5. LITHUANIA

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5.1. Introduction

Lithuania has had three National Energy Strategies, adopted in 1994, 1999 and 2002 (Lithuania Ministry of Economy, 2002). The third National Energy Strategy can be considered a sustainable energy development strategy. The next National Energy Strategy should be approved in 2007. Lithuania entered the European Union (EU) in 2004 and its energy policy should be consistent with EU energy policy. A main goal of international and EU energy policy is to secure a sustainable energy future. The application of ISED to Lithuanian energy policy should help to address sustainable energy development challenges and monitor progress achieved in approaching main energy indicators of EU-15 countries as a result of energy policy harmonization and law approximation.

The purpose of this case study is to apply ISED in order to assess energy sector developments and to monitor progress achieved towards established targets. Appropriate ISED address priority concerns or strategic priorities of the Lithuanian energy sector with respect to defined related targets. Analysis of trends of selected indicators and their interlinkages with other indicators (driving force indicators, etc.) allow definition of problematic issues, assessment of the effect of policy measures proposed in the strategy, and the definition of new policy measures and actions to be implemented in order to achieve progress on priority targets established by the third National Energy Strategy. The application of modern strategic planning methods such as the ISED tool in the preparation of national energy strategies will help to create a consistent and well-structured strategy framework addressing all three dimensions of sustainability and to enhance the quality of policy analysis.

The scope of the study is to define priorities of energy sector development based on the third National Energy Strategy and to conduct policy analysis using the ISED tool. The main priority areas of energy policy are addressed using targeted indicators, driving force indicators and response actions on selected targeted indicators.

5.2. Overview of the Lithuanian Energy Sector

The Republic of Lithuania, located on the south shore of the Baltic Sea, regained its independence in 1991 after the break-up of the former Soviet Union. The population in the country is about 3.69 million (2000), and its density is 56.6 inhabitants/km^2. Lithuanian territory is 65,300 km^2, and it is bordered by Latvia to the north; Belarus to the east; Belarus, Poland, and The Russian Federation to the south; and the Baltic Sea to the west. The Lithuanian currency, the litas, has an exchange rate of 2.97 litas to the U.S. dollar (as of October 2003). The GDP (based on purchasing power parity) was \$27.6 billion in 2002, which ranks 84th out of 212 countries around the world. In 2004 Lithuania joined NATO and the European Union. Table 5.1 provides the total primary energy supply and final energy consumption structure dynamics in Lithuania 1990-2000. In the structure of primary energy supply in the year 2000, oil products amounted to 31%; natural gas 31%; solid fuel 10%; and nuclear 28%.

Lithuania's relatively small oil resources are not nearly enough to meet its needs, and so the country has become heavily dependent upon petroleum imports. Consumption of crude oil has been about one order of magnitude greater than domestic production. All of Lithuania's natural gas is imported from Russia by the gas pipeline company, Lietuvos Dujos, as there is no natural gas production within

Lithuania. The security of supply is a very important issue for the Lithuanian energy sector. The net energy import amounted to more than 50% in 2002.

The current structure of Lithuania's primary energy supply is very favorable with respect to greenhouse gas (GHG) emissions. Emissions of the main pollutants (SO_2, NOx, NMVOC, dust) from fuel combustion are quite low and Lithuania meets the requirements of all international conventions in the field of atmospheric pollution. Nevertheless, in the future when the Ignalina nuclear power plant (NPP) is closed, its share will be replaced by fossil fuels. This will have an impact on GHG emissions increases.

TABLE 5.1 ENERGY BALANCE STRUCTURE DYNAMICS IN LITHUANIA, KTOE

	1990	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002
Energy production	4,667	4,095	3,551	2,381	3,478	4,342	3,908	4,438	3,482	3,178	4,129	4,857
Crude oil	12	64	72	82	115	155	212	278	233	316	475	439
Peat	14	25	12	21	14	18	21	17	23	12	11	11
Nuclear	4,438	3,814	3,195	2,008	3,081	3,633	3,133	3,532	2,570	2,194	2,961	3,686
Hydro	36	27	34	39	32	28	25	36	36	29	28	30
Wood	167	165	239	231	237	508	516	576	621	627	654	690
Imports	11,891	7,054	5,849	5,654	5,313	4,945	4,904	4,811	4,407	4,298	3,933	3,751
Natural gas	4,678	2,768	1,496	1,731	2,028	2,168	2,002	1,754	1,826	2,323	2,145	2,169
Crude oil	7,282	4,277	4,113	3,483	3,245	3,007	3,037	3,442	2,694	1,999	2,050	2,013
Electricity	-1,033	-457	-236	99	-231	-444	-303	-523	-231	-115	-341	-558
Coal	963	466	475	342	270	213	169	138	118	91	79	127
Gross inland consumption	16,558	11,149	9,400	8,036	8,792	9,287	8,812	9,249	7,889	7,476	8,063	8,607
Oil products	7,294	4,341	4,185	3,565	3,360	3,163	3,249	3,720	2,926	2,315	2,525	2,453
Natural gas	4,678	2,768	1,496	1,731	2,028	2,168	2,002	1,754	1,826	2,323	2,145	2,169
Nuclear & hydro	3,442	3,384	2,993	2,146	2,882	3,217	2,855	3,045	2,375	2,108	2,648	3,158
Solid fuel	1,144	656	726	594	521	739	705	731	762	730	745	828
Final consumption by fuel	10,784	7,281	5,145	4,810	4,544	4,531	4,505	4,445	4,075	3,813	3,896	3,893
Natural gas	672	696	458	392	371	413	382	344	374	409	388	401
Oil products	4,538	2,747	1,769	1,643	1,650	1,535	1,624	1,645	1,502	1,357	1,420	1,411
Solid fuel	1,031	566	623	492	421	626	594	622	642	666	585	590
Heat	3,276	2,433	1,723	1,714	1,554	1,398	1,326	1,253	995	848	949	913
Electricity	1,267	840	571	570	548	560	579	581	563	533	554	578
Final consumption by sector												
Manufacturing	4,052	2,813	1,299	1,129	1,088	1,004	995	996	836	827	792	886
Transport	1,715	1,151	1,125	1,151	1,170	1,125	1,253	1,313	1,174	1,056	1,153	1,191
Agriculture	897	460	344	248	191	207	173	160	113	102	100	109
Households	1,946	1,764	1,603	1,522	1,409	1,553	1,498	1,450	1,419	1,354	1,372	1,385
Commercial sector	2,173	1,093	773	761	686	642	586	526	533	473	472	476

Final energy consumption in Lithuania amounted to 3.9 Mtoe in 2002. The structure of final energy consumption in Lithuania was the following in 2000: manufacturing 21.7%; transport 27.7%; agriculture 2.7%; household 35.5%; and the services sector 12.4%.

Almost three-quarters of Lithuania's total electricity production is presently generated by the Ignalina nuclear power plant. A historical summary of the structure of electricity generation and consumption in Lithuania is shown in Table 5.2.

Though there has been considerable attention devoted to improving the safety of Ignalina and analysts are looking at safety systems which could allow the plant to operate through 2025, instead of shutting it down in the 2005 to 2010 time frame, the European Union is concerned about the safety of Ignalina, and has pushed for its retirement. The Lithuanian parliament agreed to the closure of Unit 1 at Ignalina by 2005 as one of the conditions for Lithuania's admission to the EU. To help in planning the closure and in developing alternative power sources, the EU initially committed 10 million Euros to aid Lithuania in 2000, and announced an additional 20 million Euros per year from 2000 to 2006. The EU Phare program also pledged $195 million in June 2000 to help Lithuania shut down the facility.

The Lithuanian Economics Ministry estimates a much higher cost for closing both units: $2.4 billion by 2020, with the total cost eventually reaching more than $3 billion. In addition, Lithuanian energy officials have estimated that it would cost $910 million to modernize the non-nuclear plants to make up for lost capacity if Ignalina is retired. This will cause a significant burden on the Lithuanian economy. First, prices of electricity will increase significantly and will reach 10-14 EURct/kWh, according to some estimates (Lithuania Ministry of Economy, 2002). The closure of the Ignalina nuclear power plant will have a significant impact on unemployment as well: five thousand workers will be fired, and about four thousand people whose activities are related to the plant will also lose their jobs. The Ignalina region will thus be faced with these and other problems after the closure.

TABLE 5.2 ELECTRICITY PRODUCTION AND CONSUMPTION, GWH

	1990	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002
Gross electricity production	28,405	18,707	14,122	10,021	13,898	16,789	14,861	17,631	13,535	11,425	14,736	17,720
Ignalina NPP	17,033	14,638	12,260	7,706	11,822	13,942	12,024	13,554	9,862	8,419	11,362	14,142
Public CHP plants	10,809	3,527	1,244	1,563	1,275	1,917	2,001	3,108	2,734	2,254	2,589	2,638
Autoproducers (CHP)	149	72	38	34	50	56	68	74	79	109	85	160
Kruonis HPPS		159	187	266	378	548	474	478	447	304	375	427
Kaunas HPP	396	300	381	438	357	315	277	391	388	313	284	316
Small HPP	18	11	12	14	16	11	17	26	25	26	41	37
Net import	-11,975	-5,303	-2,732	1,099	-2,678	-5,159	-3,525	-6,082	-2,682	-1,336	-3,964	-64,87
Own use in power plants	2,109	1,760	1,574	1572	1,541	1,683	1,563	1,684	1,586	1,385	1,522	1,647
HPS water pumping	-	225	263	372	517	748	647	654	615	426	517	580
Losses in the network	1,552	1,686	2,204	1,981	2,008	1,779	1,585	1,519	1,330	1,281	1,416	1,426
Other Energy Sector	756	561	657	683	799	904	805	939	779	800	871	858
Final consumption	14,734	9,764	6,641	6,629	6,371	6,514	6,735	6,752	6,542	6,196	6,446	6,722
Manufacturing	8,274	4,537	2,771	2,802	2,813	2,519	2,776	2,620	2,407	2,294	2,346	2,546
Agriculture	2,942	1,513	705	576	523	501	426	413	226	188	197	188
Households	1,767	2,414	1,493	1,545	1,499	1,606	1,720	1,743	1,886	1,767	1,818	1,811
Commercial sector	1,504	1,159	1,579	1,604	1,441	1,803	1,724	1,895	1,949	1,871	1,995	2,095
Transportation	248	141	93	102	96	85	89	81	75	76	90	82

Disaggregated results of the final energy consumption dynamics and forecast in the case of the most probable base case scenario by economic sectors developed in the National Energy Strategy (Lithuania Ministry of Economy, 2002) are shown in Figure 5.1. Energy demand in the household sector will decrease during the planning period by 7.5%. As one can see from Figure 5.1, energy consumption in the trade and service sector and agriculture will increase only by 20-30%. Energy consumed in the manufacturing and transport sectors will increase by 80%.

Development of final energy structure by fuel source, and demand forecasts until the year 2020 are presented in Figure 5.2.

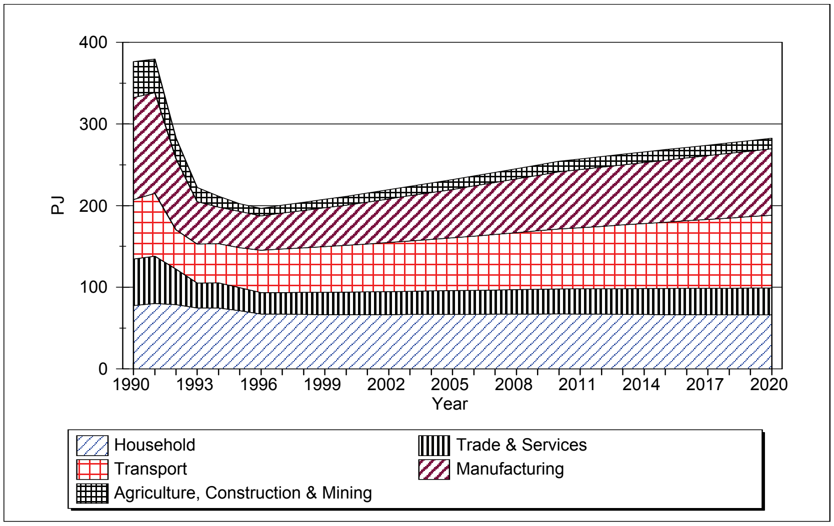

Figure 5.1 Final energy demand by sectors of economy (base scenario)

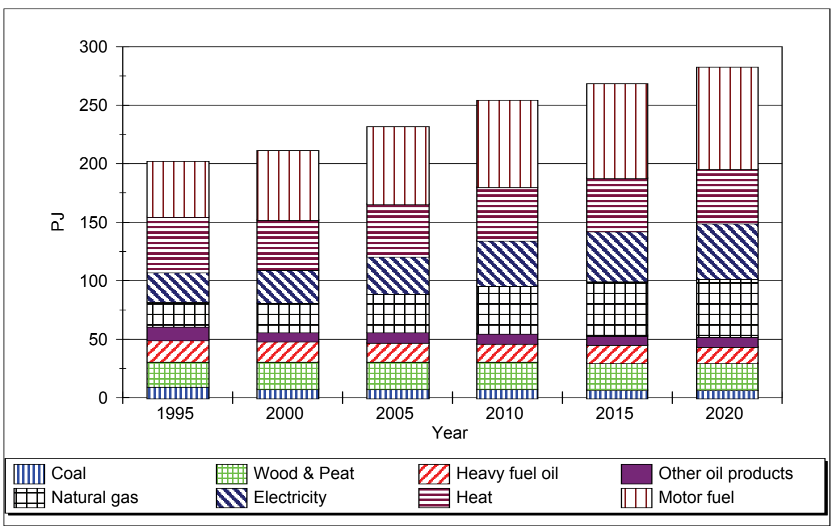

Figure 5.2 Final energy demand by fuel sources (base scenario)

Lithuania inherited from its Soviet past a strong energy sector, created with large-scale export possibilities (Table 5.3). Currently, the export and domestic consumption are almost half what they were in 1990. However, all of the generating plants and their operating staff have been fully retained. This represents a heavy burden on Lithuania's economy, as it increases energy production costs, reduces the competitiveness of goods, and hampers exports.

