGENOUS ENERGY PRODUCTION

No	Item	Unit	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002
17.1.	Total indigenous primary energy production	Mtoe	5.10	5.69	5.46	5.48	5.24	5.38	5.87	6.76	6.93	6.9
17.1.1.	Coal	%	19.0	18.9	18.8	20.8	20.3	19.8	17.4	15.1	14.3	13.8
17.1.2.	Oil	%	1.3	1.2	1.4	1.3	1.2	1.1	1.1	0.9	3.0	0.8
17.1.3.	Gas	%	4.1	4.1	5.2	4.7	4.3	3.8	2.8	2.0	2.2	2.2
17.1.4.	Nuclear indigenous	%	66.4	66.3	65.6	64.7	65.3	66.6	70.5	74.8	69.2	72.4
17.1.5.	Hydro power	%	5.9	6.6	7.7	7.1	7.3	7.4	7.1	6.4	6.0	6.4
17.1.7.	Renewables & wastes	%	3.4	3.0	1.4	1.4	1.6	1.3	1.1	0.9	5.3	4.5
17.2.9.	Total electricity	TWh	25.3	25.6	27.7	28.8	28.9	26.8	28.3	28.0	28.4	31.0

Table 8.13 shows the ratio of net import (imports minus exports) to the primary energy consumption for each particular year as a total as well as by fuel types, such as oil and petroleum products, gas, coal and electricity. Although nuclear energy (balanced as nuclear primary heat) is considered an indigenous primary energy source, all of the nuclear fuel elements are imported and Slovakia does not have any enrichment arrangements.

TABLE 8.13 NET ENERGY IMPORTS DEPENDENCY [%]

No	Item	Unit	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002
18.1.	Total primary energy	%	71.7	68.0	70.2	70.6	71.3	70.2	67.7	63.1	63.4	63.3
18.3.	Oil	%	97.8	97.9	97.9	97.9	98.1	98.3	97.9	98.0	92.9	98.4
18.4.	Gas	%	95.8	95.1	94.6	95.3	96.0	96.5	97.2	97.7	97.6	97.4
18.5.	Coal	%	84.2	80.3	80.9	78.7	79.1	77.3	77.5	76.2	77.7	77.6
18.6.	Electricity	%	5.6	1.7	5.0	12.2	14.0	4.8	2.0	-9.6	-13.0	-13.4

The indigenous and imported energy shares show a stable trend (Tables 8.12 and 8.13). Only in the case of nuclear energy share in the years 1998 - 2000 is there an impressive increase, due to the operation of new nuclear units. It brings about a decrease of electricity imports as well as the import of other energy sources used to generate electricity. However, the planned retirement of the old nuclear plants will lead to an import dependency increase. The future of nuclear energy is connected with the privatisation process of the power utility. There are now potentially available two additional units (i.e., 2 x 440 MWe), and their finalisation and operation are a subject of discussions. Their operation should help maintain the present share of energy imports. The requirements for the completion of these units are included in the new proposal for energy policy.

8.5.2.3. Conclusion of ISED related to the security of energy supply

- Domestic low grade brown/lignite coal and hydropower represent important indigenous primary energy sources.
- The potential for additional hydropower increases is limited, as well as for domestic brown coal resources.
- The resources of domestic coal are dedicated for installed thermal power plants, and its use must overcome environmental limitations, both from the point of view of basic pollutants (i.e., SO_2, NO_x, CO and SP) and GHG (i.e., CO_2) emissions.
- Nuclear energy is a dominant domestic source, although the nuclear fuel is imported. The increase of nuclear capacity brought about an increase in the indigenous energy share and less dependency on the short-term energy market situation.
- The planned shut down of the old nuclear plant will bring an additional increase of energy import dependency, if the new nuclear units are not finalised.
- The completion of the two additional nuclear units (2 x 440 MWe) is required in the new proposal of energy policy, and represents one of the measures to increase energy supply security.

8.5.3. Sustainable development

This issue of sustainable development in Slovakia is consistent with priority No.1 of the new proposal of energy policy - *Reliable, environmentally acceptable and economically effective energy supply*, defined by the following strategies of this priority:

Strategy 1: To adopt adequate measures for elimination of impacts from shut-down of some of the currently operating plants, so as to avoid a dependence on electricity imports in long-term perspective.

Strategy 2: To modernize energy plants and technology processes with the simultaneous decrease of energy intensity and the reduction of negative environmental impacts.

Strategy 3: To replace the 220 kV system by 400 kV systems gradually in compliance with planned changes in the infrastructure of the national economy and industry for coordinated advancement of all Slovak regions.

Strategy 4: To ensure technical safety of energy plants, quality and proper maintenance levels of systems and networks.

Strategy 5: To ensure continual nuclear safety and operational ability of nuclear power plants.

Strategy 6: To optimize operating and investment costs to cover the main operations and achievement of adequate profit necessary for further development of the power and gas systems.

Strategy 7: To increase economic and energy efficiency.

Strategy 8: To support research and development, and development of applied research in the energy industry.

Strategy 9: To introduce new technologies, innovations and best available techniques in the energy industry.

Strategy 10: To ensure operating management of the SR power system with the objective of reaching well-balanced electricity consumption and generation in real time.

Strategy 11: To decrease the dependence on sources from risky regions; to realize the measures derived towards increasing the reliability of energy supply from foreign sources.

Strategy 12: To monitor the security of electricity and gas supply.

Considering the above strategies, ISED indicators related to energy efficiency are fully consistent with Strategy 7. Nevertheless, common objectives of this priority can be classified and analysed fully or partly with the following ISED:

Energy intensity and efficiency of energy supply

ISED # 9. Energy intensities

ISED # 12. Energy supply efficiency

ISED # 14. Energy use per unit of GDP

ISED # 16. Energy consumption per capita

Environmental impact of energy system

ISED # 13. Status of deployment of pollution abatement technologies

ISED # 23. Quantities of air pollutant emissions

ISED # 24. Ambient concentration of pollutants in urban areas

ISED # 26. Quantities of greenhouse gas emission from energy related activities

8.5.3.1. Energy intensity and efficiency of energy supply

Final energy intensity

The data on ISED # 9 in Table 8.14 represent an *Indirect Driving Force Within the Energy Sector.* The energy intensity of individual economic sectors relates energy demand to production activity, and is given by the share of sectoral contribution to GDP creation and final energy consumption. The development of final energy intensity by sectors during the studied period is illustrated in Figure 8.12 and Table 8.14.

TABLE 8.14. END-USE ENERGY INTENSITIES BY SECTORS

9.	Energy intensities	Units	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002
9.1.	Final energy intensity	toe/ 1,000$	0.755	0.661	0.631	0.603	0.54	0.519	0.515	0.485	0.470	0.447
9.1.1.	Industry & construction	toe/ 1,000$	1.084	0.908	0.896	0.802	0.766	0.663	0.682	0.747	0.614	0.597
9.1.2.	Agriculture	toe/ 1,000$	0.582	0.325	0.34	0.325	0.321	0.28	0.285	0.258	0.185	0.159
9.1.3.	Commercial & services	toe/ 1,000$	0.352	0.334	0.25	0.277	0.235	0.285	0.258	0.182	0.147	0.138
9.1.4.	Transportation	toe/ 1,000$	0.253	0.234	0.24	0.139	0.141	0.139	0.131	0.136	0.521	0.707

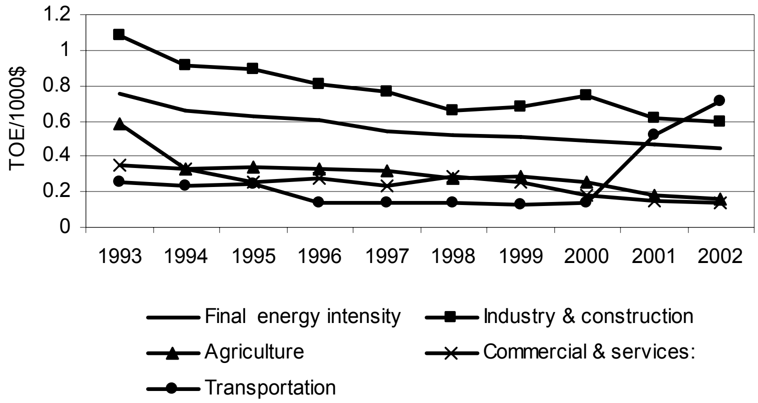


Figure 8.12 End-use energy intensities by sectors

Final energy intensity was continuously decreasing in all sectors until 2000. In some sectors this parameter started to increase again in 2001. The changes which occurred were mainly related to the economic restructuring process that had impacts on both the final energy consumption and energy intensity. Figure 8.13 compares the trends of energy intensity (EI), final energy use (FEU) and VA growth in two important sectors - industry and services and commercial.

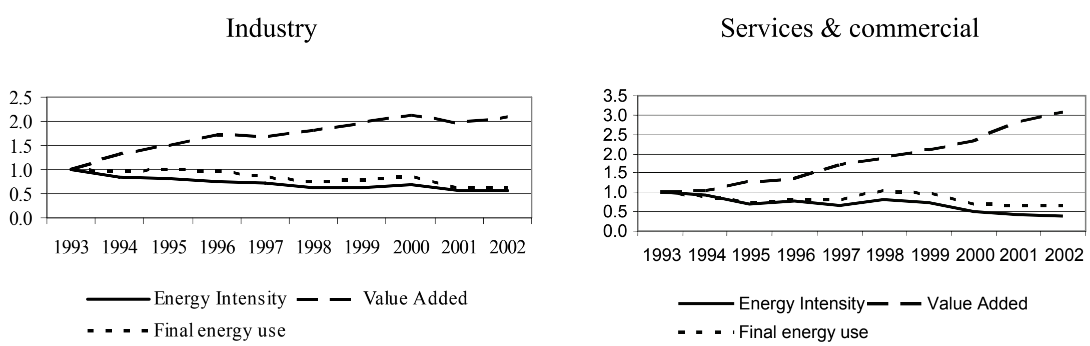


Fig. 8.13 Trends of final energy intensity - EI, final energy uses FEU and VA growth

The transportation sector is one of the sectors with increasing fuel consumption. Available statistical data in a form which enables calculations of ISED for Slovakia have only been issued since 1997. Table 8.15 gives the input data and ISED calculated per actual activity in passengers and freight transport.

TABLE 8.15 END-USE ENERGY INTENSITY OF TRANSPORT

	Unit	1997	1998	1999	2000
Passenger travel	Bpkm	37	37	36	34
Energy consumption	MTOE	0.707	0.761	0.754	0.751
Passenger travel energy intensity	kgoe/1,000 pkm	19.31	20.72	21.00	21.79
Freight transport	Btkm	29.243	30.972	30.039	41.198
Energy consumption	MTOE	0.533	0.602	0.535	0.503
Freight transport energy intensity	kgoe/1,000 tkm	18.23	19.43	17.81	17.09

The main impact on final energy intensity in the residential sector is from the use of space heating and electricity (see Table 8.16). Related ISED were calculated from Energy Statistics, excluding data for motor fuel consumption for transportation. The item *Total energy* represents the sum of fuel, heat and electricity consumption per capita, while conventional energy represents the consumption of fossil fuels.

TABLE 8.16 ISED FOR ENERGY INTENSITY IN THE RESIDENTIAL SECTOR

9.1.5.	Indicator	Unit	1993*	1994*	1995*	1996*	1997	1998	1999	2000	2001	2002
9.1.5.1	Total energy	kgoe/cap	417	360	401	455	448	465	470	436	484	550
9.1.5.2	Conventional energy	kgoe/cap	417	360	401	455	448	465	470	436	484	550
9.1.5.3	Space heating	kgoe/m^2	16.0	16.0	16.0	16.0	16.0	16.0	16.5	15.7	N/A	N/A

*Data extrapolated from these in period 1997-2000

A World Bank study on energy efficiency (World Bank/MES, 2002) was used as input data for the estimation of specific heat consumption per area. Data for period 1993-1996 were extrapolated from those in period 1997-2000.

Data on electricity intensity were calculated based on input data from Energy Statistics (SOS, 2005).

Time series of these data by sectors are outlined in Table 8.17.

TABLE 8.17 ISED OF ELECTRICITY INTENSITY BY SECTORS

		Unit	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002
9.2.	Electricity intensity	kWh/$	1.17	1.11	1.12	1.14	1.06	0.94	1.00	0.97	0.97	0.91
9.2.1.	Industry and construction	kWh/$	1.29	1.40	1.20	1.27	1.32	1.22	1.20	1.29	1.38	1.24
9.2.2.	Agriculture	kWh/$	1.46	0.75	0.76	0.73	0.92	0.70	0.64	0.57	0.53	0.50
9.2.3.	Commercial & services	kWh/$	0.66	0.44	0.66	0.68	0.53	0.40	0.56	0.48	0.62	0.56
9.2.4.	Residential	kWh/cap	775	838	931	1,013	1,022	1,042	1,051	1,003	971	912
9.2.5.	Transportation	kWh/$	0.75	0.73	0.66	0.43	0.42	0.41	0.36	0.38	0.01	0.28

Energy supply efficiency

As in ISED group #9, the ISED group #12 represent indirect driving forces. Data are summarized in Table 8.18.

TABLE 8.18 PARAMETERS OF ENERGY SUPPLY EFFICIENCY

12.	Energy supply efficiency	Unit	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002
12.1.	Ratio of total final energy to total primary energy supply	%	72.2	68.2	66.9	66.6	63.7	64.5	64.5	61.5	59.9	58.7
12.2.	Average fuel effectiveness of thermal power plants	%					30.8	30.2	30.4	31.0	31.2	0.0
12.3.	Electricity transmission and distribution losses	%					7.2	7.6	6.5	6.5	4.7	3.6
12.4.	Gas transportation and distribution losses	%					0.0	0.0	0.0	0.0	0.4	0.0
12.5.	Oil refining efficiency	%					85.4	86.6	86.4	87.9	N/A	N/A
12.6.	Electricity supplies from CHP plants as percentage of total electricity generation *1	%					18%	18%	17%	17%	16%	14%

*1 This ISED is relevant to the Priority No 3.

Decreases in the total final/primary energy supply ratio is caused by the increasing share of nuclear energy. The efficiency of nuclear PWR power plants is lower than that of thermal power plants due to the physical characteristics of the PWR reactor, which do not allow the generation of superheated steam.

Energy use per unit of GDP and per capita

The most important driving forces for country development are the activities of the national economy and the related energy intensity. This ISED #14 represents a direct driving force, while ISED #16 represents a state indicator (see Tables 8.19 and 8.20). Both of them are the result of the interaction between previous ISED groups - the final energy intensity and the energy supply efficiency. Historical figures for Slovakia (similarly as in other Economies in Transition countries) show a decrease in energy intensity, primarily due to the industrial restructuring and economic transformation.

For primary conventional energy, fossil fuel consumption is considered, while total energy represents the sum of fuels, primary (nuclear and geothermal) heat, and electricity (import /export balance and hydropower).

TABLE 8.19 ENERGY USE PER UNIT OF GDP

No	Item	Unit	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002
14.1.	Total primary energy	toe/ 1,000$	1.05	0.97	0.94	0.91	0.85	0.81	0.80	0.79	0.78	0.76
14.2.	Primary conventional energy	toe/ 1,000$	1.04	0.96	0.94	0.90	0.84	0.80	0.80	0.79	0.77	0.75
14.3.	Electricity use	kWh/$	1.47	1.40	1.43	1.40	1.34	1.19	1.24	1.20	1.18	1.25

Considering the national priorities, the ISED #14.1 *Energy use per unit of GDP* characterizes the bulk of national energy policy, covering the efficiency of energy transformation process as well as the efficiency of final energy use. The EU accession processes as well as economic transformation should move this indicator closer to the one of the EU average. To obtain the necessary time series for EU average, data from the *Energy intensity of the economy* issued by the EUROSTAT was employed (EUROSTAT, 2005). This indicator is calculated as a ratio of the gross inland consumption of energy and the gross domestic product. The gross inland consumption of energy is here estimated as the sum of the gross inland consumption of five energy types: coal, electricity, oil, natural gas and renewable energy sources. This is different than the primary energy sources definition used for the national

balance in Slovakia, where this parameter represented the sum of primary sources, including fuel consumption, primary nuclear heat, electricity export/imports and renewable energy sources. To preserve consistency in this comparison, the EUROSTAT approach for processing of domestic data was employed. All energy intensity data are expressed in units of kgoe per GDPppp in 1,000 EUR (1995).

TABLE 8.20 ENERGY CONSUMPTION PER CAPITA

16.	Energy consumption/cap	Unit	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002
16.1.	Total primary energy	toe/cap	3.38	3.32	3.41	3.46	3.39	3.35	3.37	3.39	3.52	3.51
16.2.	Automotive fuel	toe/cap	N/A	0.24	0.24	0.23	0.26	0.28	0.27	0.26	0.26	0.31
16.3.	Renewables & wastes	toe/cap	0.03	0.03	0.01	0.01	0.02	0.01	0.01	0.01	0.07	0.06
16.4.	Electricity	MWh/cap	4.74	4.78	5.16	5.35	5.36	4.96	5.24	5.18	5.27	5.76

8.5.3.2. Environmental impact of energy system

Current stage of air pollution abatement technology deployment

Data for FGD were calculated as the ratio of power plant capacity with the applied abatement technology to the total installed capacity. The figures in Table 8.21 were obtained for the public thermal power plants only, as there are not any installed abatement technologies (except for suspended particulates precipitators) in other units and industrial CHP. Emission abatement policy in sectors other than the electricity sector is preferably focused on fuel switching towards less carbon intensive fuels (Slovenske Elektrarne, 1996-2000).

TABLE 8.21 EXTENT OF APPLICATION FOR BASIC POLLUTANTS ABATEMENT (%)

13.1.	Extent of use of pollution abatement	Unit	1997	1998	1999	2000	2001
13.1.1.	SO_2	%	13	13	13	25	25
13.1.2.	NOx	%	1	1	19	31	31
13.1.3.	Particulates	%	100	100	100	100	100
13.2.	Average performance of removal						
13.2.1.	SO_2	%	79	79	79	79	79
13.2.2.	NOx	%	35	35	35	35	35
13.2.3.	Particulates	%	98	98	98	98	98

Emissions of basic air pollutants

Figures in Table 8.22 correspond to production of energy related emissions of basic pollutants from fossil fuel combustion and transformation processes.

TABLE 8.22 ENERGY RELATED EMISSIONS OF BASIC AIR POLLUTANTS (MENV, 2003)

No	Item	Unit	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002
23.1.			Energy related activities:									
23.1.1.	SO_2	kt	228	151	148	125	114	108	105	72	89	68
23.1.2.	NOx:	kt	77	61	69	44	42	44	44	41	39	32
23.1.3.	Particulates:	kt	98	55	53	42	38	36	35	33	32	27
23.1.4.	CO:	kt	202	66	65	75	61	63	62	65	61	43
23.1.5.	VOC:	kt	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
23.2.			From electricity production:									
23.2.1.	SO_2:	kt	84	58	64	83	79	74	74	43	52	41
23.2.2.	NOx:	kt	37	30	36	26	25	26	25	23	18	12
23.2.3.	Particulates:	kt	14	9	11	10	12	11	10	9	8	7
23.2.4.	CO:	kt	2	2	2	2	2	2	2	2	2	2
23.2.5.	VOC:	kt	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
23.3.			From transportation:									
23.3.1.	SO_2:	kt	1.8	1.8	2.4	2.3	2.4	2.7	1.1	0.9	0.9	0.9
23.3.2.	NOx:	kt	51.9	52.5	52.9	43.4	44.5	46.3	42.9	38.3	40.6	44.7
23.3.3.	Particulates:	kt	3.1	3.1	3.2	2.5	2.7	2.9	2.7	8.0	9.0	10.3
23.3.4.	CO:	kt	151	185	181	154	144	145	133	38.3	40.6	44.7
23.3.5.	VOC:	kt	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	

Slovakia has accepted international treaties and commitments for reduction of NO_x and SO_2 emissions. According to the *Protocol on acidification, eutrofication and ground layer ozone* (MENV, 1999), the total emissions of SO_2 for Slovakia in 2010 cannot exceed a level of 110 kt , and for NOx of 130 kt. Actual data in Table 8.22 also indicate offsets in NOx and SO_2 emissions related to these targets, but additional measures to ensure the meeting of this goal have nonetheless been adopted.

Energy related greenhouse gas emissions

Another important parameter that was the subject of this study is GHG emissions (see Table 8.23).

TABLE 8.23 ENERGY RELATED GHG EMISSIONS (TRANSPORT RESEARCH INSTITUTE, 2000)

No	Item	Unit	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002
26.1.	Total GHG	Mt CO_2 eq.	44.5	41.4	42.8	43.4	43.6	41.9	40.6	38.7	40.2	40.7
26.1.1.	CO_2	Mt CO_2 eq.	42.9	39.8	41.1	41.6	41.8	40.1	38.9	37.0	38.5	38.9
26.1.2.	CH_4	Mt CO_2 eq.	1.4	1.4	1.5	1.5	1.5	1.5	1.5	1.4	1.4	1.5
26.1.3.	N_2O	Mt CO_2 eq.	0.2	0.2	0.2	0.2	0.2	0.3	0.3	0.2	0.3	0.3
26.2.	GHG/capita	Mt CO_2 eq./cap	8.3	7.7	8.0	8.1	8.1	7.8	7.5	7.2	7.5	7.6
26.3.	GHG/GDP	Mt CO_2 eq./1,000 $	2.6	2.3	2.2	2.1	2.0	1.9	1.8	1.6	1.7	1.6
26.4.	Energy related	Mt CO_2 eq.	39.4	36.0	37.0	37.5	37.5	35.4	34.3	32.9	33.7	34.9
26.5.	Transportation	Mt CO_2 eq.	4.0	4.2	4.5	4.6	4.7	5.1	5.0	4.5	4.9	5.8

The ISED #26.4 in Table 8.23 quantifies GHG emissions from electricity generation. Data on GHG emissions by sectors in IPCC tables were given in aggregated form only (electricity, heat production and transport activity), and therefore these data were put into Table 8.23. The total balance of GHG emissions is determined by contributions of:

Energy related GHG emissions – emissions from fossil fuel combustion and transformation (includes thermal power plants, CHP, HP and technological combustion), except for the input from mobile sources in transport and agriculture.

The EU as a whole (i.e., under the bubble concept) agreed in the Kyoto Protocol to an 8% reduction of its greenhouse gas emissions, compared to the base year 1990, during the first commitment period 2008-2012. The reductions for each of the EU-15 countries have been agreed upon under the so-called EU Burden Sharing agreement, which allows some countries to increase emissions, provided these are offset by reductions in other Member States. Some of EU associated countries have chosen other reduction targets and other base years, as was allowed in the Kyoto Protocol. Slovakia has agreed to reduce GHG emissions at the same level as the EU, and used the same base year 1990.

For almost the entire period, Slovakia accounts for potential GHG emission offsets. This offset is the result of a total decline of national economic performance after 1990, followed later by its increase in connection with simultaneous structural changes in primary energy use. The use of nuclear energy for electricity generation also played an important role.

Solid and liquid waste production

Data on the production of solid and liquid wastes necessary for ISED were only available from the public electric utilities (Slovenske Elektrarne, 1996-2000). Therefore, the figures in Table 8.24 do not include data from regional public CHP and HP, or industrial sources.

TABLE 8.24 SOLID, LIQUID AND RADIOACTIVE WASTES FROM ENERGY ACTIVITY

No	Item	Unit	1997	1998	1999	2000
28.1.	Wastewater discharges: (Storm water discharges associated with energy related activity)	m^3	312,180	275,949	289,207	267,950
28.2.	Radionuclides in liquid radioactive discharges	GBq	35,560	N/A	N/A	23,887
28.2.1.	Info\244.doc	GBq	0	N/A	N/A	0
28.2.2.	Info\245.doc	GBq	35,560	N/A	N/A	23,887
31.1.2.	Low and intermediate level radioactive waste, long-lived (LILW-LL)	m^3	172.0	314.5	169.8	217.0

Ambient concentration of air pollutants in urban areas

Ambient concentrations of SO_2, NO_x, CO, suspended solid particulates and ozone are measured and recorded in several monitoring stations in Slovakia (SOS, 1995-2003) (see Table 8.25). Annual data for pollution (i.e., ambient concentrations and emission inventories) are issued by the SHMÚ for selected regions and towns. To quantify air pollution, data from the city of Banska Bystrica, located in the middle of Slovakia, were chosen for this analysis.