A considerable fraction of equipment and facilities within the country's power system (generation, transmission and distribution network), natural gas supply system, and refinery are obsolete and require modernization. Privatization programs have made considerable progress. Lithuania has privatized its oil industry and restructured the electricity and heat sectors. It has separated electrical generation, transmission, and distribution and has started privatization within this sector as well.

TABLE 5.3 CAPACITIES OF THE LITHUANIAN ENERGY SYSTEM

	Potential	Used in 1990		Used in 1993		Used in 1996	
		total	exported	total	exported	total	exported
Installed electricity generating capacity, GW	6.3	5.1	-	3.1	-	3.2	-
Electricity production, TWh	35[(1)]	28.1	11.7	14.1	2.7	16.8	5.2
Oil processing, Mt	12	9.6	3.2	5.2	1.2	4.3	0.9
Gas import by pipeline, 10^9, m^3	10	6.2	-	1.9	-	3.1	-

(1) Theoretical maximum output of power plants when load factor is assumed to be equal to 70%.

From the point of view of the three dimensions of sustainability, Lithuania's energy sector is characterized by low environmental pollution because of the current favorable primary energy supply structure; but this will change significantly after 2009. It also has low economic and energy efficiencies because of an obsolete energy infrastructure, and comparatively high energy prices given the low population incomes, which creates problems in energy affordability. Most of these problems are reflected in the energy policy priorities developed in the third National Energy Strategy.

5.3. Review of Lithuanian Energy Statistics Capability

Lithuania's energy statistics are comprehensive and publicly available, and there are sufficient energy statistics to construct all the relevant ISED for the country. The main institution responsible for energy statistics collection and maintenance is the Lithuanian Department of Statistics (LDS). Within this Department, the energy statistics group publishes comprehensive annual *Energy Balances* (LDS, 2001a). The Lithuanian Energy Institute (LEI) in co-operation with the Lithuanian Ministry of Economy publishes an annual energy statistics brochure entitled *Energy in Lithuania* (LEI, 2001a), providing readers with comprehensive information on primary and secondary energy development trends, energy balances (addressing oil refining, electricity and heat), and energy prices and tariffs.

Other stakeholders in the Lithuanian energy sector also publish annual statistics relevant to ISED. The energy company JSC "Lithuanian Energy" (JSC, 2001), the transmission system operator, publishes the annual activity report *Lithuanian Energy Annual Report*; JSC "Lithuanian Gas" (www.dujos.lt) publishes *Lithuanian Gas Annual Report*. The regulatory institution National Control Commission for Prices and Energy (www.regula.is.lt) publishes the annual *Activity Reports of the National Control Commission for Prices and Energy*.

Information about the transport sector is presented in the annual brochure *Transport and Communications* by the Lithuanian Department of Statistics (LDS).

All economic information is presented in the Statistical Yearbook of Lithuania (LDS, 2001b), also published by the LDS (www.std.lt), as well as the annual LDS National Accounts of Lithuania. (LDS, 2001c).

Information about atmospheric pollution from stationary and mobile pollution sources is provided in the LDS annual review *Natural Resources and Environmental Protection* (LDS, 2001d), and another LDS annual brochure, *Air Pollution in Cities*. The Ministry of Environment (www.gamta.lt) publishes an annual report on work done, entitled *State of the Environment*. This brochure also includes relevant information about the state of the environment, the level of pollution, and implemented measures.

Information relevant for the development of indicators in the social dimension may be found in the monthly brochure *Economic and Social Development in Lithuania* (LDS, 2001e) and the annual brochures *Social Protection in Lithuania* (LDS, 2001f) and *Household Income and Expenditure* (LDS, 2001g) also published by LDS.

Most indicators from ISED have been collected, although there are problems associated with some indicators. Consistent and comparable data are not available for prices, subsidies and taxes (#3). There are no official statistical data for final energy intensity of selected energy intensive products (#10) and, for example, fossil fuel efficiency for electricity generation can be calculated only manually, subtracting fuel used for heat production at combined heat and power plants (CHP). There is no flue gas desulfurization installed in Lithuania. Some power plants have installed pollution abatement measures such as low NOx burners, electrostatic precipitators, but such information can be collected only personally because there are no official statistical data about status of deployment of pollution abatement technologies (#13). There are no official statistical data on (#15) expenditures in the energy sector for environmental control, hydrocarbon exploration, R&D, or net energy import expenses. National statistics provide data that may not be consistent for international comparisons addressing, for example, private consumption and prices of electricity, fuels, etc. (#20). Also, there are no consistent official statistical data on percentage of income spent for energy by average and poor populations (#21). There are no official statistical data about the fraction of the population heavily dependent on non-commercial energy or without electricity (#22).

Information on the following environmental dimension indicators is also lacking in official Lithuanian statistics:

24.4 Ambient concentration of CO pollutants in urban areas

24.5 Ambient concentration of ozone pollutants in urban areas

25 Land area where acidification exceeds critical load (CL)

27.2, 27.3 Radionuclides (tritium, carbon-14) in atmospheric radioactive discharges are presented in official data as total long-term radionuclides

28.1 Wastewater discharges

28.2 Radionuclides in liquid radioactive discharge

29 Generation of solid waste (only the micro level data)

30 Accumulated quantity of solid waste (only the micro level data)

31 Generation of radioactive waste from fuel cycle chains of nuclear power generation

33 Land area taken by energy facilities

34 Fatalities due to accidents with breakdown of fuel chain

37 Lifetime of proven recoverable oil reserves

40 Intensity of use of forest resources as fuelwood.

In general energy statistics capability is adequate enough to conduct energy policy analysis but some information on environmental issues related to the energy sector is lacking. This information should be included in energy statistics.

The Statistical Yearbook of Lithuania started to publish indicators of sustainable development in 2004. These indicators are to be used for the monitoring of implementation of the Lithuanian National Sustainable Development Strategy adopted in 2003. These indicators are directly linked to objectives and tasks outlined in the Strategy. The following indicators relevant to the energy sector are addressed in the Statistical Yearbook: GHG emissions, final energy consumption, final energy intensity of GDP and final energy intensities of economic sectors, share of renewables in TPES, in electricity generation and a balance of fuels consumed in the transport sector. The data for 1990, 1995, 2001, 2002 and 2003 are presented in the Yearbook.

5.4. Lithuanian Energy Priority Areas

At the beginning of 1994, the first National Energy Strategy, outlining the principal provisions of the Government on the renovation and development of the energy sector, was approved for a comparatively long period – until the year 2015. Clearly, great precision of predictions cannot be expected, because this forecast was made during a time of rapid change. The Energy Law adopted in 1995 includes an assumption that the energy strategy will be approved by the Parliament and will be revised every five years. The second National Energy Strategy adopted by Parliament in 1999 amended and specified the energy development trends defined in 1994. During its preparation, obvious changes in the economy and energy sectors have been included, the experience and information needed for planning and forecasting the development of separate branches of the energy sector have been used, and changes in the neighboring countries and their plans for energy development have been assessed.

The third National Energy Strategy adopted in 2002 (Lithuania Ministry of Economy, 2002) deals with very important issues emerging within the Lithuanian energy sector, as well as related to the country's economy. Lithuania entered the EU in 2004, and the decision about closing the Ignalina NPP affected this strategy, requiring an evaluation of consequences and future energy sector development patterns. So the new energy strategy was adopted on the threshold of entering the EU. The main issue in preparation of the third National Energy Strategy was to establish priorities for energy sector development. For the third Strategy, the main priorities were reliable and safe energy supplies at least cost, seeking to prepare Lithuania's energy sector for the competitiveness in EU energy markets and pollution reductions required after the closure of the Ignalina NPP.

Preparing the Lithuanian energy sector for integration into EU energy markets while seeking to ensure its competitiveness is an important strategic objective for future energy sector development. All legal acts regulating the Lithuanian energy sector must be harmonized with EU directives and regulations including technical, environmental, and efficiency requirements, as well as economic, management and property components. The Association Agreement with the EU, the Energy Charter and other international treaties on basic requirements and provisions in the energy sector should also be taken into consideration during the formation of the aims of the National Energy Strategy. The principles and statements of the EU and its Member States in energy policy formation have to be assessed when preparing energy policy objectives.

The following priorities of energy policy were addressed in the third National Energy Strategy.

1. Decrease in energy intensity

Vast energy saving potential exists in the energy sector, including on the demand side which is inherited from the past when conditions of cheap energy existed. Rapid and comprehensive utilization of this potential should be the main aim of the Strategy. Lithuania has almost no indigenous cheap primary energy resources. Therefore rational, efficient and thrifty use of all energy forms in all stages of the energy system is a permanent objective and must have a high priority. Energy use per unit of GDP can be used to indicate the general relationship of energy consumption to economic development and provide a rough basis for projecting energy consumption and its environmental impacts with economic growth. Energy consumption per unit of commercial and service sector output can be used to monitor trends in energy consumption in this sector.

2. Promotion of renewable energy sources

Studies of the indigenous energy resources performed in Lithuania during recent years show that the European Union goal of satisfying approximately 12% of the energy demand of each country by renewable energy resources could be implemented in principle in Lithuania. Pilot projects implemented in recent years justify the possibility of accelerating the utilization of indigenous energy resources, particularly for heat supply. However, the current use of these resources is rather low. The increase of indigenous fuel utilization is restricted by regulated costs for domestic fuel (i.e., sod peat, wood chips) production, which has already reached or even exceeded the price of imported heavy fuel oil. The structure of energy supply in terms of shares of energy sources in primary energy supply and electricity generation could be used to monitor the trends in renewable energy source utilization.

3. Increase in security of supply

Increase in security of supply is one of the main principles of EU energy policy. Lithuania has few domestic energy resources and depends on imports from only one supplier – The Russian Federation. When making the energy sector development plans for Lithuania, security of supply must be considered as a very important issue, and the possibility of increasing diversification of fuels and fuel supplies should be taken into account.

4. Improvement of quality of life

Energy is a key factor in development and in providing vital services that improve the quality of life. Limited access and limited affordability to energy are serious constraints of development in the developing world, where the per capita use of energy is less than one sixth of that of the industrialized world. Access to energy is one of the key issues of sustainable energy development. An indicator of energy access and affordability is energy consumption per capita.

5. Decrease in energy impact on the environment

A very important problem in the Lithuanian energy sector is related to the Ignalina nuclear power plant. This plant is the main source of electricity production in Lithuania. Over the period of the last five years it generated 80-85% of the total electricity production, so atmospheric emissions from the power and heat sector were very low. The future development of the whole energy sector is greatly influenced by the closure of this nuclear power plant. The first unit was closed in 2004 and the second will be closed in 2009. Limiting the increase in air emissions is a major environmental objective in Lithuania.

5.5. Implementation of the ISED Framework

For this case study, which aims to implement the ISED framework for future Lithuanian national energy strategies, the following priority areas were selected based upon the main energy policy directions developed by the third National Energy Strategy:

- Energy consumption;
- Energy intensities;
- Structure of the economy;
- Energy security;
- Energy prices;
- Environmental energy situation.

Seeking to review the state of energy priorities, it is possible to select relevant indicators from the ISED list and complete an analysis of trends and impacts of current energy policies. A very important step is to identify targeted indicators, as well as driving forces for selected targeted indicators (Table 5.4). As targeted indicators, the following indicators within the economic dimension were selected:

#3 Energy prices;

#4 Shares of sectors in GDP value added;

#9 Energy intensities of economic sectors;

#11 Energy mix;

#12 Energy supply efficiency;

#14 Energy use per unit GDP;

#16 Energy consumption per capita;

#17 Indigenous energy production;

#18 Net energy import dependency.

Social indirect and direct driving force indicators will be analyzed to address energy price and energy affordability issues, which are also within Lithuania's energy priority areas.

For the environmental energy situation, only two direct driving force indicators of the environmental dimension were selected: #23 Quantities of SO_2 and NO_X emissions and #26 Quantities of CO_2 emissions.

TABLE 5.4 INDICATORS ADDRESSING PRIORITY AREAS OF OUR STUDY

Number	Indicators	Dimension	Type
#2	GDP/capita adjusted at PPP in USD'95	Economic	Indirect driving force
#3	Current end-use energy prices	Economic	Indirect driving force
#4	Shares of sectors GDP adjusted at PPP in USD'95 value added	Economic	Indirect driving force
#9	Energy intensity of economic branches (GDP adjusted at PPP in USD'95)	Economic	Indirect within energy sector driving force
#11	Energy mix	Economic	Indirect within energy sector driving force
#12	Energy supply efficiency	Economic	Indirect within energy sector driving force
#14	Energy intensity of GDP (adjusted at PPP in USD'95)	Economic	Direct within energy sector driving force
#16	Energy consumption per capita	Economic	State
#18	Net energy import dependence	Economic	State
#19	Income inequality	Social	Indirect driving force
#20	Ratio of monthly disposable income per capita (in USD'95) of 20% poorest households to the prices of major energy sources	Social	Indirect within energy sector driving force
#21	Fraction of disposable income per capita (in USD'95) spent on fuel by average population and group of 20% poorest population	Social	Direct within energy sector driving force
#23	Quantities of SO_2 and NOx emissions from energy sector	Environmental	Direct within energy sector driving force
#26	Quantities of CO_2 emissions from energy sector	Environmental	Direct within energy sector driving force

Trends in economics and demographics are the main driving forces for energy consumption, energy intensities, environmental energy impacts, etc. So first it is necessary to assess the trends in economics and demographics. Then, trends in energy consumption and energy intensities, structural changes in the economy and other trends can be assessed. This analysis allows the evaluation of implemented energy policies, and the formulation of new policies.