TABLE 8.25 AMBIENT CONCENTRATION OF AIR POLLUTANTS IN THE CITY OF BANSKA BYSTRICA

24.	Pollutant	Unit	1993	1994	1995	1996	1997	1998	1999	2000	2001
24.1.	SO_2	$\mu g/m^3$	33.2	31.4	27	31.6	26.1	24	18.8	14.4	10.9
24.2.	NO_x	$\mu g/m^3$	89.31	112.7	74.5	81.5	94.6	72.5	55.4	61.3	58.6
24.3.	TSP*	$\mu g/m^3$	78.29	85	75.7	82.9	60.6	45.4	36.5	40.1	35.0
24.4.	CO	$\mu g/m^3$	1,240	911.5	1,354	1,400.8	704	335.8	288.1	266.7	226.7
24.5.	Ozone	$\mu g/m^3$	35	34	38	28	35	42	42	41	N/A

**TSP Total suspended particulates*

8.5.3.3. Conclusions of ISED related to sustainable development

The total final energy intensity declined during the period under consideration. Nevertheless, in the case of the industrial sector, there was some increase of energy intensity connected with the revival of the steel making industry due to foreign investment (i.e., by the company US STEEL). Metallurgy is a very energy-intensive manufacturing branch, but the additional investment in machinery with lower energy intensity will lead to a decrease of energy intensity in the industrial sector too. The main decrease of bulk final energy intensity is due to the increase of commercial and service sector share of the GDP.

The passenger travel energy intensity (kgoe/1,000 pkm) increased, while freight transport energy intensity (kgoe/1,000 tkm) also increased in the period from 1997-2000. The analysis did not include an important development since 2004, which was an increase of motor fuel prices.

Total energy intensity (kgoe/cap) in the residential sector indicated a decrease in the beginning of the period of analysis, followed by an increase in recent years. The planned investment in building insulation should lead to an improvement in this situation.

The electricity intensity (kWh/$) on the national level decreased, even though in some sectors this value increased (i.e., industry). This trend is related to the process of industrial restructuring and economic transformation, represented by the changing GDP structure.

Energy supply efficiency expressed by ISED #12.1: *Ratio of total final energy to total primary energy supply* declined, due to the installation of new nuclear units.

The gross energy intensity for Slovakia fluctuated around the same level, and was higher than the $EU_{average}$ value during the entire period under consideration.

Basic pollutants (SO_2, NOx, CO and SP) and GHG emissions declined during the period under consideration. This was due to the decrease of energy intensity, the installation of new nuclear unit, as well as the increasing share of NG in the fuel mix. The basic pollutant emissions decrease had a beneficial effect on ambient pollutant concentrations.

8.6. Applied ISED as a Tool for Assessment of Current Energy and Environmental Policy in Priority Areas

The IAEA methodology looks at targeted indicators, and the opportunity for responses that could positively influence selected ISED. Observed trends of historical data are important in such an analysis, and consistent data for a long time period are preferred. Even though the time schedule in this analysis only covers the period 1993 - 2002, it is possible to observe some interdependencies of individual ISED from these historical data. These relationships are significant from the economical transformation and EU accession points of view.

Based upon research experiences gained from analyses of available data, it is estimated that a decisive role for achieving energy system sustainability in Slovakia will depend upon the following factors:

- The role of nuclear energy in the electricity generation mix. Two new nuclear units have been brought into operation during the analysed period.
- Adopted environmental policy aimed at emission reductions of basic air pollutants (SO_2, NO_x, SP and CO). Emission charges and emission stack concentration limits represent the active tools.
- Pricing policies, targeted at removing energy price distortions and accomplishing price liberalisation.

In the next section, the impacts of the above specified factors are illustrated, with the help of designed ISED and their relationships.

8.6.1. Bulk indicators of economic development and impacts on energy system and environment

The following indicators enable the quantification of economic development and its impact on the energy system and the environment:

- GDP as indicator of national economic development;
- Total primary energy supply (TPES) and final energy uses (FEU) as indicator of development in the whole energy system;
- Energy related CO_2 and SO_2 emissions as the most sensitive indicators of environmental impacts of the energy system.

These indicators can be shown together (Figure 8.14) to analyze the overall trend. Data for the GDP in Figure 8.14 are reported using fixed prices for the year 1995 and fixed exchange rate for the same year (GDP fp.95USD).

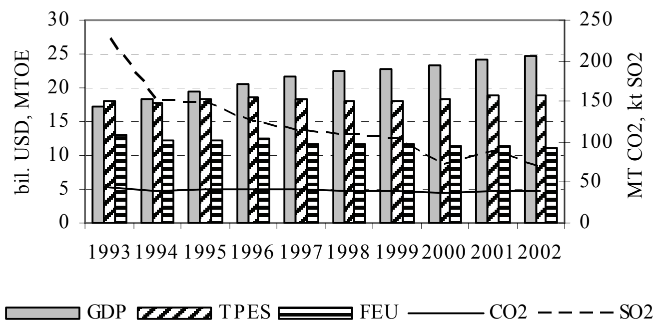


Figure 8.14 GDP, TPES, FEU and emissions of CO_2 and SO_2

While the GDP increases, TPES and FEU trajectories are quite stable. CO_2 emissions show a slight tendency to decrease, while the decline of SO_2 emissions is more impressive.

Based upon research experience gained during the ISED analyses, it appears that the evaluation of the energy system and its environmental impacts in Slovakia, from a sustainable development point of view will depend upon:

- The economy's development and the process of its restructuring;
- The primary energy mix, together with the role of nuclear energy for electricity generation;
- Adopted environmental policies aimed at emission reductions of basic air pollutants (SO_2, NO_x, SP and CO). Emission charges and emission stack concentration limits represent active abatement policy tools.
- Liberalisation of energy prices, and pricing policies aimed at removing energy price distortions.

8.6.2. Structural Changes and Final Energy Demand

The main characteristics of the process of economic restructuring in Slovakia have already been presented. A decreasing share of industry versus increasing shares of the commercial and services sector in GDP creation were identified. This should ultimately result in a decrease of the final energy use intensity.

There is interdependency between the industrial share of the GDP and the total final and primary energy intensity.

In addition to a decrease in the total national energy intensity, the energy intensity of the industrial sector has also changed during the observed period (Figure 8.15).

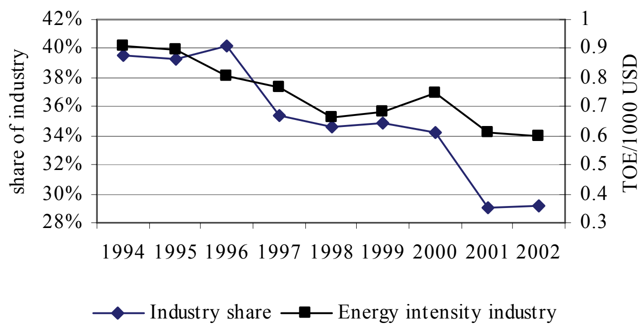


Figure 8.15 Industrial energy intensity and share of GDP

The continuous decrease in the industrial energy intensity began to change in 1998, when there was a slight increasing tendency. This primarily reflected the situation in the metallurgy sector (i.e., the process of privatisation and economical revival after restructuring). This is illustrated in Figure 8.16 too, which compares trends of industrial share of GDP, industrial final energy uses (FEU) and industrial energy intensity (EI).

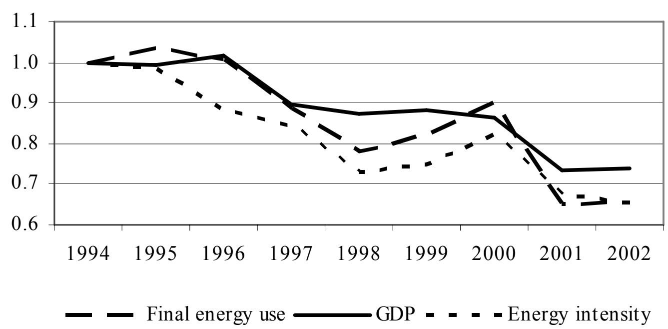
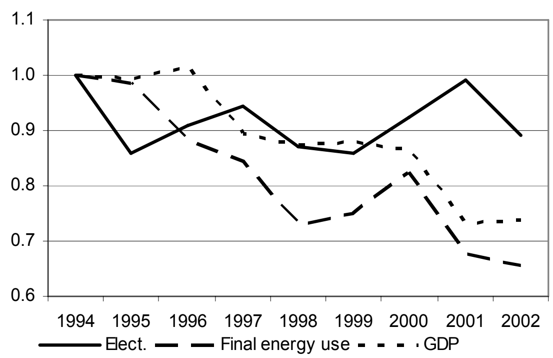


Figure 8.16 Trends of industrial GDP, FEU and EI (1994 = 100%)

It appears that the electricity share of final energy use could serve as the ISED indicator to illustrate the intensity of economic restructuring. This parameter will be influenced by the share of final/primary energy, too. It is a very sensitive indicator, especially in the industrial sector, where it can quantify the stage of transferring from heavy, highly energy intensive industrial entities towards new, less energy intensive ones. Figure 8.17 provides trends of industrial electricity intensity (Elect), compared with the trends for industrial final energy use (FEU) and industrial share of GDP(GDP). The Figure also gives the shares of individual sectors in final electricity consumption during the period. As one might note, the sectoral share for electricity consumption seems to be stable, and the tendency for electricity intensity follows quite closely the final energy intensity curve.

Electricity, final energy use and GDP trends for industry



Share of industrial sectors in final electricity consumption

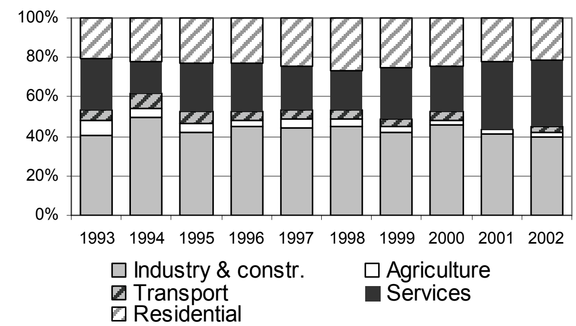


Figure 8.17 Trends of industrial electricity demand (1994 =100%) and shares of individual sectors in final electricity consumption

8.6.3. Energy Mix and Its Impact on Energy and Emission Intensity

Energy intensity is influenced by the structure of the fuel and energy mix as well. The fuel mix has a direct impact on the environment, and is therefore affected to some degree by adopted environmental policy. Changes in the share of fossil fuels with different carbon intensity, as well as the share of nuclear sources in electricity production, play an important role and therefore represent very sensitive issues.

The data in Table 8.18 show a continuous decrease in the ratio of FEU/TPES in Slovakia. The main reason for the observed tendency is an increase in the share of nuclear primary energy in the TPES.

The energy conversion efficiency in a PWR nuclear plant is limited by the physical characteristics of this technology. Therefore the ISED *Ratio of total final energy to total primary energy supply* does not illustrate the actual situation of the energy efficiency process, but only the structure of the primary energy supply. Although the increase in primary nuclear heat brings about a decrease in the final/primary energy ratio, it still has positive impact on air pollution.

Considering that the primary energy level is stable, the decrease in CO_2 emissions is therefore a result of changes in the primary energy mix. The penetration of non-fossil energy and NG, as well as declines in coal consumption, play an important role. These trends can also be seen in Figure 8.18, which shows growth indices of energy carriers' consumption and energy related CO_2 and SO_2 emissions. While for CO_2 emissions fuels used play an important role in the primary energy mix, in the case of SO_2 the use of abatement technology has a significant impact as well. Both of these impacts resulted in greater reductions of SO_2 emissions after the years 1995 and 1999.

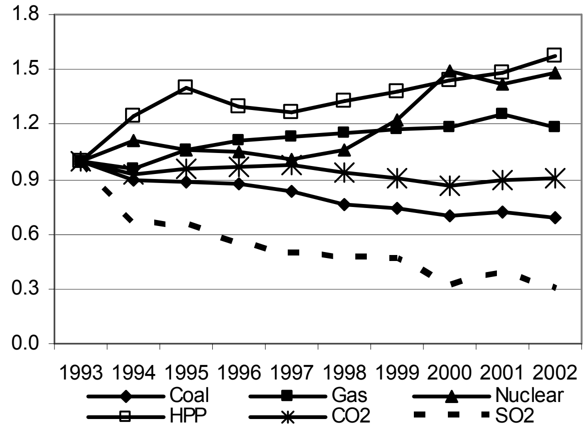


Figure 8.18 Comparison of primary energy and CO_2 & SO_2 emission trends (1993 = 100%)

8.6.4. Decrease in final energy use by applying energy conservation measures

Energy conservation measures are demonstrated options that could be directly stimulated by adopting economic measures and/or technical benefits.

Figure 8.19 illustrates the impact of pricing policy, where the district heating price is related to the district heating demand in the residential and industrial sectors.

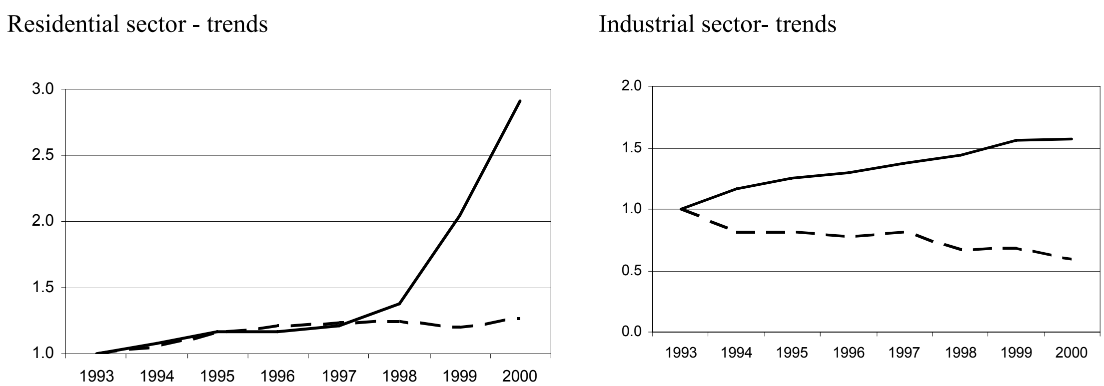


Figure 8.19 Trends of district heat demand and prices by sectors (1993 =100%)

The correlation between the price of heat and heat demand doesn't seem to exist in the residential sector as it does for industry. This is not the only reason for the industrial decline, however, as on-going structural changes also played an important role. Increases in gasoline prices in the transportation sector do not correlate with a decrease in motor fuel consumption (see Figure 8.20). The reason for this trend may be that passenger transport is driven more by the business activities of new private companies than by the use of a car for private purposes. Simultaneously, a reduction of public transport outputs could play an important role as well.

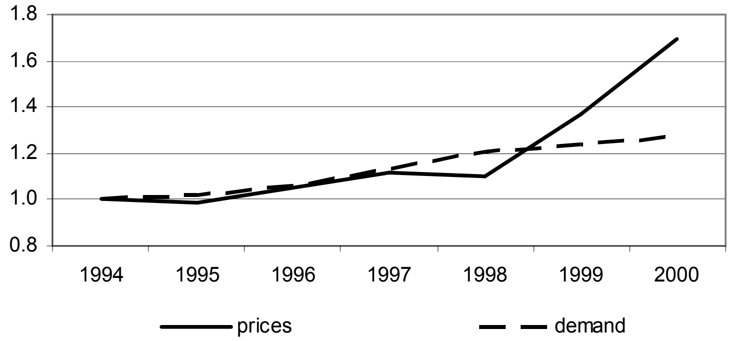


Figure 8.20 Trends of gasoline prices and demand (1994 =100%)

8.6.5. Environmental Impacts of Energy System

A number of issues related to primary energy supply have already been discussed (see Section 8.6.1). Response actions that will have a direct impact on the primary energy mix have been initiated by the adopted environmental legislation framework. Implementation of stack emission concentration limits and energy charges for basic pollutants in Slovakia stimulate fuel switching to less carbon intensive fuels (e.g., the use of NG instead of the sulphur-containing fuels such as coal or HFO, the use of lower sulphur content coal, such as at the CHP at US Steel, etc.). Figure 8.21 illustrates the trends in non-fossil primary energy and NG shares, along with the rends in emissions of air pollutants. The increasing share of less carbon intensive energy carriers brought about a decline in emissions.

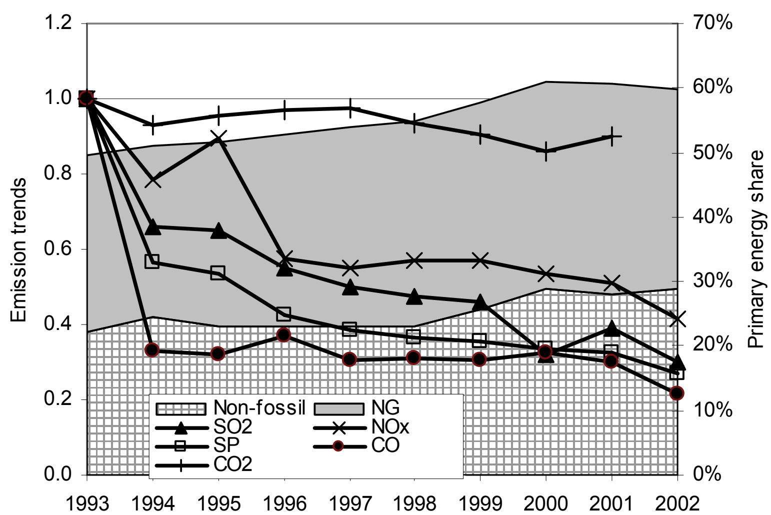


Figure 8.21 Correlations of primary energy mix and emission trends

The role of nuclear energy is usually the subject of heated discussions. There has been a demonstrated positive impact of increased share of nuclear and other non-fossil primary energy sources on pollutant emissions. A negative impact from the use of nuclear is the generation of radioactive wastes. The data in Table 8.26 show the radioactive waste releases and the share of nuclear in primary energy, for the period 1997-2000. The data show that the increases in radioactive emissions are lower than the increase in the primary nuclear energy share. This represents a positive trend.

TABLE 8.26 NUCLEAR ENERGY SHARE AND RADIOACTIVE EMISSIONS, 1997 AND 2000

ISED #	Item	ISED unit	1997	2000	2000 values/ 1997 values
11.3.4.	Nuclear power share in electricity	%	18.7	27.6	1.47
27.1.	noble gases:	GBq	26,300	29,232	1.11
27.4.	iodine-131:	GBq	0.87	0.97	1.11
28.2.	Radionuclide in liquid radioactive discharges	GBq	35,560	23,887	0.67
31.1.2.	Low and intermediate level radioactive waste, long-lived (LILW-LL):	m^3	172.0	217.0	1.26

8.7. Strategies for Improvements in Priority Areas

The future strategy of Slovakia's national energy system development will be heavily influenced by the country's EU membership effort. This will result in:

- a liberalization of its energy market;
- participation in the EU CO_2 emissions trading scheme;
- full harmonization of energy and environmental legislation system with EU practices;

Using the IAEA analytical tool ENPEP/BALANCE, three scenarios (i.e., low, medium and high) have been designed and analysed. This enabled an analysis of the impact of new strategies for energy sector development on potential trajectories by selected ISED. Details on key assumptions used to develop these scenarios are provided in Annex 8.D and are summarised as follows:

Scenario 1 - Low GDP growth rate as a driving force, combined with a high nuclear option and impacts of energy and environmental policy on final energy demand and fuel mix (including the use of renewable energy sources).

Scenario 2 - Medium GDP growth rate as a driving force, combined with a low nuclear option and impacts of energy and environmental policy on final energy demand and fuel mix (including use of renewable energy sources).

Scenario 3 - High GDP growth rate as a driving force, combined with a low nuclear option and development without impacts of energy and environmental policy on the final energy demand and fuel mix.

The high nuclear option holds that the retired 2 x 440MWe nuclear units in NPP Bohunice will be replaced by the finalized units in NPP Mochovce with the same capacity. The low nuclear option holds that the retired 2 x 440MWe nuclear units in NPP Bohunice will be replaced by newly installed NG-fired combined cycle units. The impact of environmental policy represents an increase of the NG share of the fuel mix for electricity and heat generation. Without this impact, the fuel mix for electricity and heat generation would not be influenced by environmental legislation.

Based on available input and calculated output data, the trajectories of the following ISED have been estimated:

- Macroeconomic data (i.e., population growth rate and GDP/cap development);
- Share of individual economic sectors in GDP to illustrate stages of economic transformation;
- Primary energy consumption and primary energy mix;
- Evaluation of environmental impacts through trends of basic air pollutants.

8.7.1. Population growth rate and GDP/cap

Table 8.27 and Figure 8.22 provide projections for the population growth rate. In all demographic scenarios published by the Slovak Statistical Office (SOS, 2002b), a decrease in total population is considered. This predicted trend closely follows observed trends in other developed countries, but in Slovakia some changes in the social structure due to the process of economic transformation will also play an important role. The natural increase or decrease in the population and the final number of inhabitants will also influence other ISED (i.e., where this figure is used as a denominator).

TABLE 8.27 PREDICTION OF POPULATION DEVELOPMENT

Population	Unit	2000	2005	2010	2015	2020	2025
Low scenario	mill.	5.403	5.373	5.342	5.291	5.211	5.096
Medium scenario	mill.	5.403	5.377	5.360	5.329	5.278	5.199
High scenario	mill.	5.403	5.379	5.386	5.388	5.374	5.335

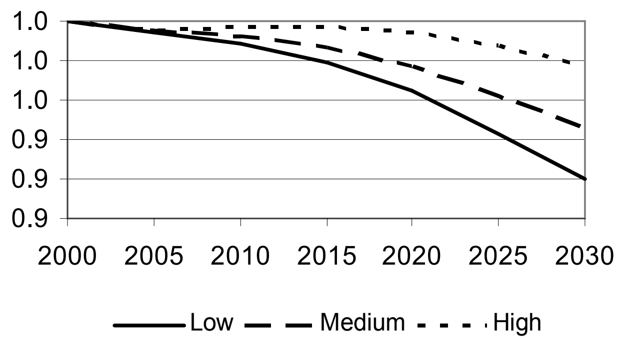


Figure 8.22 Future trends of population growth rate (2000 = 100%)

Table 8.28 shows projections of GDP and GDP/cap growth.

TABLE 8.28 GDP AND GDP/CAP GROWTH

Scenario		Unit	2000	2005	2010	2015	2020	2025
Low	GDP	bil.USD	31.28	34.85	39.43	44.61	50.47	57.11
	GDP/cap	$/ cap	5,790	6,486	7,381	8,432	9,686	11,206
Medium	GDP	bil.USD	31.28	35.95	42.29	49.74	58.51	68.82
	GDP/cap	$/ cap	5,790	6,686	7,890	9,334	11,085	13,237
High	GDP	bil.USD	31.28	36.76	46.91	59.87	76.41	97.52
	GDP/cap	$/ cap	5,790	6,833	8,710	11,112	14,219	18,280

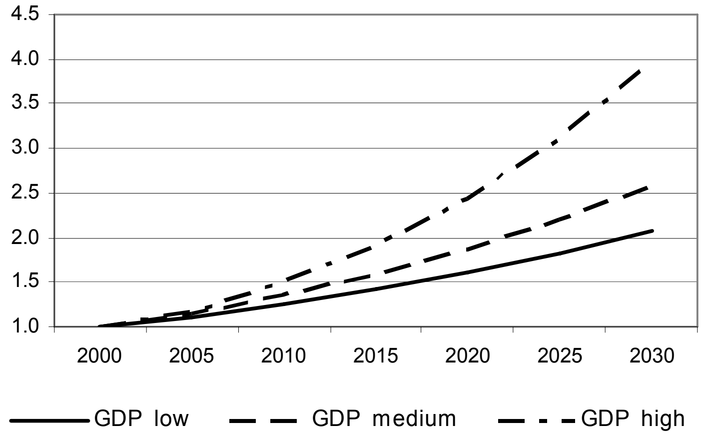


Figure 8.23 Comparison of GDP and GDP/cap trends

As is seen in Figure 8.23, the slope of the GDP/cap curve is higher than that of the GDP one, due to the decreasing number of inhabitants in all scenarios.

8.7.2. Share of economic sectors in GDP and transformation process

The shares of industry and services and commercial sectors in GDP creation serve as an indication of structural changes. Data for the individual sector's share are presented in Annex 8.D. Figure 8.24 indicates the share of these sectors for individual scenarios.