A main objective of Lithuania's energy strategy is to ensure preparation of the Lithuanian energy sector for successful competition in EU energy markets. In order to evaluate the gap in convergence[1] between primary energy indicators in Lithuania and the EU-15, a comparison between selected targeted and affected state indicators of Lithuania and EU-15 averages were conducted. In addition, a comparison of Lithuanian indicators with some EU member states having some similar population and climate characteristics (Denmark, Ireland, and Finland) but different industrial structure was performed. Some general data for these countries are presented in Table 5.5.

[1] Convergence means the approaching of the main Lithuanian indicators to EU-15 levels.

TABLE 5.5 THE MAIN GEOGRAPHICAL, DEMOGRAPHICAL AND CLIMATE CONDITIONS OF LITHUANIA AND EU MEMBER STATES SELECTED FOR COMPARISON

Country	Territory, thousand km^2	Population, millions	Density of population, inhab/km^2	The mean annual temperature, ^oC	The share of final energy consumption in manufacturing, % (2000)	Value added of manufacturing in GDP, % (2000)
Denmark	43	5	116.2	8	25	28
Finland	338	5.2	15.3	3	50	34
Ireland	70	3.9	55.7	9	30	42
Lithuania	65.3	3.69	56.6	6	22	31

5.5.1. Trends in economics and demographics

Figure 5.3 presents the dynamics of Lithuanian population growth from 1990 to 2002. This is the first indirect driving force indicator of the economic dimension from the ISED list (#1) and has an impact on all other indicators. As one can see from Table 5.6 and Figure 5.3, population decreased in Lithuania, especially in 2001 and 2002. From 1990 to 2002, the population in Lithuania decreased by 5.9%.

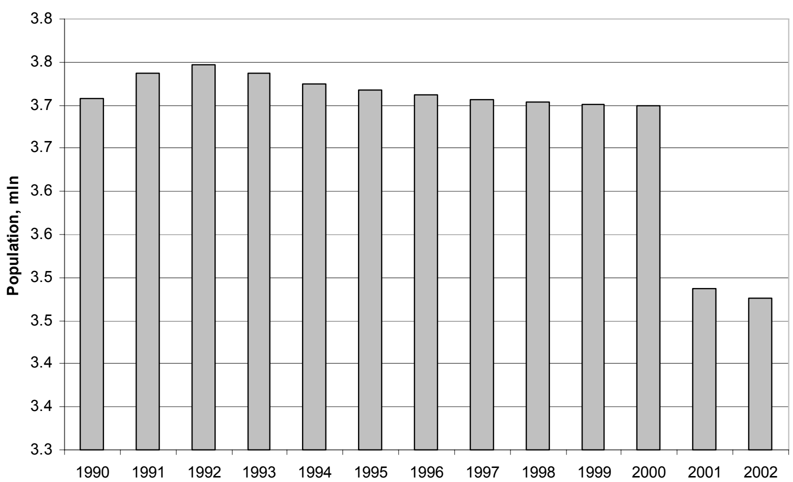

Figure 5.3 Population

TABLE 5.6 LITHUANIAN POPULATION, MILLIONS

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002
Population, millions	3.694	3.702	3.706	3.694	3.671	3.643	3.615	3.588	3.562	3.536	3.512	3.487	3.476

Figure 5.4 and Table 5.7 show the GDP trend in Lithuania. The restoration of independence in Lithuania provided a significant change in the economic system. The transition period and the re-organization of the economy brought about a temporary decline in GDP. The 1994 GDP was only 56% of the 1990 figure but since 1994 there has been economic growth every year with the exception of 1999 due to the impact of the economic crisis in Russia. The GDP grew in 2001 by 6.5% and in 2002 by 6.7%.

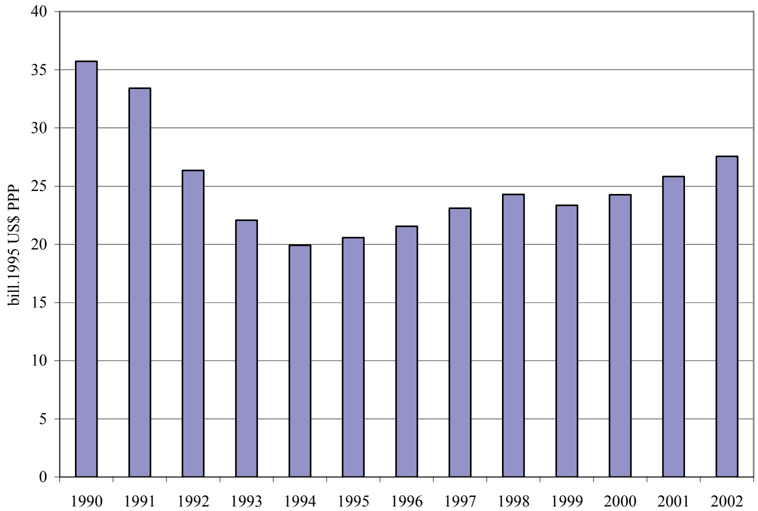

Figure 5.4 GDP

TABLE 5.7 LITHUANIAN GDP, BILLION 1995 US$ PPP

1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002
35.73	33.41	26.35	22.07	19.91	20.57	21.54	23.11	24.29	23.34	24.25	25.83	27.56

Figure 5.5 shows GDP per capita. This is the second (#2) indirect driving force indicator of the economic dimension from the ISED list, and it also has a significant impact on all other indicators. Levels of GDP per capita are obtained by dividing the annual GDP (at prices based on purchasing power parity, or PPP) by the population. This indicator is a basic economic growth indicator, and measures the level and extent of economic output. Since the population decreased while GDP increased during the 1994-2002 period a decoupling trend between economic growth and population growth is observed for this period.

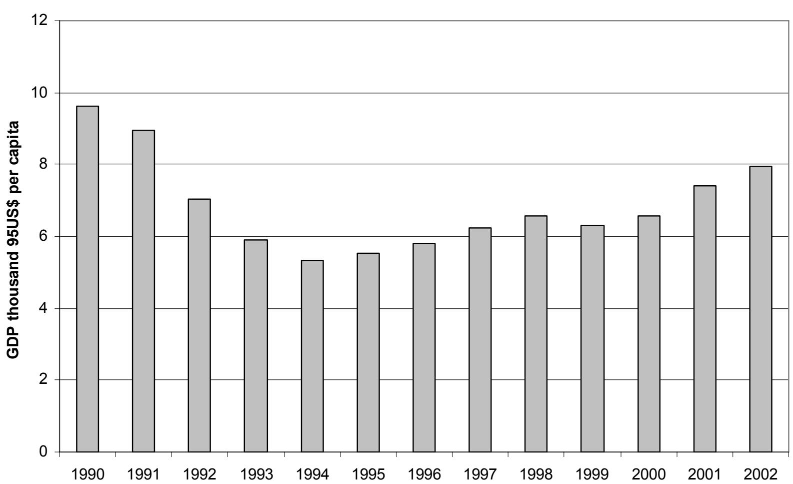

Figure 5.5 Lithuania: GDP per capita PPP 95 US$

The Lithuanian GDP per capita (expressed in PPP) can be compared with the same indicator for other EU countries (Finland, Ireland, Denmark) and with the EU-15 average (see Figure 5.6).

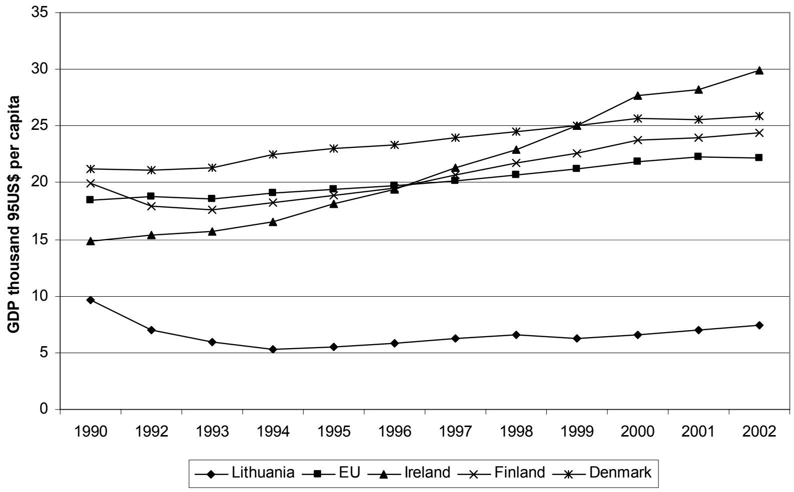

Figure 5.6 GDP per capita in Lithuania and some EU countries

From 1990 to 1994 GDP/capita was decreasing in Lithuania. Since 1995, it began to grow but in 1999 it slightly declined because of the economic recession. Since 2000, the positive trend in GDP/capita can be observed. As of 2002 this indicator was still only 70% of its 1990-year level. For the EU-15, this indicator is almost three times higher. Ireland has experienced a particularly high GDP per capita, during the 1990s, and in 2002 was fully twice as high as in 1990.

5.5.2. Energy consumption

Energy consumption per capita is the main state indicator (#16) from the ISED list. In addition to TPES per capita and electricity per capita, the analysis of final energy consumption per capita is included in this study.

This indicator was selected as a primary indicator for Lithuania though there are still a lot of debates about the desirable level of energy consumption per capita to be achieved by transition countries. From the sustainable development point of view, an increase in energy consumption per capita may not be desirable for some countries but for countries with transitional or developing economies, a sufficient level of well-being and other basic social needs may not be achieved without a considerable increase in per capita energy consumption.

An analysis is necessary to determine the trends on per capita energy consumption and the main driving forces for this state indicator including: energy intensities of economic branches, structure of economy, energy intensity of GDP, and end-use energy prices. This analysis allows the evaluation of current policies in these areas and the selection of policy actions on targeted indicators, which will positively affect energy consumption patterns in Lithuania.

The transition period from a centrally planned economy to a free market economy was accompanied by economic decline (Figure 5.4). The trend in total primary energy supply followed this economic development trend (Figure 5.7 and Table 5.8). The decline of GDP in all economic sectors (without exception) was followed by a similar decrease of total primary energy supply and final consumption in Lithuania. In 2000 TPES amounted to only 45% of the 1990 level. During the period 1996 to 2000 TPES has varied from 9.3 Mtoe in 1996 to 7.5 Mtoe in 2000, the variation depending upon electricity export. The electricity export to Belarus and other neighbouring countries was very unstable during this period because of problems related to non-payment for electricity provided.

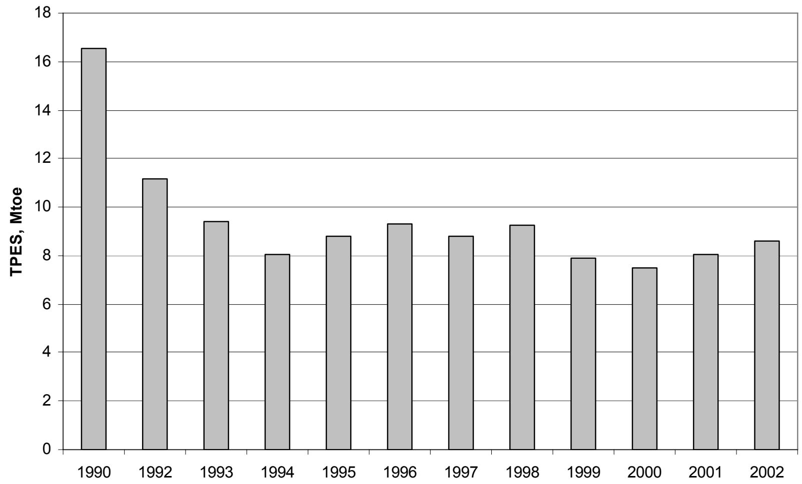

Figure 5.7 Lithuania: TPES, Mtoe

TABLE 5.8 TOTAL PRIMARY ENERGY SUPPLY (TPES), FINAL ENERGY CONSUMPTION (FEC) AND FINAL ELECTRICITY CONSUMPTION (FELC) IN LITHUANIA

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002
TPESMtoe	16.56	17.20	11.15	9.40	8.04	8.78	9.29	8.81	9.24	7.86	7.47	8.04	8.59
FEC, Mtoe	10.78	8.78	7.28	5.14	4.81	4.54	4.53	4.51	4.44	4.08	3.81	4.01	4.14
FELC, TWh	14.73	11.90	9.76	6.64	6.63	6.37	6.51	6.73	6.75	6.54	6.20	6.43	6.78

Final energy consumption is presented in Figure 5.8.

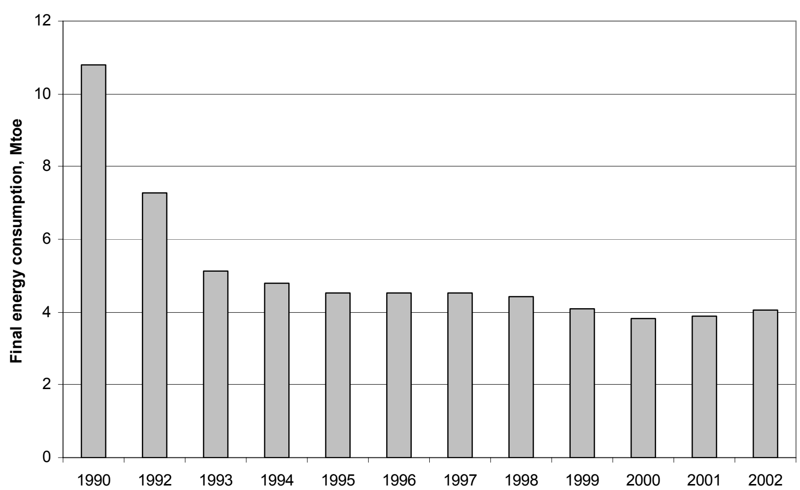

Figure 5.8 Final energy consumption

As one can see from Figure 5.8 and Table 5.8, final energy consumption was continuously decreasing from 1990 until 2000, when it stabilized. In 1995 final energy consumption amounted to 54% of the 1990 level and final electricity consumption decreased in 2000 to 61% of the same level.