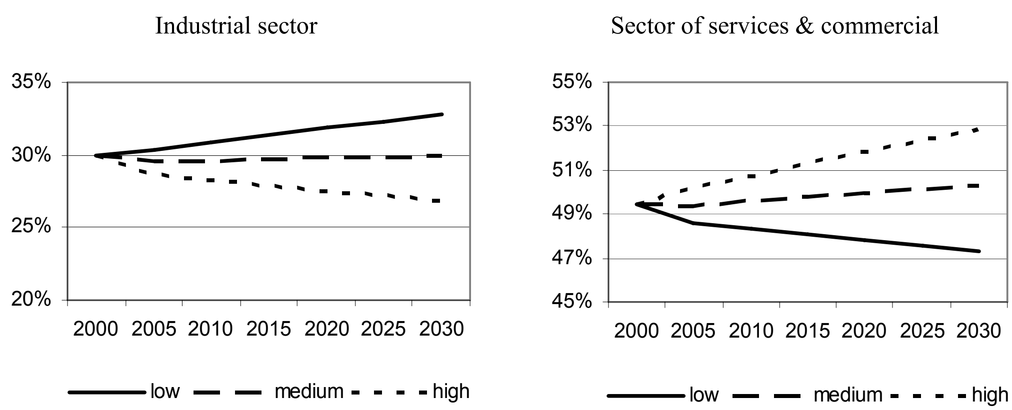


Figure 8.24 Development of GDP share for industrial and service and commercial sectors for individual scenarios of GDP growth rate.

As is seen in Figure 8.24, the scenario with the high GDP growth rate will bring a decrease in the share of the industrial sector, and an increase in the share of the services and commercial sector in GDP. A contrary tendency is observed in the low GDP scenario, and thus the higher GDP growth rate is connected primarily with an increase of activity in the services and commercial sector. This fact will also positively affect the level of energy intensity. Projections show that the VA share of individual industrial branches will not be changed substantially during the period followed (as is seen in Table 8.29).

TABLE 8.29 VA SHARE OF INDUSTRIAL ENERGY INTENSIVE BRANCHES

Year	2005			2010			2015		
Scenario	low	medium	high	low	medium	high	low	medium	high
Iron and steel	13.4%	13.4%	13.4%	12.9%	12.9%	12.9%	12.3%	12.3%	12.3%
Machinery	23.7%	23.6%	23.6%	24.3%	24.2%	24.2%	24.9%	24.9%	24.8%
Chemicals	7.9%	7.9%	7.9%	8.0%	8.0%	8.0%	8.2%	8.2%	8.2%
Petroleum refining and coke production	5.7%	5.7%	5.7%	5.8%	5.8%	5.8%	6.0%	6.0%	6.0%
Non-metallic minerals	5.6%	5.6%	5.6%	5.6%	5.6%	5.6%	5.6%	5.6%	5.6%
Paper and pulp	4.5%	4.5%	4.5%	4.5%	4.5%	4.5%	4.5%	4.5%	4.5%

8.7.3. Structure of Primary Energy Sources

Based on the scenario assumptions, estimates of primary energy consumption and primary energy mix were calculated, together with relevant ISED. Figure 8.25 gives the structure of TPES for each scenario. All scenarios consider the retirement of old units of existing power plants. In the low scenario, the building of new units is considered. The higher share of nuclear in the case of the "low" scenario brings about a decrease in the share of fossil fuels. A preferred case is the one in which natural gas is used as fuel in newly installed combined cycle units. These units are considered to replace retired capacity of old nuclear power plants in the years after 2008, together with addressing the increase in electricity demand.

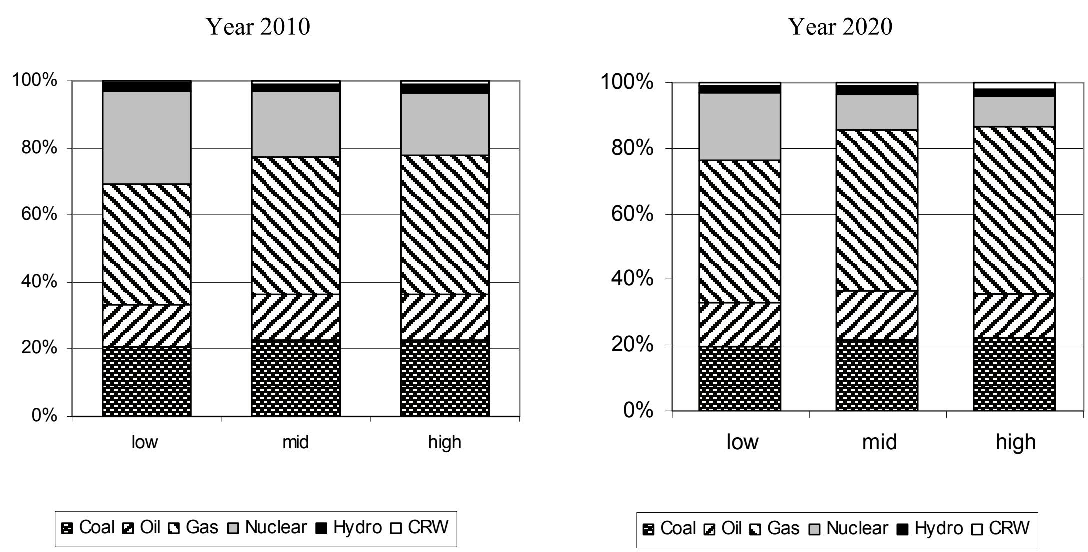


Figure 8.25 Predicted structures of primary energy sources for 2010 and 2020

8.8. Findings and recommendations

8.8.1. ISED Relation to National Priorities

The applicable ISED, designed according to IAEA methodology, are directly and/or indirectly related to the following priority groups of national policy:

8.8.1.1. EU accession process

Comparing energy price relationships in Slovakia and selected EU countries (i.e., Germany and Netherlands), it can be seen that price levels for end-use energy carriers in Slovakia is still lower than those for EU representatives. On the other hand, energy price distortions have been continuously removed, in the cases of natural gas, district heat and electricity. The price relationship in households and the industrial sector was changed towards a real economic model by removing cross-sector subsidies. The newest fiscal measure is levelization of taxes (both income tax and VAT) at the level of 19%, and involvement of only one group of VAT. These were applied in January 2004, and were not discussed in this study, but they will have a significant impact on future economic development in Slovakia.

The process of economic restructuring is connected with the structural changes of GDP creation by sectors. In the period studied, total GDP was increasing continuously, and the share of industry slightly declined while the share of the commercial and services sector increased. These changes are directly reflected in the final energy intensity figures. The trends for the industrial share of GDP indicated decline, and in the year 2000 reached approximately the level of Germany, but it remained higher than for the other reference EU country (i.e., the Netherlands). The process of privatization in the last year, accompanied with higher foreign investments, resulted in some revival in the machinery and metallurgy branches. These changes resulted in some increase in industrial energy intensity. Future development of metallurgy in Slovakia will strongly depend on the actual EU policy related to quotas for steel exports (as this could determine additional revival in this energy intensive industrial sector) and/or environmental requirements.

8.8.1.2. Security of energy supply

Slovakia is a country highly dependent on energy imports. The only meaningful domestic indigenous energy sources are brown coal and hydropower. Both are limited in their potential, and domestic coal/lignite is, in addition, characterized by low quality. For a system with these characteristics, it is obvious that only a combination of intensive energy conservation policies, active participation in the European and world energy markets, and a higher diversification of energy sources could ensure the security of energy supply. The required legislative framework has already been implemented and is still being enhanced in Slovakia.

8.8.1.3. Sustainable development

Security of energy supply and environmental issues represent the additional parameters that need to be attained in terms of sustainability. The adopted environmental legislation framework for air protection in Slovakia first focused on the reduction of basic pollutants, which also had a positive side effect on the emissions of greenhouse gases (namely CO_2). To meet emission standards, fuel switching towards less carbon intensive fuels has been the measure most frequently used. This has a direct impact on the primary energy mix (i.e., increasing the share of natural gas). The levels of both basic air pollutants and GHG emissions have been positively influenced by the economy restructuring, through its positive effect of decreasing energy intensity. A new comprehensive legislation framework for waste treatment adopted in Slovakia is in all areas fully compatible with EU directives, and serves as another supporting tool for sustainable development. It appears that further steps in harmonization with EU environmental directives will result in additional energy savings and decreased emission intensity on both a GDP and per capita basis. The combination of higher incomes in recent years with the adopted tax reform (i.e., one tax level of 19%) seems to provide a promising situation, with the latter tool offering a positive impact by decreasing the unemployment rate.

8.8.2. Interdependency of Applied ISED

The IAEA methodology looks at targeted indicators, and the opportunity for responses that could positively influence selected ISED. Even though the period covered in this analysis was relatively short, there has been an attempt to clarify the interdependency of the ISED and to illustrate the impact of the economic transformation process and environmental measures on the energy system.

Concerning the pricing policy, the only strong direct relationship between price and demand was found in the distict heat supply for industry. Nevertheless, considering that both a price increase and industrial restructuring should be accompanied by a decrease in energy intensity and both occurred over the same period, the actual heat demand decrease would have been influenced simultaneously by both factors. There were other complex relationships in energy pricing and demand as well. For example, even though the price of gasoline increased significantly, this had no direct impact on gasoline consumption. The gasoline consumption probably increased due to the increased number of cars in the vehicle fleet, and also because of the increase in private enterprise activities.

The process of economic restructuring has had a positive impact on both the energy and emission intensity. On the other hand, the process of privatisation and the increase in foreign investment led to the revival in metallurgy branches and have had a direct impact on negative changes in energy intensity and GHG emissions production. However, the production level of GHG emissions will be directly limited by the EU quota rules and, therefore, should not result in any dramatic increase.

8.8.3. Recommendations for Additional Analyses

Based on experience gained with the collection of data, data quality analyses, design of ISED and analyses of ISED trends, findings during the development of this study could be summarized as follows:

The proposed set of ISED is relevant for Slovakia, except for the ISED related to the energy access for the poorest group of inhabitants; until now, the electricity and gas network is available to 90% of the population.

The indicator addressing the *Percentage in urban areas* is not very relevant for the final energy use analyses in Slovakia. A better approach would be to implement an ISED relevant to the dwelling structure and the type of heat supply (e.g., share of population living in family and apartment housing; share of heat supply from centralized district heat versus individual space heating system; split of thermal energy consumption to space heating versus hot water supply; etc.). Based on available data, time series for new proposed ISED indicators were calculated, and the results are given in Table 8.30.

TABLE 8.30 INDICATOR FOR HEAT SUPPLY IN THE RESIDENTIAL SECTOR

Parameter	Unit	1993	1994	1995	1996	1997	1998	1999	2000
Share of family houses	%	50.2	50.3	50.3	50.3	50.3	50.3	50.5	50.7
Share of apartment houses	%	49.8	49.7	49.7	49.7	49.7	49.7	49.5	49.3
Share of centralized heat supply	%	92.4	92.4	92.3	92.2	92.2	92.1	92.0	91.9
Share of individual heat supply	%	7.6	7.6	7.7	7.8	7.8	7.9	8.0	8.1

The ISED related to activities in the transportation sector do not fully reflect the on-going transformation process in this sector. This process is namely characterised by changes in vehicle fleet numbers and structures, especially in the individual transport mode (see Table 8.31). Since 1990 the number of vehicles per capita has increased in Slovakia by 34% on average, with Bratislava and Košice getting the largest share of this increase (64% and 46%, respectively). Slovakia is among EU countries with medium-developed motorism. To compensate for this huge increase in energy consumption and negative impacts on air pollution (i.e., sustainability aspects), legislation and regulatory rules regarding improvements in car quality have been adopted as well.

TABLE 8.31 DEVELOPMENT OF VEHICLE FLEET STRUCTURE FOR PERSONAL CARS (TRANSPORT RESEARCH INSTITUTE, 2000)

Vehicles	Unit	1994	1995	1996	1997	1998	1999	2000
<1,400ccm	%	75.1	73.5	68.5	56.8	53.3	50.3	48.5
<1,400ccm & catalyst	%	3.6	5.0	8.9	12.3	13.6	14.4	15.2
1,400-2,000ccm	%	9.7	9.8	9.6	13.9	14.9	15.2	15.5
1,400-2,000ccm & catalyst	%	1.1	1.2	2.3	3.0	5.0	6.3	7.3
>2,000 ccm	%	2.8	2.9	3.2	3.9	3.7	3.5	3.4
>2,000 ccm & catalyst	%	0.3	0.5	1.1	0.9	1.0	1.0	1.0
diesel cars	%	2.0	2.3	2.3	6.7	6.8	6.9	7.0
LPG cars	%	0.0	0.0	0.0	0.0	0.0	1.3	1.5
2 stroke cars	%	5.3	4.7	4.1	2.5	1.7	1.0	0.5

Availability of input data was a determining factor for some of the ISED. The adopted legislation framework (i.e., especially the "*rules of three companies,"* in which energy and other statistical data for individual sector or industrial branches can only be openly published if this aggregation has more than three companies) does not allow the development of ISED for some of the most important production and energy consuming companies.