Figure 5.9 shows final electricity consumption figures for the considered period.

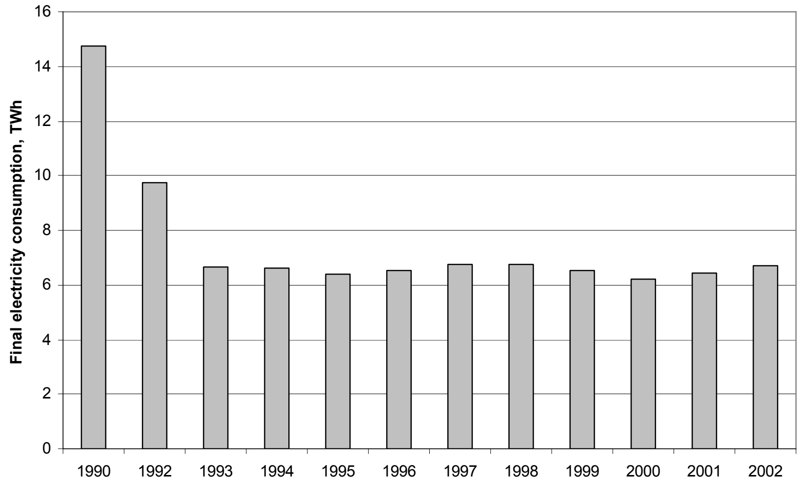

Figure 5.9 Final electricity consumption

Final electricity consumption has decreased in 2000 to less than 50% of the consumption of the 1990-year level. Since 1996, some increases in electricity consumption can be noticed, but from 1998 to 2000 electricity consumption again decreased. Since 2001 final electricity consumption has started to increase slowly.

In Figure 5.10 and Table 5.9 GDP, TPES and electricity growth indices are presented.

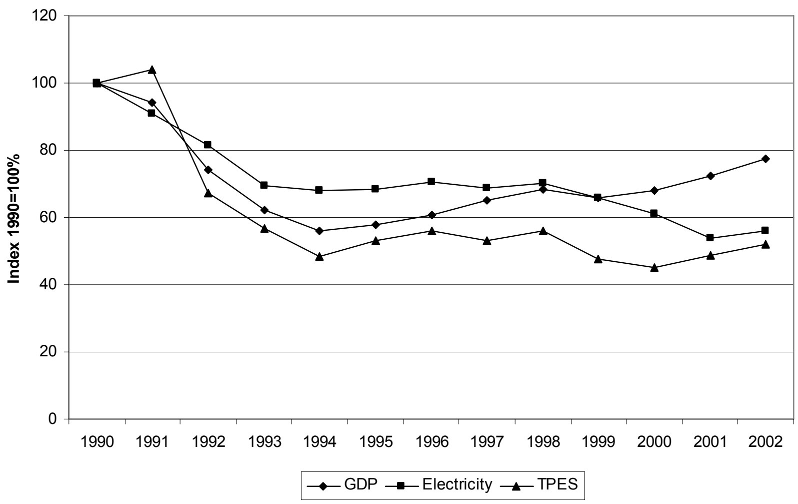

Figure 5.10 GDP, electricity, TPES growth index in Lithuania

TABLE 5.9 GDP, TOTAL PRIMARY ENERGY SUPPLY (TPES) AND ELECTRICITY CONSUMPTION GROWTH INDEX IN LITHUANIA

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002
GDP	100	94.32	74.27	62.22	56.14	57.99	60.72	65.14	68.47	65.80	67.97	72.49	77.44
Electricity	100	90.79	81.59	69.33	67.95	68.29	70.54	68.76	70.05	65.82	61.19	53.7	55.9
TPES	100	103.87	67.33	56.75	48.54	53.05	56.08	53.23	55.83	47.47	45.11	48.69	51.98

As one can see from Figure 5.10, from 1999 to 2002 favorable trends decoupling economic growth from energy and electricity consumption can be observed.

In Figure 5.11 data on final energy consumption per capita for Lithuania, EU-15 and a few EU member states (Finland, Denmark, Ireland) are presented. As one can see from Figure 5.11 in 1990 the final energy consumption per capita in Lithuania exceeded the EU-15 average in the past but starting in 1991 it became lower and by 2000 it was 2.5 times lower than that of the EU-15 average. Final energy consumption per capita in Denmark and Ireland is almost equal to the EU-15 average. In Finland, the final energy consumption per capita is very high. This is related to the high final energy intensity of the economy (especially industry), and the comparatively low energy prices combined with high population income and low population density.

Though Denmark has a similar industrial structure as Lithuania, similar climate, size of territory and population, final energy consumption per capita is significantly lower in Lithuania. This can be related mainly to the high-energy prices and low GDP per capita characteristics of Lithuania. The GDP per capita in Denmark is almost four times higher than in Lithuania.

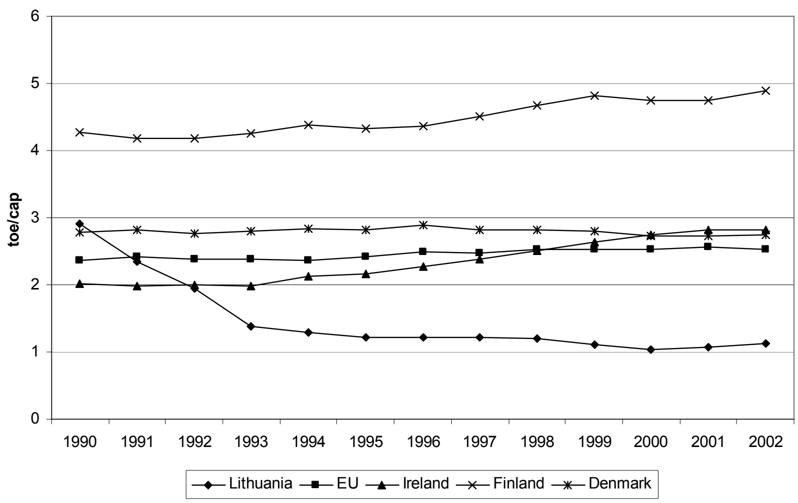

Figure 5.11 Final energy consumption per capita in Lithuania and some EU member states

In Figure 5.12 data on primary energy supply per capita in Lithuania, Ireland, Denmark, Finland and EU-15 are presented. The situation for TPES per capita in these countries is very similar to final energy per capita. This indicator for Ireland and Denmark is the same as the EU-15 average. In Finland, TPES per capita is more than 1.5 times higher than in EU-15. TPES/capita in Lithuania in 1990 was higher than the EU-15 average, but over ten years it has decreased significantly, and in 2000 it was almost half of the EU-15 average level.

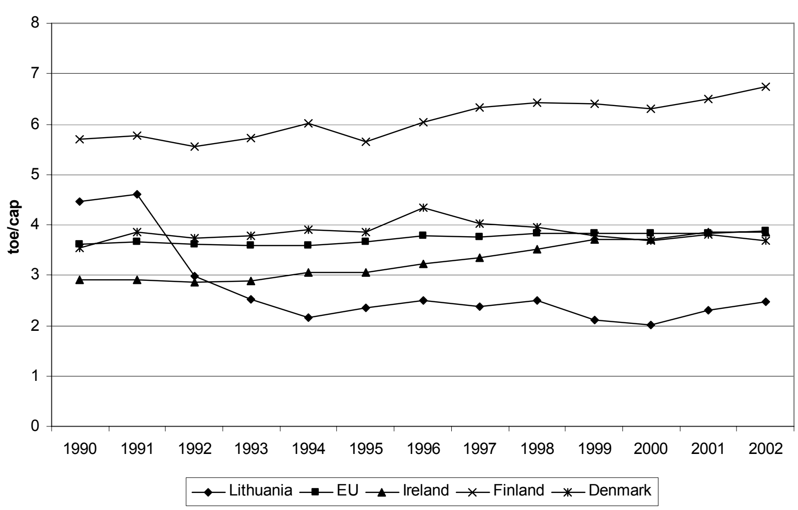

Figure 5.12 Primary energy supply per capita in Lithuania and some EU member states

For comparison, TPES per capita in eight EU accession countries are presented in Figure 5.13. As shown in this figure TPES per capita in 2000 was the lowest in Latvia. In Lithuania, this indicator was at the same level as in Poland and Hungary and slightly higher than in Latvia. Slovakia, Estonia and Slovenia constitute a second group of accession countries, for which the TPES/capita is about 1.5 times higher than in the previous group. Only in the Czech Republic the per capita TPES for 1999 and later years was at the same level as the one corresponding to the EU-15 average.

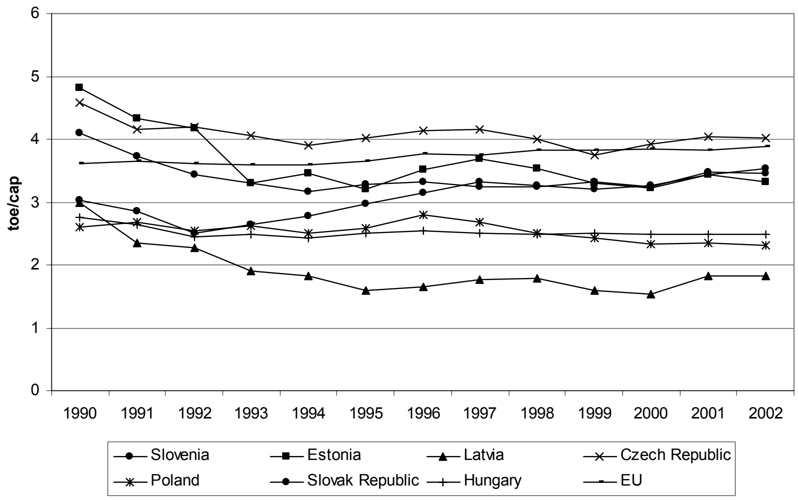

Figure 5.13 TPES per capita in accession countries and EU-15 average

Final energy consumption per capita in Lithuania is thus about 2.5 times lower than the EU-15 average, but TPES per capita is about 1.6 lower than the EU-15 average. Energy efficiency is therefore rather low in Lithuania. Losses during the transformation process in the Lithuanian energy sector are almost 1.5 times higher than the EU-15 average.

Electricity generation and use is one of the main criteria for assessing progress. The world average electricity consumption per capita in industrial countries was about 9,000 kWh/year/capita in 2000. There are, however, wide differences among industrial countries in terms of average rates of electricity utilization. In countries in transition, this indicator was 4,250 kWh/year/capita (UNDP et al., 2000). In Figure 5.14 electricity consumption per capita in Lithuania, Finland, Ireland and EU-15 are presented. The electricity consumption in Lithuania in 2000 was less than one-third of the EU-15 average, and only half of the average level of transition economies. Even in 1990, electricity consumption per capita in EU-15 was about 20% higher than in Lithuania (Table 5.10). During 1990–1994, the difference between Lithuania and EU-15 increased sharply. A stabilization of electricity consumption per capita since 1994 can be observed in Lithuania. Nevertheless, in the EU-15, electricity per capita is still increasing while at the same time final energy and TPES per capita in EU-15 are stabilizing. One can conclude then that final energy and electricity consumption per capita in Lithuania are very low compared to the EU-15 levels, and the convergence of these indicators will require some time.

TABLE 5.10 ELECTRICITY CONSUMPTION PER CAPITA IN LITHUANIA AND SOME EU MEMBER STATES, KWH/CAP

	1990	1994	1995	1996	1997	1998	1999	2000	2001	2002
Lithuania	3,973.5	1,780.2	1,713.8	1,755.0	1,816.7	1,822.8	1,767.7	1,675.2	2,893	3,013
EU-15	4,959.0	5,112.8	5,276.5	5,401.5	5,486.3	5,609.5	5,719.3	5,888.7	6,038	6,270
Ireland	3,379.7	3,942.5	4,122.5	4,365.6	4,560.1	4,762.3	5,013.9	5,330.1	5,470	6,115
Finland	11,811.8	12,779.3	12,779.6	12,965.9	13,688.9	14,137.1	14,352.0	14,564.9	14,919	14,609
Denmark	5,695.1	5,960.4	5,984.3	6,117.3	6,037.9	6,056.8	6,058.1	60,79.0	6,172	6,002

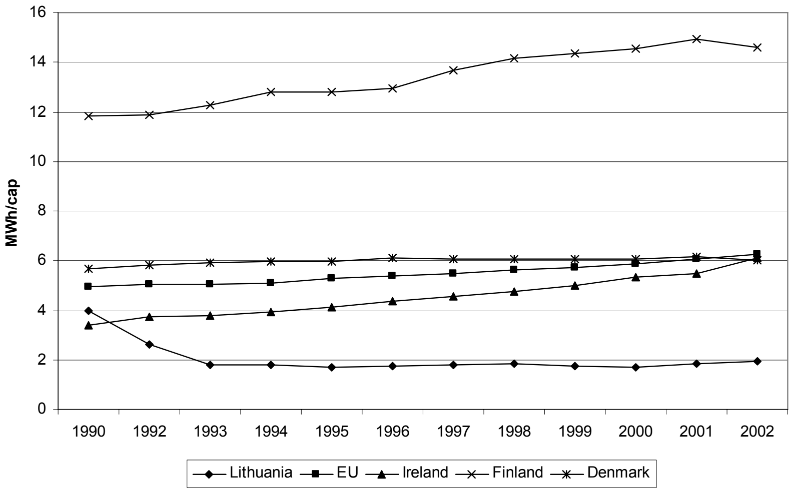

Figure 5.14 Electricity consumption per capita in Lithuania, EU-15, Denmark, Finland and Ireland

Growth indices of TPES, final energy and electricity consumption per capita in Lithuania, Denmark, Finland, Ireland and EU-15 are presented in Figure 5.15 through Figure 5.17.