Although energy data are available for a relatively wide range of industrial branches, the definition of activity as a mass or volume of product presents a problem.

8.8.4. Dissemination of Project Results

Among the main goals of this project, the dissemination of lessons learned and results throughout the nationwide network of experts and official representatives involved directly in the decision making process for energy sector development plays an important role.

The Interim Report developed during the first year of the project was distributed to official representatives in all institutions related to the subject in order to provide comprehensive information on priority areas and policies and to show the results from this study.

Results from the first project phase were also summarised in an article published in the domestic expert and public journal ENERGETIKA, issued by the Slovak Energy Agency.

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ANNEX 8.A Total Fuel Balance

TABLE A.1 TOTAL BALANCE OF SOLID FUELS – YEAR 2000 [TJ]

	Coking coal	Hard coal	Brown coal	Briquettes	Coke	Other solid fuel	Total
Domestic	0	0	42 629	-	-	2 971	45 600
Import	75 751	56 245	9 164	92	4 069	0	145 321
Export	0	0	80	0	1 629	0	1 709
Stock exchange	-174	-6 263	-526	2	417	-346	-6 890
Other sources	0	1 093	-1 768	0	0	0	-675
Primary sources	75 577	51 075	49 419	94	2 857	2 625	181 647
Production	0	0	0	0	47 969	1 198	49 167
Consumption	64 645	44 900	40 676	0	17 520	3 797	171 538
Mining	0	0	24	0	0	0	24
Transformation	64 645	0	0	0	17 449	1 198	83 292
Heat generation	0	14 056	16 776	0	71	2 475	33 378
Electricity generation	0	30 821	23 876	0	0	124	54 821
Distribution, losses	0	23	0	0	0	0	23
Final energy uses	10 932	6 175	8 743	94	33 306	26	59 276
Forestry	3	1	28	0	14	15	61
Agriculture	7	17	261	1	60	0	346
Industry	10 893	5 863	0	2	30 653	0	47 411
Construction	2	5	66	0	8	1	82
Transport	0	30	478	3	290	0	801
Residential	27	25	1 926	22	56	10	2 066
Other	0	234	5 984	66	2 225	0	8 509

Other solid fuel – includes biomass and waste

TABLE A. 2 TOTAL BALANCE OF LIQUID FUELS – YEAR 2000 [TJ]

	Crude oil	Gasoline	Diesel oil	LFO	HFO	Kerosene	OLF	Total
Domestic	2 436	-	-	-	-	-	-	2 436
Import	221 184	4 220	4 095	2	1 461	0	400	231 362
Export	609	37 620	60 421	779	17 494	407	2 269	119 599
Stock exchange	2 856	435	46	-37	374	-15	0	3 659
Other sources	0	-605	915	0	2 867	-326	0	2 851
Primary sources	225 867	-33 570	-55 365	-814	-12 792	-748	-1 869	120 709
Production	0	59 635	90 279	1 523	20 563	2 035	24 399	198 434
Consumption	225 867	18	12	95	4 429	0	22 525	252 946
Mining	0	0	0	0	0	0	0	0
Transformation	225 825	0	0	0	122	0	369	226 316
Heat generation	0	0	5	95	3 052	0	16 197	19 349
Electricity generation	0	0	0	0	1 247	0	5 959	7 206
Distribution, losses	42	18	7	0	8	0	0	75
Final energy uses	0	26 047	34 902	614	3 342	1 287	5	66 197
Forestry	0	68	578	3	0	55	0	704
Agriculture	0	252	5 459	112	2	0	0	5 825

Industry	0	1 321	3 877	142	3 220	37	0	8 597
Construction	0	420	2 205	170	0	0	5	2 800
Transport	0	1 186	6 998	4	120	484	0	8 792
Residential	0	12 805	2 525	0	0	0	0	15 330
Other	0	9 995	13 260	183	0	711	0	24 149

LFO – Light fuel oil
HFO – Heavy fuel oil
OLF – Other liquid fuels includes liquid residues from refinery and residual oil from refinery and chemical industry and black liquor

TABLE A.3 TOTAL BALANCE OF GASEOUS FUELS – YEAR 2000 [TJ]

	NG	CoG	BFG	LPG	OGF	Total
Domestic	5 620	-	-	0	-	5 620
Import	241 349	0	0	1 264	0	242 613
Export	0	0	0	23	0	23
Stock exchange	-18 158	0	0	-57	0	-18 215
Other sources	15 479	0	0	0	0	15 479
Primary sources	244 290	0	0	1 184	0	245 474
Production	-	12 164	17 123	173	13 473	42 933
Consumption	87 793	5 772	9 861	0	12 516	115 942
Mining	141	0	0	0	0	141
Transformation	9 075	1 691	4 711	0	8 628	24 105
Heat generation	55 705	2 449	3 047	0	3 708	64 909
Electricity generation	20 104	1 542	1 339	0	180	23 165
Distribution, losses	2 768	90	764	0	0	3 622
Final energy uses	156 497	6 392	7 262	1 357	957	172 465
Forestry	114	0	0	0	0	114
Agriculture	1 911	0	0	117	6	2 034
Industry	72 581	6 392	7 262	158	945	87 338
Construction	1 117	0	0	281	0	1 398
Transport	384	0	0	6	6	396
Residential	60 360	0	0	454	0	60 814
Other	20 030	0	0	341	0	20 371

NG – natural gas
CoG – coking gas from coking battery
BFG – blast furnace gas
OGF – other gaseous fuels include converter gases in metallurgy and refinery gases

ANNEX 8.B Data of ISED

TABLE B 1. ISED #1- POPULATION, #2- GDP #3 - END USE PRICES

ISED #	Indicator	Unit	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002
1.	**Population**		5.336	5.356	5.368	5.379	5.388	5.393	5.399	5.403	5.379	5.379
1.1.	Total:	Million										
2.	**GDP per capita**											
2.1.	GDP per capita (using ER)	$/ cap	2,593	3,112	3,612	3,991	4,448	4,873	5,258	5,814	6,314	6,712
2.2.	GDP per capita (using PPP):	$/ cap	8,319	9,910	9,281	10,095	10,703	11,720	13,584	14,197	15,261	15,926
3.	**End-use energy prices with and without tax/subsidy**											
3.1.	***Automotive fuel***											
3.1.1.	Premium gasoline/unleaded gasoline (91 RON)											
3.1.1.1	with tax/subsidy	$/1,000 lt	664	671	653	711	742	713	856	1,114	1,057	1,010
3.1.1.2	without tax/subsidy	$/1,000 lt	257	258	242	289	330	315	379	510	463	424
3.1.2.	Premium unleaded gasoline (95 RON)											
3.1.2.1	with tax/subsidy	$/1,000 lt	647	665	655	702	745	734	910	1,126	1,067	1,012
3.1.2.2	without tax/subsidy	$/1,000 lt	280	286	272	315	354	332	397	519	471	425
3.1.3.	*Automotive gasoline (diesel) for commercial use*											
3.1.3.1	with tax/subsidy	$/1,000 lt	452	455	474	535	702	706	738	867	838	769
3.1.3.2	without tax/subsidy	$/1,000 lt	197	200	206	252	317	292	342	462	424	392
3.2.	**Industry**											
3.2.1.	***Electricity:***											
3.2.1.1	with tax/subsidy	$/MWh	49	49	49	51	55	58	57	66	70	72
3.2.1.2	without tax/subsidy	$/MWh	49	49	49	51	55	58	57	65	69	72
3.2.2.	***Heat:***											
3.2.2.1	with tax/subsidy	$/GJ	6.2	7.3	7.8	8.1	8.5	9.0	9.7	9.8	N/A	N/A
3.2.2.2	without tax/subsidy	$/GJ	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
3.2.3.	***Natural gas:***											
3.2.3.1	with tax/subsidy	$/GJ (GCV)	2.84	2.94	3.07	3.08	3.21	3.54	3.56	3.78	4.16	4.85
3.2.3.2	without tax/subsidy	$/GJ (GCV)	2.84	2.93	3.07	3.08	3.21	3.54	3.56	3.78	4.16	4.85
3.2.4.	***Light fuel oil***											
3.2.4.1	with tax/subsidy	$/thousand lt	175.7	145.5	133.1	147.5	155.2	150.3	167.1	240.4	324.2	350
3.2.4.2	without tax/subsidy	$/thousand lt	175.7	145.5	133.1	147.5	155.2	150.3	167.1	240.4	324.2	350
3.2.5.	***Steam coal:***											
3.2.5.1	with tax/subsidy	$/tone	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
3.2.5.2	without tax/subsidy	$/tone	34.1	40.7	43.3	47.6	49.6	53.9	58.1	59.9	N/A	N/A
3.3.	**Households**											
3.3.1.	***Electricity:***											
3.3.1.1	with tax/subsidy	$/MWh	31.4	31.4	31.4	32.5	33.2	33.2	48.4	78.0	102.2	101.6

3.3.1.2	without tax/subsidy	$/MWh	29.8	29.7	29.7	30.6	31.3	31.3	44.5	70.1	92.0	91.8
3.3.2.	***Heat:***											
3.3.2.1	with tax/subsidy	$/GJ	4.0	4.4	4.7	4.7	4.9	5.5	8.2	11.8	N/A	N/A
3.3.2.2	without tax/subsidy	$/GJ	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
3.3.3.	***Natural gas:***											
3.3.3.1	with tax/subsidy	$/GJ (GCV)	1.87	1.87	1.95	1.98	2.04	2.08	2.60	4.04	4.50	4.60
3.3.3.2	without tax/subsidy	$/GJ (GCV)	1.77	1.76	1.84	1.87	1.92	1.96	2.40	3.67	4.09	4.18
3.3.4.	***Light fuel oil***											
3.3.4.1	with tax/subsidy	$/1,000 lt	176	145	133	147	155	150	167	240	324	350
3.3.4.2	without tax/subsidy	$/1,000 lt	10	9	300	301	308	317	327	344	352	45
3.3.5.	***Brown coal***											
3.3.5.1	with tax/subsidy	$/t	30.8	39.8	44.5	47.2	51.2	56.2	64.1	67.8	N/A	N/A