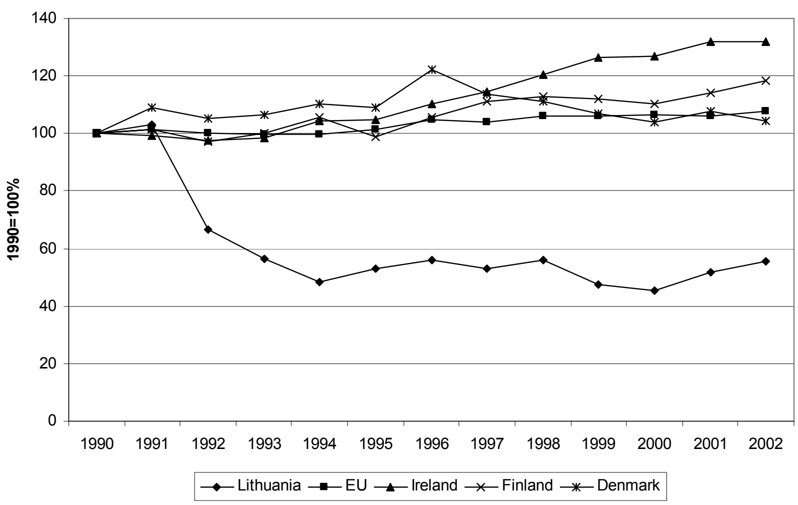

Figure 5.15 TPES per capita growth indices in Lithuania, Finland, Ireland and EU-15

As shown in Figure 5.15, the TPES growth index is the highest in Ireland. In Finland and Denmark, growth rates are similar to EU-15 average growth rates. Lithuanian TPES per capita growth rates tended to be negative until 2000, but from 2000 to 2003 some increase of TPES per capita can be observed in the country. As shown in Figure 5.16 and Figure 5.17, final energy and electricity consumption per capita growth rates are quite similar to the TPES per capita growth rates.

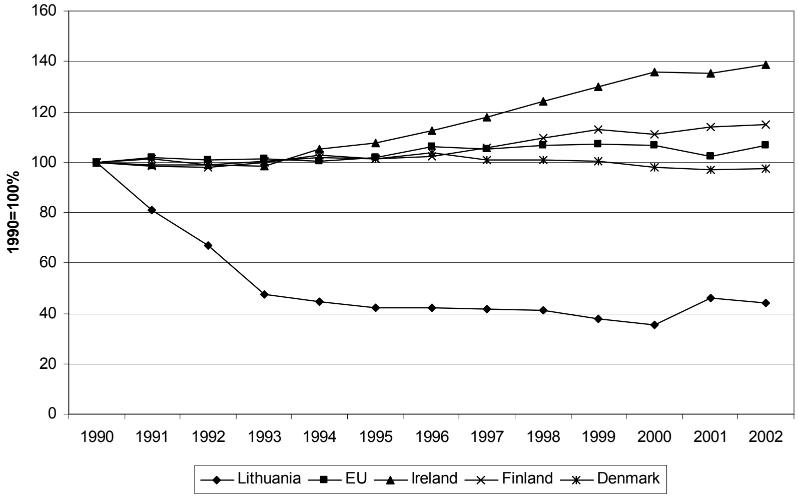

Figure 5.16 Final energy consumption per capita growth indices in Lithuania, Denmark, Finland, Ireland and EU-15

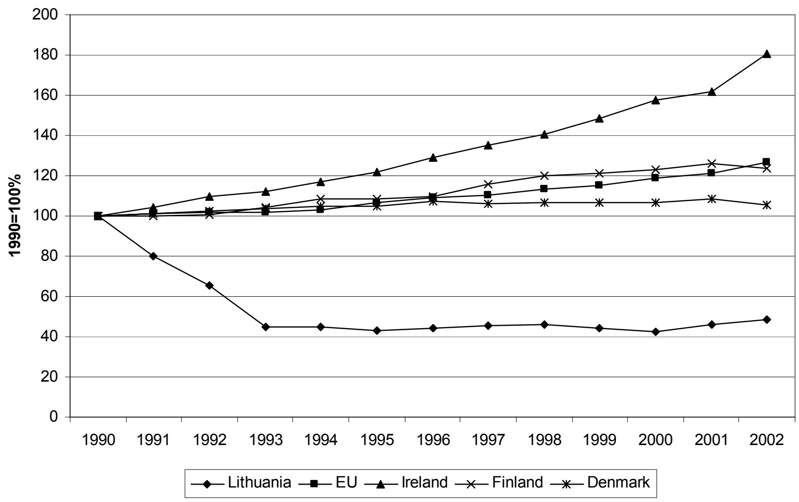

Figure 5.17 Electricity consumption per capita indices in Lithuania, Denmark, Finland, Ireland and EU-15

Electricity consumption per capita growth trends were negative in Lithuania until 1993 and stable until 2000. The very low final energy and electricity consumption per capita may imply low living standards in Lithuania. Therefore an analysis of energy affordability is necessary, in order to define reasons for such low final energy and electricity consumption levels, and to define measures which could improve the situation.

The big difference between TPES and final energy consumption per capita shows the low energy conversion efficiency in the Lithuanian energy system compared with the EU-15. Further analyses of energy use efficiency and energy intensities are necessary in order to define measures capable of improving the situation.

5.5.3. Energy intensities

TPES/GDP indicator (#14) from the ISED list was selected as a targeted indicator for the decrease in energy intensity of the Lithuanian economy. There is no doubt about desirable future trends for this indicator. Primary energy intensity of GDP is a direct driving force indicator of the economic dimension and has a significant impact on the energy consumption per capita levels analyzed in Section 5.2**.** In the ISED list it is being considered as a direct driving force indicator. It can be measured in toe per thousand US$ and kWh per US$ for electricity. This indicator shows the trends in overall energy use relative to GDP and indicates the general relationship of energy consumption to economic development.

Table 5.11 and Figure 5.18 show primary energy supply per unit of GDP for Lithuania, EU-15, and some EU member states.

TABLE 5.11 TOTAL PRIMARY ENERGY SUPPLY PER UNIT OF GDP IN LITHUANIA AND SOME EU MEMBER STATES, TOE/1,000 95US$ PPP

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002
Lithuania	0.46	0.51	0.42	0.43	0.40	0.43	0.43	0.38	0.38	0.34	0.31	0.27	0.27
EU-15	0.20	0.20	0.19	0.19	0.19	0.19	0.19	0.19	0.18	0.18	0.18	0.18	0.18
Ireland	0.20	0.19	0.19	0.18	0.18	0.17	0.17	0.16	0.15	0.15	0.13	0.14	0.13
Finland	0.29	0.31	0.31	0.32	0.33	0.30	0.31	0.31	0.30	0.28	0.26	0.27	0.28
Denmark	0.17	0.18	0.17	0.18	0.17	0.17	0.18	0.17	0.16	0.15	0.14	0.14	0.14

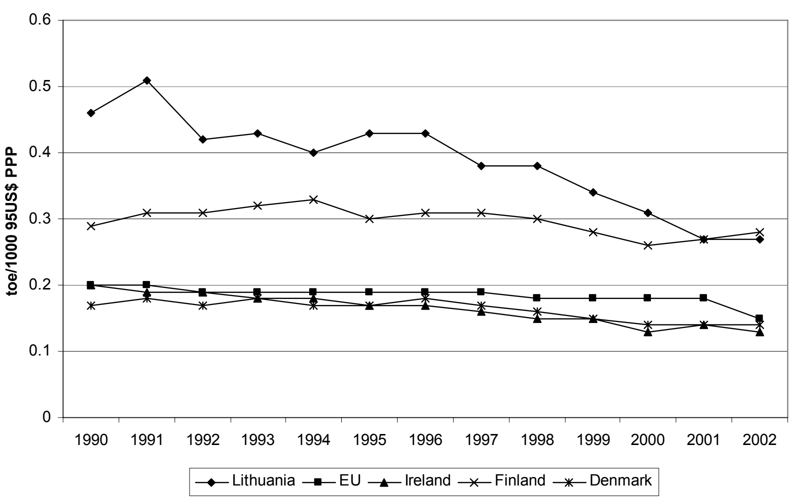

Figure 5.18 Total primary energy supply per unit of GDP in Lithuania and some EU member states

Table 5.11 shows the positive trends for primary energy intensity: that is, each unit of GDP requires less primary energy resources. In 1999 TPES/GDP in Lithuania amounted to 0.34 toe/thousand 95US$ PPP, a figure almost twice as high as the same indicator for 15 EU countries (IEA, 2001a). Figure 5.18 shows, however, a decreasing trend in this intensity indicating steady improvements in this indicator.

Primary energy intensity in Lithuania is higher than in Finland, even though this country is characterized by having both high-energy intensity and high energy consumption levels when compared with other EU-15 member states. Primary energy intensity in Denmark and Ireland (which have comparable national characteristics to Lithuania) is similar to the EU-15 average.

Final energy intensities in Lithuania, Denmark, Finland, Ireland and the average of EU-15 countries are presented in Figure 5.19. As one can see from Figure 5.19, final energy intensity in Lithuania was 1.3 times higher than in the EU-15 in 2000. But in 1990 it was even more than twice as high as in the EU-15. The positive trend in decreasing final energy intensity shows improvements in final energy use efficiency in Lithuania. Overall, final energy intensity is still quite high in Lithuania and significantly exceeds the EU-15 average level.

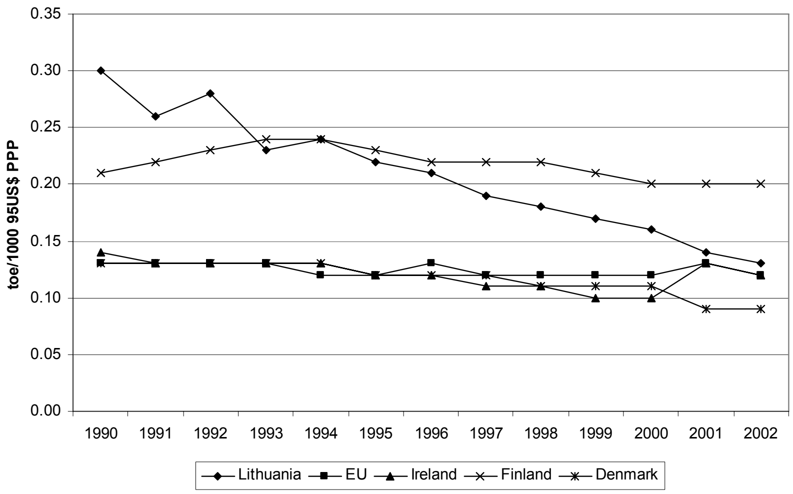

Figure 5.19 Final energy intensity in Lithuania, Denmark, Finland, Ireland and EU-15

Changes in final energy intensity and consumption were also analyzed. Growth indices of final energy intensity and final energy consumption per capita growth are presented in Figure 5.20. As can be seen, the rates of both indicators are decreasing, with energy consumption per capita decreasing more sharply within the country. For comparison purposes, trends of the same indicators for EU-15 countries (average) and Lithuania are presented in Figure 5.21.

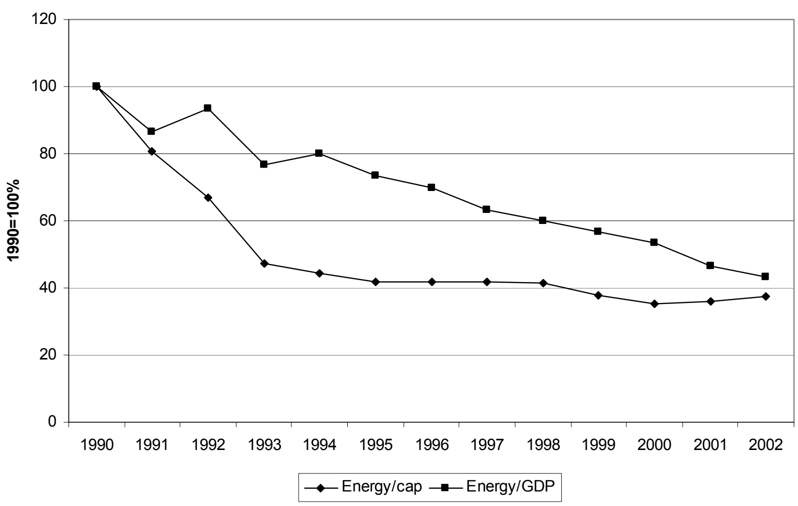

Figure 5.20 Lithuania: Final energy intensity and final energy consumption per capita

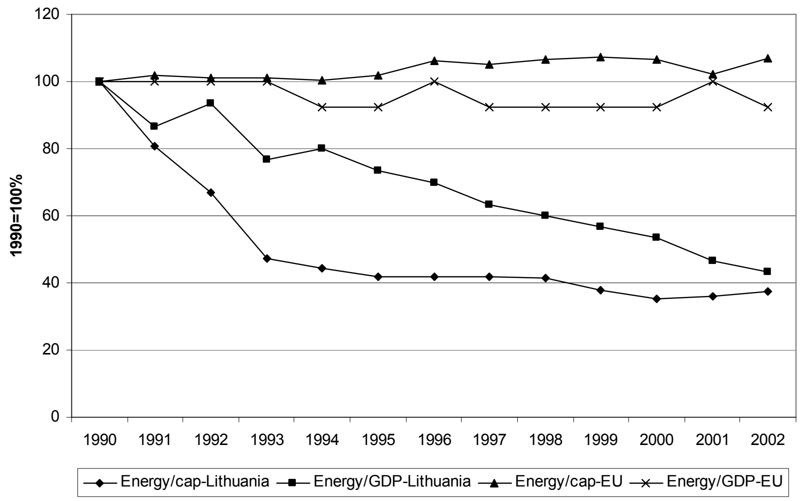

Figure 5.21 Final energy intensity growth index in Lithuania compared with EU-15 – Final energy/GDP and Final energy/capita

In EU-15 countries final energy intensity is also decreasing, but at slower rates than in Lithuania because the level of final energy intensity is significantly lower in the EU-15 than in Lithuania. Final energy consumption per capita is increasing in EU-15 countries, but in Lithuania it decreased through 2000.

In Figure 5.22 and Figure 5.23 TPES/GDP and final energy/GDP growth indices, respectively, are presented for Lithuania and selected EU member states.

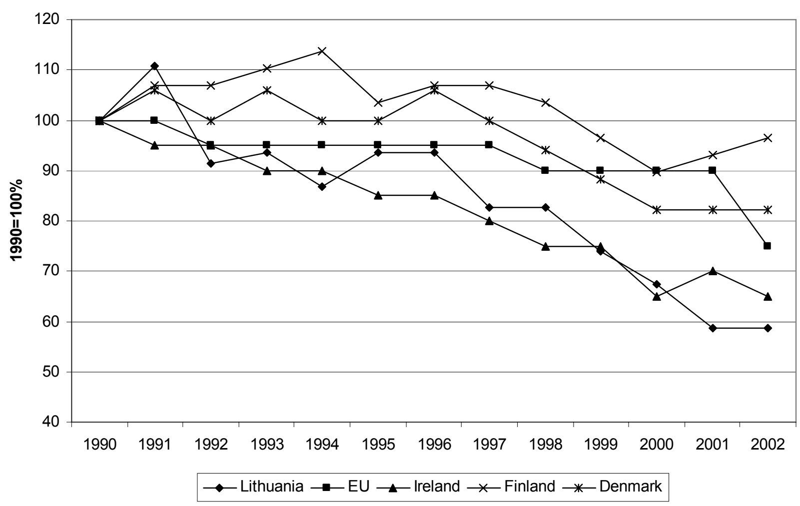

Figure 5.22 TPES/GDP growth indices in Lithuania, Denmark, Ireland, Finland and EU-15 average

As shown in Figure 5.22 primary energy intensity is decreasing at the highest rates in Lithuania and Ireland. In Denmark and Finland the rates of decrease are slower, and similar to the EU-15 average.

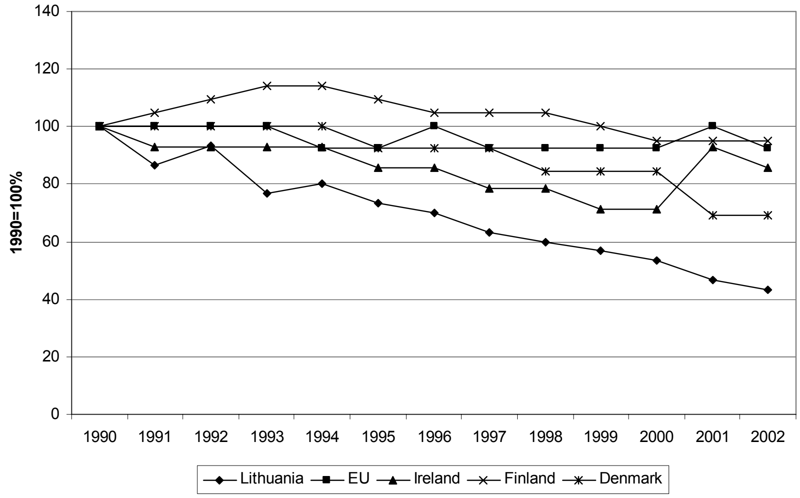

Figure 5.23 Final energy intensity growth indices in Lithuania, Denmark, Ireland, Finland and EU-15

Figure 5.23 shows that decreasing final energy intensity rates are quite different among the countries presented. The highest decreasing final energy intensity rates are in Lithuania followed by Ireland, Denmark and Finland.

Analyzing the same indicator (#14) for electricity, as shown in Figure 5.24 and Figure 5.25, the same trends as with final energy intensity and final energy consumption per capita can be observed. Electricity intensity per GDP is almost stable in EU-15 countries since 1990, but electricity consumption per capita is increasing, and at even higher rates than final energy consumption per capita.

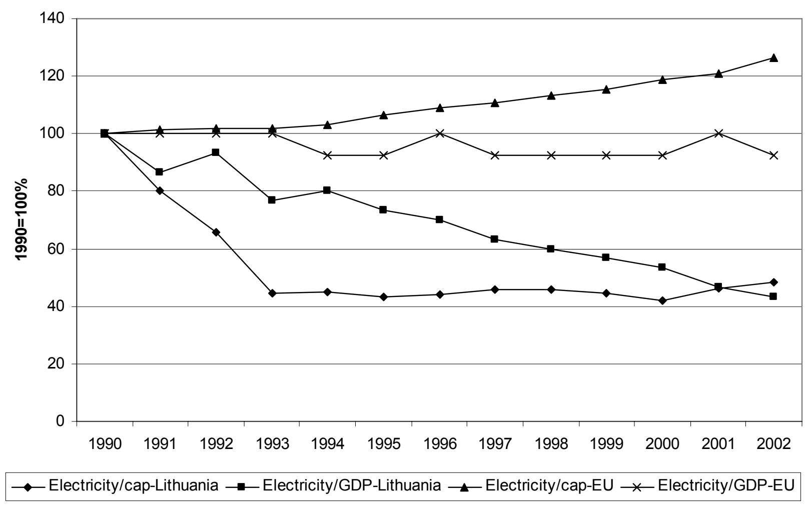

Figure 5.24 Growth indices in Lithuania comparing with EU-15 – Electricity/GDP and Electricity/capita

In Figure 5.25 final electricity intensity growth indices for Lithuania and select EU member states are presented.

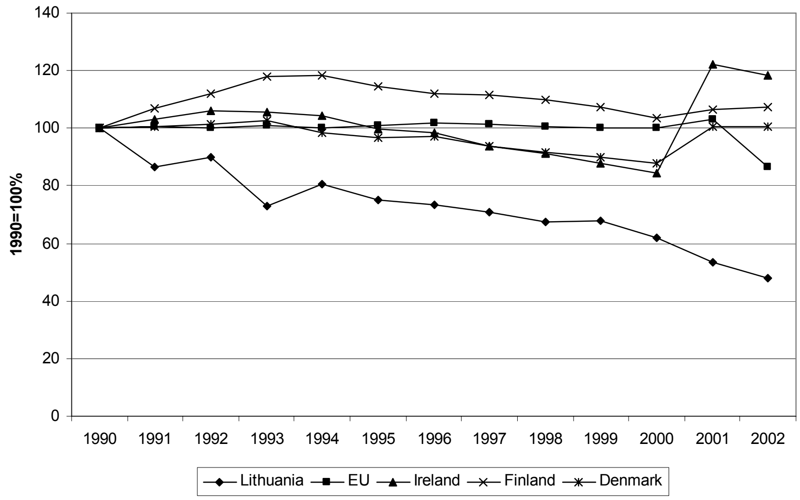

Figure 5.25 Final electricity intensity growth indices in Lithuania, Denmark, Ireland, Finland and EU-15 average

As shown in Figure 5.25 the situation with final electricity intensity growth indices is similar to the situation of final energy intensity presented in Figure 5.23. Final electricity intensity was decreasing in Lithuania at relatively higher rates.

Figure 5.26 shows the relationship between final energy intensity and GDP per capita for Lithuania and the EU-15. A decreasing trend is observed for final energy intensity in Lithuania during both the decreasing per capita GDP period (1990-1994) and the increasing per capita GDP period that followed. In EU-15, in general while the per capita GDP follows an increasing trend the intensity has remained fairly stable during the considered period. This Figure illustrates that Lithuania's per capita income is still far behind that of the EU-15 countries and that final energy intensity has decreased dramatically and was close to that of the EU-15 in 2002.

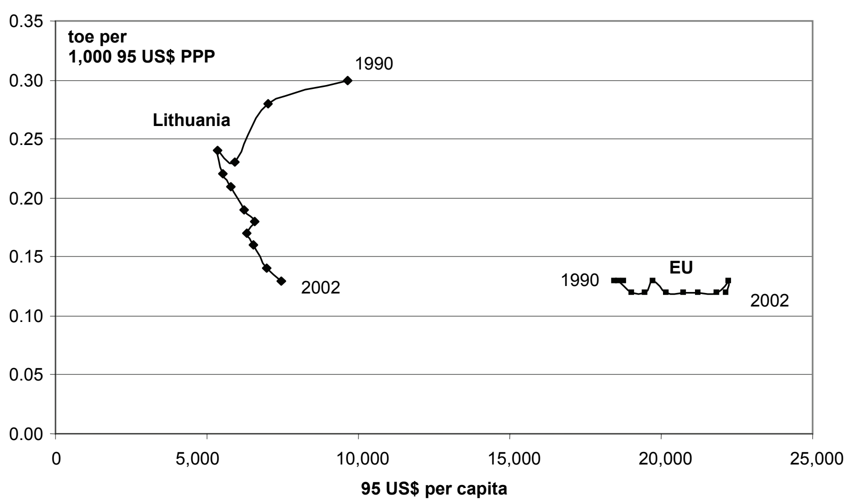

Figure 5.26 Final energy intensity and GDP per capita in Lithuania compared to EU-15

Figure 5.27 shows the relationship between final energy consumption per capita and final energy intensity for Lithuania and EU-15. As one can see, there are some differences in the trends between Lithuania and the EU-15. In Lithuania, final energy intensity decreases along with a decrease of final energy consumption per capita even after 2001 when some increase of final energy consumption per capita is observed. In the EU-15, final energy intensity is slowly decreasing along with a slow increase of final energy consumption per capita.

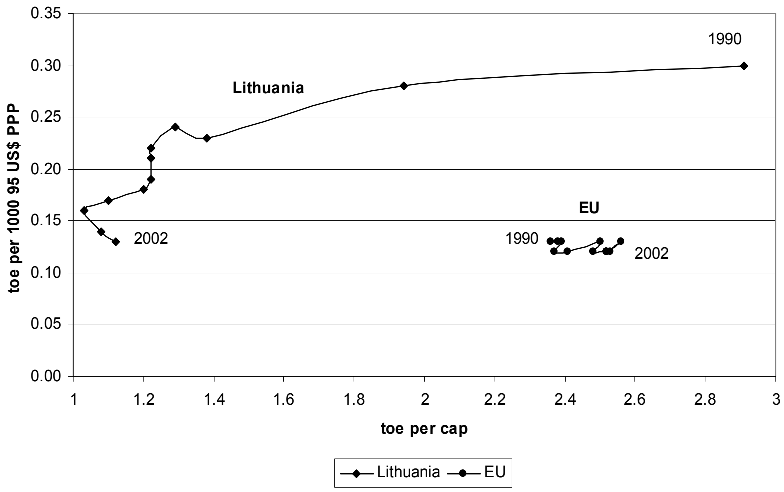

Figure 5.27 Final energy intensity and final energy consumption per capita in Lithuania compared to EU-15

Market economies had nearly linear relationships between GDP and TPES since 1982 (UNDP et al., 2000). This trend was associated with an elasticity of energy demand to GDP of about 0.85; each additional percentage of GDP growth resulted in 0.85% growth in primary energy demand. It averaged about 0.75 in developed market economies and a one-to-one relationship in developing market economies. The significant differences between developing and developed market economies had two origins: the transformation of some unaccounted non-commercial energy into commercial energy when the economy grows, and the relocation of some industries because the economic inputs, mostly labors and energy, are cheaper in the developing countries than in the developed countries. In general for market economies since 1997, GDP growth rates were faster than TPES growth rates.

Another situation is characteristic of transition economies. Since 1989 elasticity of energy demand to GDP has been negative. One might expect in the future, as restructuring comes to an end, that the elasticity of energy demand to GDP in transition economies will probably approach the level of market economies. Therefore the convergence of energy intensity and energy consumption per capita between accession countries and EU-15 member states is inevitable. The only question is when this will happen and what the future energy consumption per capita is likely to be in EU member states including the current accession countries.

The main conclusion from this section is that in EU-15, the positive trends of decoupling final energy and electricity intensity from final energy and electricity consumption per capita can be noticed. In Lithuania final energy and electricity intensity of GDP was much higher than the ones for EU-15 but have been decreasing and by 2002 have reached similar levels.

Lithuania primary energy intensity is still about twice higher than the EU-15 average. In order to define the impact of the structural changes in the economy on energy intensity, a less aggregated analysis of energy intensity is necessary.

5.5.4. Structure of economy

By analyzing energy intensity in less aggregated levels, the trends in energy intensity of different branches of the economy can be investigated using indicator #9 (energy intensities in economic sectors) as the targeted indicator. The increase of shares in GDP value added of economic branches consuming less energy is the favorable trend to reduce energy intensity of GDP. The share of sectors in GDP value added is an indirect driving force indicator of the economic dimension. This indicator also has a significant impact on energy consumption per capita (state indicator) and, of course, on energy intensity of GDP (direct driving force indicator).