TABLE B.2. ISED #4 - SECTORAL GDP SHARES, #5 & #6- TRANSPORTATION, #7 FLOOR AREA, #9-EI

ISED #	Indicator	Unit	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002
4.	**Shares of sectors in GDP value added in:**											
4.1.	Industry and construction	%	36.36	39.58	39.31	40.16	35.41	34.63	34.86	34.19	29	29.18
4.2.	Agriculture:	%	6.307	6.921	6.121	5.685	5.745	5.399	4.702	4.699	4.103	4.158
4.3.	Commercial & public services:	%	45.97	40.36	41.63	40.84	44.93	45.97	46.65	47.17	53.19	53.96
4.4.	Transportation:	%	8.644	11	10.75	11.08	11.04	11.1	10.9	11	11.21	10.18
4.5	Other	%	2.717	2.134	2.185	2.235	2.863	2.909	2.893	2.938	2.491	2.527
5.	**Distance traveled per capita by passengers**											
5.1.	Total:	pkm/cap	N/A	N/A	N/A	N/A	6,801	6,814	6,647	6,376	N/A	N/A
5.2.	By urban public transport:	pkm/cap	N/A	N/A	N/A	N/A	654	742.1	859	692.9	N/A	N/A
5.3.	Share of electrically driven vehicles in urban public transport:	%	N/A	N/A	N/A	N/A	0.4	0.395	0.387	0.414	N/A	N/A
6.	**Freight transport activity**											
6.1.	Total per capita:	Btkm/cap	N/A	N/A	N/A	N/A	5,427	5,743	5,564	7,625	N/A	N/A
6.2.	Percentage by truck:	%	N/A	N/A	N/A	N/A	52.49	57.84	61.64	69.37	N/A	N/A
6.3.	Percentage by train:	%	N/A	N/A	N/A	N/A	42.31	37.95	32.82	27.27	N/A	N/A
6.4.	Percentage by inland water:	%	N/A	N/A	N/A	N/A	5.194	4.213	5.536	3.357	N/A	N/A
7.	**Floor area per capita**	m^2/cap	25.73	25.74	25.78	25.84	25.91	26.02	26.17	26.37	N/A	N/A
8.	**Manufacturing value added by selected energy intensive industries**											
8.1.	Iron and steel:	%	N/A	N/A	12.17	12.41	12.18	10.71	9.547	13.83	15.94	13.7
8.2.	Machinery	%	N/A	N/A	15.69	15.63	17.63	18.65	20.09	22.52	24.61	25.99
8.3.	Chemicals:	%	N/A	N/A	10.84	10.94	10.32	9.256	7.919	8.86	8.914	8.412
8.4.	Petroleum refining and coke production:	%	N/A	N/A	4.118	3.844	5.07	3.942	3.159	6.422	4.631	4.114
8.5.	Non-metallic minerals:	%	N/A	N/A	4.393	4.552	4.639	4.998	4.834	5.651	5.893	5.859
8.5.1.	Paper and pulp:	%	N/A	N/A	4.607	3.486	3.519	3.966	3.849	4.54	5.83	5.419
9.	**Energy intensities**											
9.1.	***Final energy intensity:***	toe 1,000$	0.755	0.661	0.631	0.603	0.54	0.519	0.515	0.485	0.47	0.447
9.1.1.	Industry and construction	toe 1,000$	1.084	0.908	0.896	0.802	0.766	0.663	0.682	0.747	0.614	0.597
9.1.2.	Agriculture:	toe 1,000$	0.582	0.325	0.34	0.325	0.321	0.28	0.285	0.258	0.185	0.159
9.1.3.	Commercial and public services:	toe 1,000$	0.352	0.334	0.25	0.277	0.235	0.285	0.258	0.182	0.147	0.138
9.1.4.	Transportation:	toe 1,000$	0.253	0.234	0.24	0.139	0.141	0.139	0.131	0.136	0.521	0.707
9.1.4.1	Passengers travel:	kgoe 1,000 pkm		N/A	N/A	N/A	19.31	20.72	21	21.79	N/A	N/A

9.1.4.2	Freight activity:	kgoe 1,000 tkm		N/A	N/A	N/A	18.23	19.43	17.81	17.09	N/A	N/A
9.1.5.	***Residential sector***											
9.1.5.1	Total energy:	kgoe/cap	452	405.9	464.8	510.4	514.8	532.4	545	503.8	571.6	549.7
9.1.5.2	Total conventional energy:	kgoe/cap	452	405.9	464.8	510.4	514.8	532.4	545	503.8	571.6	549.7
9.1.5.3	Space heating:	kgoe/m^2 floor area	15.99	15.99	15.99	15.98	15.98	15.98	16.49	15.72	N/A	N/A
9.2.	Electricity intensity	kWh/$	1.173	1.109	1.121	1.141	1.061	0.937	0.999	0.969	0.97	0.915
9.2.1.	Industry and construction	kWh/$	1.293	1.397	1.2	1.271	1.318	1.215	1.2	1.288	1.384	1.245
9.2.2.	Agriculture:	kWh/$	1.464	0.755	0.761	0.73	0.918	0.697	0.644	0.565	0.535	0.498
9.2.3.	Commercial and public services:	kWh/$	0.664	0.444	0.657	0.677	0.531	0.398	0.561	0.481	0.618	0.564
9.2.4.	Residential sector:	kWh/ cap	775.3	838.1	931.1	1,013	1,022	1,042	1,051	1,003	970.8	912.2
9.2.5.	Transportation:	kWh/$	0.754	0.728	0.662	0.432	0.425	0.406	0.364	0.378	0.011	0.285

TABLE B.3. ISED #11 -ENERGY MIX, #12-EFFICIENCY, #13- ABATEMENT TECHNOLOGY

ISED #	Indicator	Unit	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002
11.	**Energy mix:**	-	-	-	-	-	-	-	-	-	-	
11.1.	***Final energy mix***											
11.1.1.	Coal:	%	18.6	17.9	15.7	16.1	15.5	13.8	12.8	12.5	9.5	11.2
11.1.2.	Petroleum products:	%	12.0	16.5	15.1	11.2	12.2	12.3	14.3	14.0	22.8	26.7
11.1.3.	Gas:	%	29.3	30.3	31.6	34.4	31.6	37.3	36.6	36.5	38.1	33.2
11.1.4.	Electricity:	%	13.4	14.4	15.3	16.3	16.9	15.5	16.7	17.2	17.8	17.6
11.1.5.	Heat:	%	26.8	20.9	22.2	22.1	23.8	21.0	19.6	19.7	9.3	9.2
11.1.7.	Renewable & wastes	%	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2.4	2.0
11.2.	**Electricity generation mix by fuel types**											
11.2.1.	Coal:	%	N/A	N/A	N/A	N/A	26.5	25.5	22.7	18.3	20.2	20.3
11.2.2.	Oil products:	%	N/A	N/A	N/A	N/A	5.0	6.2	3.2	2.4	0.7	1.2
11.2.3.	Gas based:	%	N/A	N/A	N/A	N/A	6.9	6.3	8.5	7.8	8.1	9.8
11.2.4.	Nuclear power:	%	N/A	N/A	N/A	N/A	51.3	51.5	55.7	62.5	64.5	62.4
11.2.5.	Hydro power:	%	N/A	N/A	N/A	N/A	6.7	6.7	6.4	6.1	6.0	5.7
11.2.7.	Renewable & wastes:	%	N/A	N/A	N/A	N/A	3.7	3.7	3.5	2.9	0.4	0.7
11.3.	**Total primary energy supply mix**											
11.3.1.	Coal:	%	33.9	30.7	29.4	28.7	27.8	25.9	25.0	23.3	23.4	22.4
11.3.2.	Oil:	%	16.4	18.1	19.0	18.4	18.2	19.3	17.3	15.7	15.8	17.8
11.3.3.	Gas:	%	27.4	26.7	28.6	29.7	30.8	31.7	32.0	32.0	32.9	31.0
11.3.4.	Nuclear power:	%	18.7	21.2	19.6	19.0	18.7	19.8	22.8	27.6	25.3	26.5
11.3.5.	Hydro power:	%	1.7	2.1	2.3	2.1	2.1	2.2	2.3	2.4	2.3	2.5
11.3.6.	Electricity net import	%	0.9	0.2	0.6	1.6	1.9	0.6	0.3	-1.3	-1.7	-1.9
11.3.8.	Renewable & wastes:	%	0.9	1.0	0.4	0.4	0.5	0.4	0.4	0.3	1.9	1.6
12.	**Energy supply efficiency**											
12.1.	Ratio of total final energy to total primary energy supply:	%	72.2	68.2	66.9	66.6	63.7	64.5	64.5	61.5	59.9	58.7
12.2.	Average fuel effectiveness of thermal power plants	%	N/A	N/A	N/A	N/A	30.8	30.2	30.4	31.0	31.2	N/A
12.3.	Electricity transmission and distribution losses	%	N/A	N/A	N/A	N/A	7.2	7.6	6.5	6.5	4.7	3.6
12.5.	Oil refining efficiency:	%	N/A	N/A	N/A	N/A	85.4	86.6	86.4	87.9	N/A	N/A
12.6.	Electricity supplies from CHP plants as percentage of total electricity generation	%	N/A	N/A	N/A	N/A	0.2	0.2	0.2	0.2	0.16	0.142
13.	**Status of deployment of pollution abatement technologies**											
13.1.	***Extent of use for abatement of:***											

13.1.1.	SO_2:	%	N/A	N/A	N/A	13.3	13.3	13.3	13.3	25.3	25.3	25.3
13.1.2.	NOx:	%	N/A	N/A	N/A	1.3	1.3	1.3	19.3	31.3	31.3	31.3
13.1.3.	Particulates:	%	N/A	N/A	N/A	100	100	100	100	100	100	100
13.2.	Average performance for removal of:											
13.2.1.	SO_2:	%	N/A	N/A	N/A		79	79	79	79	79	79
13.2.2.	NOx:	%	N/A	N/A	N/A		35	35	35	35	35	35
13.2.3.	Particulates:	%	N/A	N/A	N/A		98	98	98	98	98	98

TABLE B.4. ISED #14 = TPES/GDP, #16- TPES/CAP, #17 - INDIGENOUS ENERGY, #18- IMPORT

ISED #	Indicator	Unit	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002
14.	**Energy use per unit of GDP**											
14.1.	Total primary energy:	toe/ 1,000$	1.045	0.97	0.944	0.905	0.848	0.805	0.798	0.789	0.784	0.761
14.2.	Primary conventional energy:	toe/ 1,000$	1.035	0.96	0.94	0.902	0.844	0.802	0.795	0.787	0.769	0.748
14.3.	Electricity use:	kWh/$	1.467	1.399	1.428	1.4	1.341	1.193	1.243	1.205	1.177	1.247
16.	**Energy consumption per capita**											
16.1.	Total primary energy:	toe/ cap	3.379	3.316	3.41	3.463	3.389	3.349	3.366	3.394	3.515	3.512
16.2.	Automotive fuel:	toe/ cap	0	0.236	0.245	0.231	0.259	0.276	0.269	0.265	0.255	0.312
16.3.	Renewable & wastes	toe/ cap	0.032	0.032	0.014	0.014	0.015	0.013	0.012	0.012	0.068	0.058
16.4.	Electricity:	MWh/cap	4.741	4.785	5.158	5.354	5.36	4.961	5.242	5.18	5.274	5.759
17.	**Indigenous energy production**											
17.1.	***Indigenous primary energy***	Mtoe	5.1	5.69	5.463	5.481	5.236	5.377	5.871	6.758	6.925	6.924
17.1.1.	Coal:	%	18.99	18.91	18.8	20.78	20.28	19.79	17.4	15.07	14.28	13.75
17.1.2.	Oil:	%	1.297	1.175	1.354	1.294	1.225	1.113	1.111	0.861	3.05	0.79
17.1.3.	Gas:	%	4.079	4.062	5.164	4.714	4.312	3.766	2.818	1.986	2.197	2.198
17.1.4.	Nuclear power:	%	66.38	66.27	65.58	64.72	65.35	66.6	70.51	74.76	69.18	72.35
17.1.5.	Hydro power:	%	5.889	6.58	7.682	7.112	7.253	7.393	7.062	6.398	6.034	6.421
17.1.7.	Renewable & wastes	%	3.365	3.006	1.42	1.372	1.587	1.341	1.094	0.928	5.262	4.484
17.2.9.	Total electricity:	TWh	25.3	25.63	27.69	28.8	28.88	26.76	28.3	27.99	28.37	30.98
18.	**Energy net imports dependency**											
18.1.	Total primary energy:	%	71.71	67.96	70.15	70.58	71.33	70.23	67.69	63.15	63.38	63.35
18.2.	Total conventional energy	%	100	100	100	100	100	100	100	100	100	100
18.3.	Oil:	%	97.77	97.92	97.87	97.93	98.07	98.29	97.93	97.98	92.93	98.37
18.4.	Gas:	%	95.8	95.12	94.61	95.33	95.98	96.46	97.15	97.71	97.56	97.41
18.5.	Coal:	%	84.19	80.26	80.95	78.7	79.13	77.25	77.54	76.19	77.7	77.55
18.6.	Electricity:	%	5.601	1.669	4.992	12.23	14.04	4.822	1.971	-9.63	-13	-13.4

TABLE B.5. ISED #23 - #31 ENVIRONMENTAL IMPACT

ISED #	Indicator	Unit	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002
23.	**Quantities of air pollutant emissions**											
23.1.	***From all energy related activities:***											
23.1.1.	SO_2:	kt	228	151	148	125	114	108	105	72	89	68
23.1.2.	NOx:	kt	77	61	69	44	42	44	44	41	39	32
23.1.3.	Particulates:	kt	98	55	53	42	38	36	35	33	32	27
23.1.4.	CO:	kt	202	66	65	75	61	63	62	65	61	43
23.2.	***From electricity production:***											
23.2.1.	SO_2:	kt	84	58	64	83	79	74	74	43	52	41
23.2.2.	NOx:	kt	37	30	36	26	25	26	25	23	18	12

23.2.3.	Particulates:	kt	14	9	11	10	12	11	10	9	8	7
23.2.4.	CO:	kt	2	2	2	2	2	2	2	2	2	2
23.3.	***From transportation:***											
23.3.1.	SO_2:	kt	2	2	2	2	2	3	1	1	1	1
23.3.2.	NOx:	kt	52	53	53	43	45	46	43	38	41	45
23.3.3.	Particulates:	kt	3	3	3	3	3	3	3	8	9	10
23.3.4.	CO:	kt	52	53	53	43	45	46	43	38	41	45
24.	**Ambient concentration of pollutants in urban areas**											
24.1.	SO_2:	mg/ m^3	33.2	31.4	27	31.6	26.1	24	18.8	14.4	10.9	N/A
24.2.	NOx:	mg/ m^3	89.31	112.7	74.5	81.5	94.6	72.5	55.4	61.3	58.6	N/A
24.3.	Total suspended particulates:	mg/ m^3	78.29	85	75.7	82.9	60.6	45.4	36.5	40.1	35	N/A
24.4.	CO:	mg/ m^3	1,240	911.5	1,354	1,401	704	335.8	288.1	266.7	226.7	N/A
24.5.	Ozone	mg/ m^3	35	34	38	28	35	42	42	41	N/A	N/A
26.	**Quantities of greenhouse gas emission from energy related activities**											
26.1.	Total GHG	Mt CO_2 eq.	44.5	41.4	42.8	43.4	43.6	41.9	40.6	38.7	40.2	40.7
26.1.1.	CO_2:	Mt CO_2 eq.	42.9	39.8	41.1	41.6	41.8	40.1	38.9	37.0	38.5	38.9
26.1.2.	CH_4:	Mt CO_2 eq.	1.4	1.4	1.5	1.5	1.5	1.5	1.5	1.4	1.4	1.5
26.1.3.	N_2O:	Mt CO_2 eq.	0.2	0.2	0.2	0.2	0.2	0.3	0.3	0.2	0.3	0.3
26.2.	Total GHG per capita	t CO_2 eq./cap	8.3	7.7	8.0	8.1	8.1	7.8	7.5	7.2	7.5	7.6
26.3.	Total GHG per GDP	tCO_2 eq./1,000 $	2.6	2.3	2.2	2.1	2.0	1.9	1.8	1.7	1.7	1.6
26.4.	GHG from combustion and fuel transformation	Mt CO_2 eq.	39.4	36.0	37.0	37.5	37.5	35.4	34.3	32.9	33.7	34.9
26.5.	GHG from transportation	Mt CO_2 eq.	4.0	4.2	4.5	4.6	4.7	5.1	5.0	4.5	4.9	5.8
27.	**Radionuclide in atmospheric radioactive discharges**											
27.1.	noble gases:	GBq	N/A	N/A	N/A	N/A	26,300	N/A	N/A	29,232	N/A	N/A
27.4.	iodine-131:	GBq	N/A	N/A	N/A	N/A	0.87	N/A	N/A	0.967	N/A	N/A
28.	**Discharges into water basin associated with energy activity**											
28.1.	Wastewater discharges:	m^3	N/A	N/A	N/A	N/A	3E+05	3E+05	3E+05	3E+05	N/A	N/A
28.2.	Radionuclide in liquid radioactive discharges	GBq	N/A	N/A	N/A	N/A	35,560	N/A	N/A	23,887	N/A	N/A
28.2.1.	info\244.doc	GBq	N/A	N/A	N/A	N/A	0.236	N/A	N/A	0.266	N/A	N/A
28.2.2.	info\245.doc	GBq	N/A	N/A	N/A	N/A	35,560	N/A	N/A	23,887	N/A	N/A
31.	**Generation of radioactive waste from fuel cycle chains of nuclear power generation**											
31.1.2.	Low and intermediate level radioactive waste, long-lived (LILW-LL):	m^3	N/A	N/A	N/A	N/A	172	314.5	169.8	217	N/A	N/A
31.1.3.	Low and intermediate level radioactive waste, short-lived (LILW-SL)	m^3	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
34.	**Fatalities due to accidents:**											
34.6.1.	Hydro:	%	N/A	N/A	N/A	N/A	20.3	N/A	20	N/A	N/A	N/A
34.6.2.	Thermal power plants:	%	N/A	N/A	N/A	N/A	28.7	N/A	24	N/A	N/A	N/A
34.6.3.	Nuclear power plants:	%	N/A	N/A	N/A	N/A	51	N/A	56	N/A	N/A	N/A

ANNEX 8.C Key Assumptions applied for scenarios

TABLE C.1 FORECAST OF ANNUAL GROWTH RATE (AGR) OF ELECTRICITY DEMAND

AGR [%]	2000 / 2005	2005 / 2010	2010 / 2015	2015 / 2020	2020 / 2025	2025 / 2030
Low	1.72	0.79	0.86	0.90	0.74	0.59
Middle	1.87	1.16	1.08	0.92	0.77	0.60
High	1.75	2.49	2.40	2.24	2.15	2.04

TABLE C.2 HEAT AND HOT WATER DEMAND IN FAMILY HOUSES [%]

	2000	2005	2010	2015
Heat demand low				
Existing	0.00	-2.00	-2.00	-2.00
New build	5.98	9.71	5.58	3.99
Heat demand high				
Existing	0.00	-2.00	-2.00	-2.00
New build	5.98	11.72	6.02	4.32
Hot tap water demand low				
Existing	0.00	-2.00	-2.00	-2.00
New build	6.03	9.85	5.59	4.00
Hot tap water demand high				
Existing	0.00	-2.00	-2.00	-2.00
New build	6.03	11.89	6.01	4.33

TABLE C.3 HEAT AND TAP HOT WATER DEMAND IN APARTMENT HOUSES [%]

	2000	2005	2010	2015
Heat demand low				
Existing	0.00	-2.00	-2.00	-2.00
New build	2.24	5.91	4.55	3.44
Heat demand low with heat insulation				
Existing	-2.09	-6.80	-2.00	-2.00
New build	0.11	0.72	4.55	3.44
Heat demand high				
Existing	0.00	-2.00	-2.00	-2.00
New build	4.12	5.70	4.93	3.80
Heat demand high with heat insulation				
Existing	-2.09	-6.80	-2.00	-2.00
New build	1.94	0.52	4.93	3.80
Hot tap water demand low				
Existing	0.00	-2.00	-2.00	-2.00
New build	2.32	6.38	4.67	3.47
Hot tap water demand high				
Existing	0.00	-2.00	-2.00	-2.00
New build	4.26	6.09	5.13	3.83

TABLE C.4 ANNUAL IMPROVEMENT OF ENERGY INTENSITY IN THE INDUSTRY [%]

Energy intensity AGR	2005/2000	2020/2005	2015/2010	2020/2015	2025/2020	2030/2025
Low scenario						
Heat and technology fuels	-3.1	-3.1	-3.5	-2.9	-3.3	-3.1
Electricity	-2.0	-2.0	-2.2	-2.1	-2.1	-2.2
Middle scenario						
Heat and technology fuels	-3.1	-3.5	-2.9	-3.3	-3.1	-4.0
Electricity	-1.9	-2.3	-2.4	-2.6	-2.6	-2.7
High scenario						
Heat and technology fuels	-3.1	-3.5	-2.9	-3.3	-3.1	-4.0
Electricity	-1.9	-2.3	-2.4	-2.6	-2.6	-2.7

TABLE C.5 ANNUAL GROWTH RATE OF FINAL ENERGY DEMAND FOR CHEMICALS IN [%]

Energy intensity AGR	2005/2000	2020/2005	2015/2010	2020/2015	2025/2020	2030/2025
Low scenario						
Heat	0.233	-0.309	0.329	-0.072	0.127	-0.852
Technology fuels	1.350	1.086	1.146	1.189	0.984	0.843
Electricity	-3.080	-3.540	-2.910	-3.310	-3.060	-4.020
Middle scenario						
Heat	0.347	0.147	0.816	0.414	0.450	-0.571
Technology fuels	1.537	1.435	1.356	1.203	0.906	0.765
Electricity	-3.080	-3.540	-2.910	-3.310	-3.060	-4.020
High scenario						
Heat	0.191	1.455	2.134	1.727	1.956	0.937
Technology fuels	1.452	2.759	2.681	2.527	2.419	2.294
Electricity	-3.080	-3.540	-2.910	-3.310	-3.060	-4.020

TABLE C.6 ANNUAL GROWTH RATE OF FINAL ENERGY DEMAND FOR STEEL PRODUCTION IN [%]

Energy intensity AGR	**2005/2000**	**2020/2005**	**2015/2010**	**2020/2015**	**2025/2020**	**2030/2025**
Low scenario						
Heat	0.018	-1.592	-0.923	-1.401	-1.182	-2.199
Technology fuels	1.133	-0.215	-0.117	-0.157	-0.336	-0.528
Electricity	-3.080	-3.540	-2.910	-3.310	-3.060	-4.020
Middle scenario						
Heat	0.116	-1.107	-0.475	-1.001	-0.244	-1.644
Technology fuels	1.304	0.164	0.058	-0.223	0.209	-0.322
Electricity	-3.080	-3.540	-2.910	-3.310	-3.060	-4.020
High scenario						
Heat	-0.045	0.193	0.793	0.193	0.567	-0.544

Technology fuels	1.213	1.481	1.332	0.981	1.023	0.793
Electricity	-3.080	-3.540	-2.910	-3.310	-3.060	-4.020

TABLE C.7 ANNUAL GROWTH RATE OF FINAL ENERGY DEMAND FOR MACHINERY AND OTHER METALLURGY IN [%]

Energy intensity AGR	**2005/2000**	**2020/2005**	**2015/2010**	**2020/2015**	**2025/2020**	**2030/2025**
Low scenario						
Heat	0.018	-1.592	-0.923	-1.401	-1.182	-2.199
Technology fuels	1.133	-0.215	-0.117	-0.157	-0.336	-0.528
Electricity	-3.080	-3.540	-2.910	-3.310	-3.060	-4.020
Middle scenario						
Heat	0.116	-1.107	-0.475	-1.001	-0.244	-1.644
Technology fuels	1.304	0.164	0.058	-0.223	0.209	-0.322
Electricity	-3.080	-3.540	-2.910	-3.310	-3.060	-4.020
High scenario						
Heat	-0.045	0.193	0.793	0.193	0.567	-0.544
Technology fuels	1.213	1.481	1.332	0.981	1.023	0.793
Electricity	-3.080	-3.540	-2.910	-3.310	-3.060	-4.020

TABLE C.8 ANNUAL GROWTH RATE OF FINAL ENERGY DEMAND FOR OTHER INDUSTRY IN [%]

Energy intensity AGR	**2005/2000**	**2020/2005**	**2015/2010**	**2020/2015**	**2025/2020**	**2030/2025**
Low scenario						
Heat	0.182	-0.876	-0.230	-0.642	-0.385	-1.365
Technology fuels	1.298	0.512	0.581	0.612	0.468	0.320
Electricity	-3.080	-3.540	-2.910	-3.310	-3.060	-4.020
Middle scenario						
Heat	0.265	-0.366	0.282	-0.136	0.215	-0.761
Technology fuels	1.455	0.915	0.819	0.649	0.670	0.573
Electricity	-3.080	-3.540	-2.910	-3.310	-3.060	-4.020
High scenario						
Heat	0.093	0.962	1.612	1.201	1.447	0.458
Technology fuels	1.353	2.260	2.156	1.996	1.907	1.809
Electricity	-3.080	-3.540	-2.910	-3.310	-3.060	-4.020

ANNEX 8.D: Abbreviation and symbols

Abbreviation	Description
BC	Brown Coal
cap	Capita
CHP	Combined Heat and Power generation
EI	Energy Intensity
EU	European Union
FEU	Final Energy Uses
FGD	Flue Gas Desulphurization
GDP	Gross Domestic Product
GHG	Greenhouse Gases
HFO	Heavy Fuel Oil
HP	Heating Plant
HPP	Hydropower plant
IAEA	International Atomic Energy Agency
ISED	Indicator of Sustainable Energy Development
NG	Natural Gases
NPE	Nuclear Primary Energy
NPP	Nuclear Power Plant
PPP	Purchasing Power Parity
PWR	Pressure Water Reactor
SE	Slovak Electric Utilities
SP	Solid Particles
SR	Slovakia
TFC	Total Final Consumption
TPES	Total Primary Energy Supply
VA	Value Added
WB	World Bank