In Figure 5.28 and Table 5.12, Lithuanian GDP structure is presented.

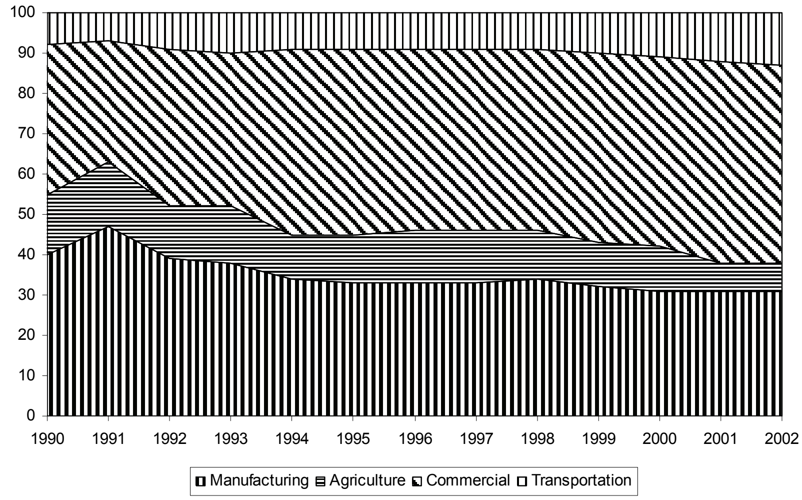

Figure 5.28 Lithuania: GDP structure

TABLE 5.12 GDP STRUCTURE, %

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002
Manufacturing	40	47	39	38	34	33	33	33	34	32	31	31	31
Agriculture	15	16	13	14	11	12	13	13	12	11	11	7	7
Commercial	37	30	39	38	46	46	45	45	45	47	47	50	49
Transportation	8	8	9	10	10	9	10	10	9	10	11	12	13

The largest share of GDP in 2002 was for the commercial sector at 49% followed by manufacturing at 31% and transportation at 13%. Since 1990 the structure of GDP has changed dramatically in Lithuania with the share of manufacturing decreasing from 40% to 31% in 2000 while the commercial sector share increased from 37% to 49%. The share of the transportation sector also increased from 8% to 13% in 2002.

The final energy consumption structure in Lithuania according to branches of the economy is presented in Figure 5.29. The structure of energy consumption in economic branches has changed dramatically in Lithuania since 1990. The largest share of final energy consumption in 2002 was in the household sector at 34% followed by transportation at 29%, and manufacturing at 22%. In 1990 the largest energy consumer in Lithuania was the manufacturing sector which had a 40% share.

As shown in Figure 5.29 and Table 5.13, the final energy consumption has significantly decreased since 1990 (more than two times). The decrease is observed in all sectors. For example, the final energy demand in manufacturing in 2002 amounted to only 22% of the 1990 level.

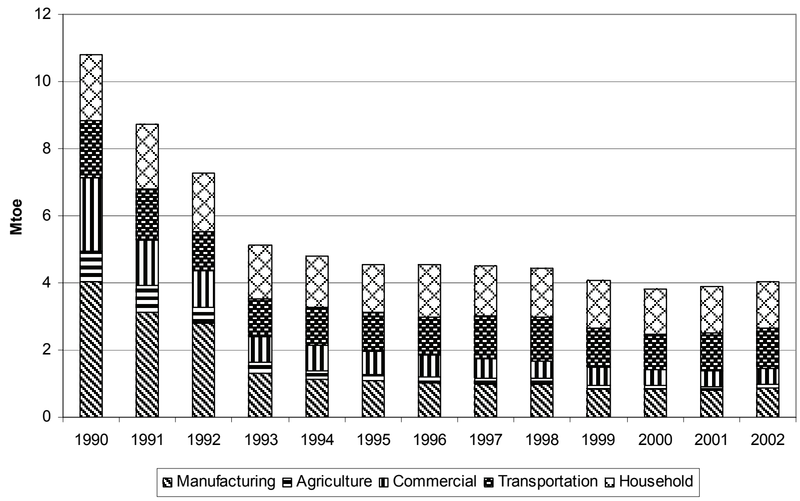

Figure 5.29 Lithuania: final energy consumption by economic sectors

TABLE 5.13 FINAL ENERGY CONSUMPTION BY ECONOMIC SECTORS, MTOE

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002
Manufacturing	4.052	3.119	2.813	1.299	1.129	1.088	1.004	0.995	0.996	0.836	0.827	0.792	0.886
Agriculture	0.897	0.814	0.460	0.344	0.248	0.191	0.207	0.173	0.160	0.113	0.102	0.100	0.109
Commercial	2.173	1.382	1.093	0.773	0.761	0.686	0.642	0.586	0.526	0.533	0.473	0.472	0.476
Transportation	1.715	1.549	1.151	1.125	1.151	1.170	1.125	1.253	1.313	1.174	1.056	1.152	1.191
Household	1.946	1.919	1.764	1.603	1.522	1.409	1.553	1.498	1.450	1.419	1.354	1.372	1.385

Energy intensity of branches of the economy (#9) is an indirect driving force indicator having an impact on the energy intensity of GDP analyzed in Section 5.2. Final energy intensity in economic sectors is presented in Figure 5.30. As one can see from Figure 5.30, and Table 5.14, final energy intensity has decreased in all sectors of the economy. In the manufacturing sector, final energy intensity decreased more than twice. In the agriculture sector, energy intensity decreased by four times.

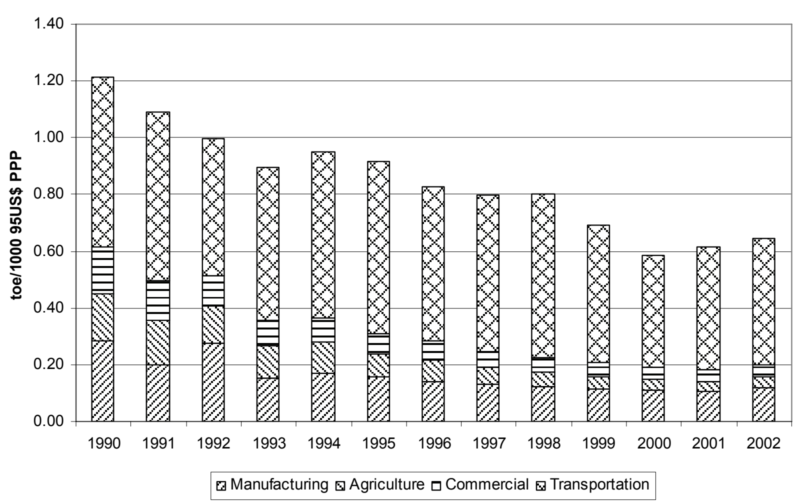

Figure 5.30 Lithuania: final energy intensity by economic sectors

TABLE 5.14 FINAL ENERGY INTENSITY BY ECONOMIC SECTORS, TOE/1,000 95US$ PPP

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002
Manufacturing	0.284	0.198	0.274	0.153	0.169	0.159	0.142	0.132	0.121	0.113	0.109	0.104	0.117
Agriculture	0.167	0.157	0.134	0.113	0.113	0.079	0.075	0.058	0.054	0.044	0.039	0.038	0.042
Commercial	0.164	0.140	0.106	0.091	0.084	0.073	0.067	0.057	0.049	0.049	0.042	0.042	0.042
Transportation	0.600	0.594	0.485	0.537	0.584	0.606	0.544	0.552	0.579	0.487	0.394	0.430	0.444

In Figure 5.31 the final energy intensities and shares of value added by economic sectors are presented.

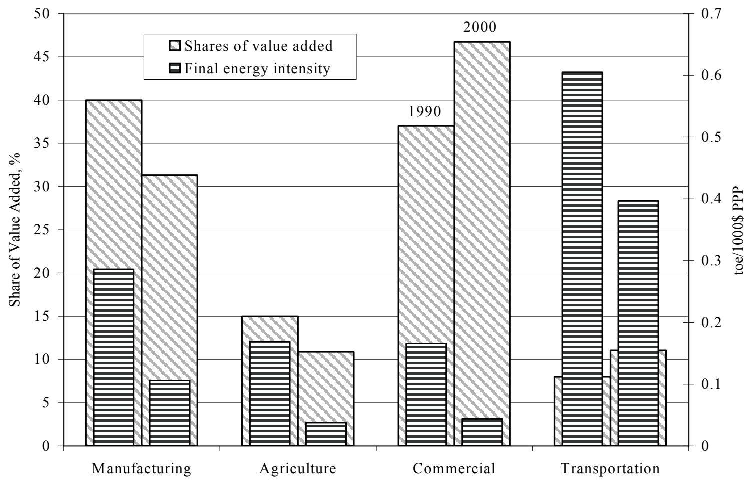

Figure 5.31 Lithuania: final energy intensities and shares of value added by sectors

As one can see from Figure 5.31, the highest shares of value added are in the commercial sector which has the lowest final energy intensity among all sectors. On the contrary, the share of value added of the transportation sector is the lowest while having the highest energy intensity. Since 1990 the share of value added from the commercial sector increased while the final energy intensity of GDP decreased. The share of value added from manufacturing decreased and the final energy intensity decreased as well. In general energy intensity decreased in all branches of the economy since 1990. The share of value added decreased in manufacturing and agriculture. All these trends have an impact on the decrease of final energy intensity of GDP in Lithuania.

Figure 5.32 and Table 5.15 show final electricity consumption by sectors of the economy. Final electricity consumption has decreased in all sectors except in the commercial and household sectors. The biggest decrease was in agriculture and manufacturing sectors. Final electricity demand in agriculture in 2002 was only 6% of the 1990 level and in the manufacturing sector about 31% of the 1990 level.

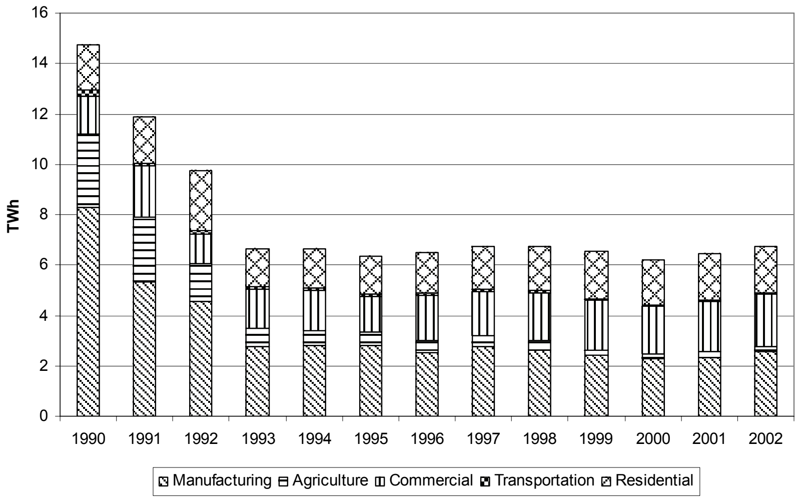

Figure 5.32 Lithuania: final electricity consumption by economic sectors

TABLE 5.15 FINAL ELECTRICITY CONSUMPTION BY ECONOMIC SECTORS, TWH

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002
Manufacturing	8.27	5.33	4.54	2.77	2.80	2.81	2.52	2.78	2.62	2.41	2.29	2.35	2.55
Agriculture	2.94	2.59	1.51	0.70	0.58	0.52	0.50	0.43	0.41	0.23	0.19	0.20	0.19
Commercial	1.50	2.01	1.16	1.58	1.60	1.44	1.80	1.72	1.89	1.95	1.87	1.99	2.10
Transportation	0.25	0.13	0.14	0.09	0.10	0.10	0.09	0.09	0.08	0.07	0.08	0.09	0.08
Household	1.77	1.84	2.41	1.49	1.55	1.50	1.61	1.72	1.74	1.89	1.77	1.82	1.81

Figure 5.33 and Table 5.16 show final electricity intensity by sectors. The average electricity intensity in 1990 amounted to 0.42 kWh/95US$. In 2002 it decreased by almost 1.6 times. In the manufacturing sector, electricity intensity decreased about two times and in agriculture about seven times.

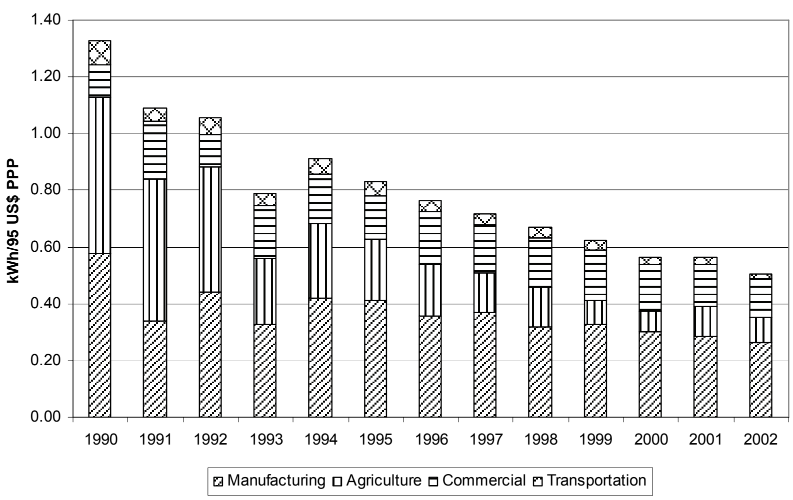

Figure 5.33 Lithuania: final electricity intensity by economic sectors

TABLE 5.16 FINAL ELECTRICITY INTENSITY BY ECONOMIC SECTORS, KWH/95 US$ PPP

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002
Manufacturing	0.579	0.339	0.441	0.327	0.420	0.411	0.356	0.368	0.318	0.325	0.302	0.299	0.263
Agriculture	0.549	0.500	0.442	0.231	0.262	0.217	0.181	0.141	0.141	0.088	0.071	0.107	0.089
Commercial	0.114	0.203	0.113	0.187	0.177	0.153	0.187	0.168	0.175	0.178	0.165	0.148	0.134
Transportation	0.087	0.050	0.060	0.045	0.052	0.050	0.041	0.039	0.036	0.031	0.028	0.028	0.020

The main conclusions from this section:

- The structure of the economy has dramatically changed in Lithuania since 1990. The share of value added of manufacturing has decreased and that of the commercial sector, which is the least energy intensive sector, has increased. In general energy intensity has decreased in all branches of the economy since 1990. All these trends have had a positive impact on the decrease of final energy intensity of GDP in Lithuania.
- The positive trends of final energy intensity decrease and structural changes in favor of less energy consuming sectors needs to be maintained and enhanced in the future in order to speed a convergence of Lithuanian energy intensities with EU-15 member states.
- The efficient use of energy resources and energy conservation is the priority of energy policy in Lithuania and is being fostered by constantly updating the National Energy Efficiency Programme (Lithuanian Ministry of Economy, 2001). The same polices should be followed in the future.

5.5.5. Energy prices

The next important issues related to energy consumption trends in Lithuania are energy prices and energy affordability. The analysis of energy prices for households can help identify reasons for low final energy and electricity consumption per capita in Lithuania. All monetary values applied in this section are based on current US dollars.

Though social targets of sustainable energy development were not addressed in the national energy strategy, the analysis performed in the sections above indicate that GDP per capita and final energy consumption per capita are very low and indicate the low living standards in Lithuania. Final energy consumption per capita in Lithuania is only half that of the EU-15, and electricity and GDP per capita less than a third. While GDP per capita is slowly increasing in Lithuania, electricity and final energy per capita are still decreasing, based on high household energy prices (especially for district heating) combined with low incomes.

Energy prices for households (indicators #3 from ISED list) are very important determinants of energy affordability. This indicator is the direct driving force indicator affecting the energy priority areas, energy intensity and energy consumption per capita levels. The changes of electricity, heat and natural gas prices for households (without taxes) are presented in Table 5.17.

TABLE 5.17 ELECTRICITY, HEAT AND NATURAL GAS PRICES FOR HOUSEHOLDS

Energy sources	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
# 3.3.1.2 Electricity without tax, USD/kWh											
Lithuania	0.0001	0.0002	0.001	0.014	0.02	0.04	0.05	0.05	0.047	0.047	0.058
EU-15	0.1087	0.115	0.1221	0.1232	0.127	0.1311	0.1305	0.128	0.1289	0.1284	0.1303
# 3.3.2.2. Heat without tax, USD/GJ											
Lithuania	0.018	0.09	0.36	2.7	14.4	33.3	64.8	80.1	94.5	97.2	103.5
EU-15	92.16	99.4	99.7	102.2	104.4	110.2	110.9	115.2	117.7	118.8	121
# 3.3.3.2 Natural gas without tax, USD/GJ											
Lithuania	0.003	0.007	0.099	2.2	3.6	4.8	5.7	5.8	5.6	5.6	8.8
EU-15	13.4	15.2	15.8	15.2	15.7	16.1	15.9	16.6	17.4	17.2	17.4

Energy prices were very low and stable for long periods of time, and uniform over large regions of the former Soviet Union. In the middle of 1992, when prices for Russian crude oil and natural gas sharply increased and started to converge with international prices, a price shock to final consumers in Lithuania became unavoidable. The Government quickly liberalized oil product prices, but they did not increase significantly as businessmen were actively buying them (very cheaply) in Russian markets and importing them into the country. Natural gas prices increased steeply, however, and caused increases in district heating prices as well. The Government put all of the burden of price increases on the still-strong manufacturing industry (i.e., prices and tariffs for gas and district heating were increased sharply for industry, but remained at low levels for households). Thus, industry was subsidizing households. Due to this experiment, industry suffered -- many industries reduced their activities, reduced heating, or switched it off entirely, and some even went bankrupt. It indirectly affected the residential sector as well, since prices for manufacturing goods went up and unemployment increased. Cross subsidies were gradually abolished in 1995, though district heating prices were subsidized until mid 1997.

From 1993 to 1997, electricity, gas and district heating tariffs rose drastically in line with overall Government policies in order to, at a minimum, recover production costs. Higher prices have an impact on energy demand but also on the ability of consumers to pay the increased rate. While the prices of crude oil, heavy fuel oil, petrol, diesel, industrial and residential electricity all increased substantially, they did so in equal terms—but the price of residential heat increased by a factor of ten. Finally, in 1997 the Government made two decisive steps: 1) it separated the district heating activities from the vertically integrated monopoly “Lithuanian energy” company; and 2) it stopped regulating energy prices. An independent Control Commission for Energy Prices and Energy Activities was established, and it was empowered to fix energy prices using technical and economic principles. The energy sector prices and tariffs are still regulated, except for prices of petroleum products and solid fuels. Price regulation and control is strong in the electricity, heat and gas sectors. This is understandable, since there is no competition in these sectors. The main objectives of the Commission are to set energy pricing principles and to implement energy policy goals for the control of energy activities. The Commission supervises the application of fixed prices for electricity, district heat, hot and cold water, and natural gas, as well as the implementation of the energy saving program.

The change in electricity prices for households in Lithuania and the EU-15 are presented in Figure 5.34. It can be seen that electricity prices in Lithuania are still only half the EU-15 average. In the EU-15, electricity prices for households were relatively stable for several years. In Lithuania electricity prices for households are increasing slightly. The closure of the Ignalina NPP in 2009 will cause significant electricity price increases, and some analyses suggest that they will reach current EU-15 average levels (Lithuania Ministry of Economy, 2002). This could cause significant social problems because, as noted earlier, GDP per capita in the country is only one-third of the EU-15 average.

GDP per capita expressed in PPP is the principal indicator of social welfare, and in 2000, this indicator was only 70% of its 1990 value in Lithuania. Though current GDP growth rates in Lithuania are quite high (6.7% in 2002 and 6.8% in 2003), the country will still not be able to reach the EU-15 average level in 2010 because GDP is also continuously increasing in the EU-15 (though at quite moderate rates).

The increase in electricity prices after the closure of the Ignalina NPP will cause considerable social problems because the support system for low-income population in Lithuania does not cover expenditures for electricity—only expenditures for heating, and hot water. The introduction of a new support scheme should therefore be considered.

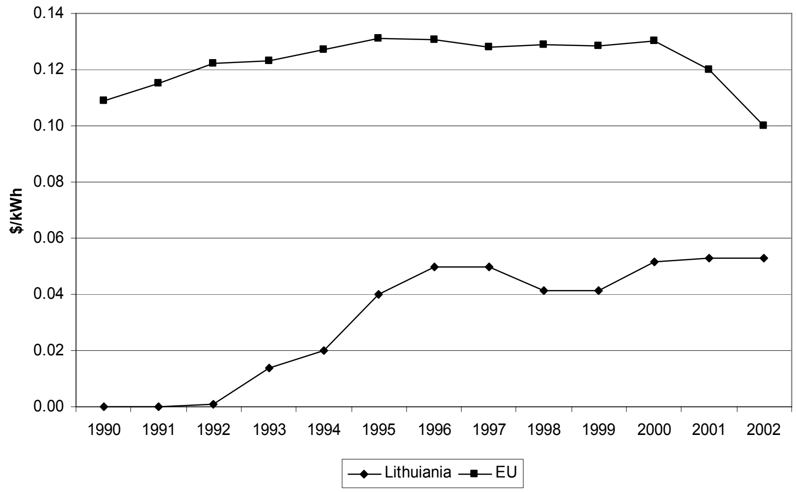

Figure 5.34 Dynamics of electricity prices for households in Lithuania and EU-15

The changes in natural gas prices for households in Lithuania and the EU-15 are presented in Figure 5.35. One can see from this figure that natural gas prices in Lithuania are roughly half of those in EU-15 countries.

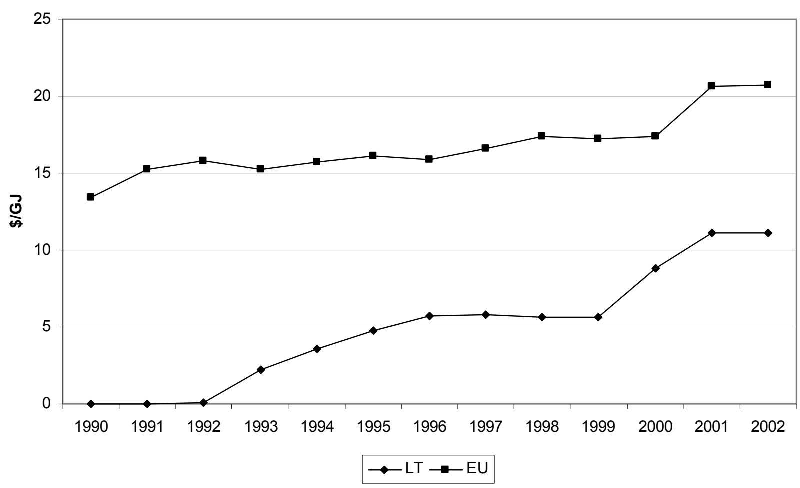

Figure 5.35 Dynamics of natural gas prices for households in Lithuania and EU-15

Changes of district heating prices for households in Lithuania and EU are given in Figure 5.36.

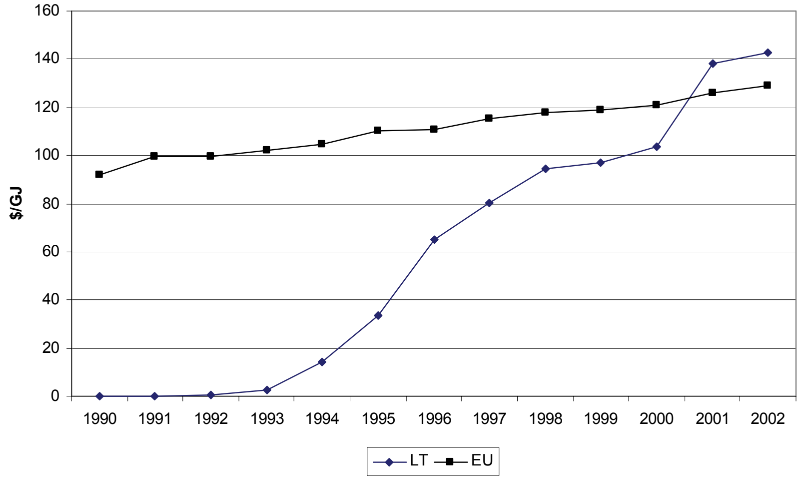

Figure 5.36 Changes in district heat prices for households in Lithuania and EU

District heat prices by 2001 were almost equal in Lithuania and in the EU-15, even though GDP per capita (adjusted at PPP) were considerably different. So one can conclude that energy prices are very high compared with the country's GDP per capita, and represent a burden for the Lithuanian population. This is evident especially in district heat prices.

The poverty level can be expressed as the percentage of population living below the national poverty line, or the population that is living below the region's extreme poverty level of 2.15 USD in PPP per day. The poverty gap is an indicator that shows the average gap between the poverty line and the mean expenditure of the poor. In Lithuania this indicator was 23% in 2000, a figure similar to other accession countries, but of course considerably higher than levels reported in the EU-15. In Ireland, for example, it was 10% in that same year and in Denmark and Finland was reported as 0%. In Moldova, the same indicator was reported to be 80% in 2001.

The national or relative poverty level is the proportion of the population in the country that has expenditures below the poverty line. The poverty line equals 50% of the mean consumption expenditures per month (260 Litas or 65 USD in 2000). Average consumption expenditures per month are calculated using an equivalence scale of the OECD: the first adult household member is equated to 1, each next adult to 0.7 and each child under 14 to 0.5.

The poverty level in Lithuania has been recorded and reported since 1996. Figure 5.37 and Table 5.18 show that the poverty level was decreasing up to 1999 and then started to increase because of the crisis. Since 2001 a positive trend of poverty level decrease can be noticed in Lithuania. The current poverty level in Lithuania is about 16%, which is still quite high compared with Western European countries.

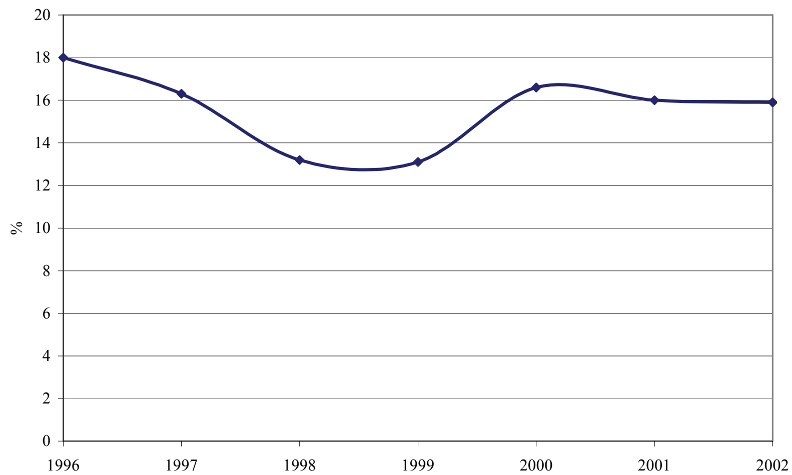

Figure 5.37 National or relative poverty level

TABLE 5.18 NATIONAL POVERTY LEVEL, %

	1996	1997	1998	1999	2000	2001	2002
Lithuania	18.0	16.3	13.2	13.1	16.6	16.0	15.9

According to World Bank data, the poverty level in Lithuania was 3.1% in 1999 when applying the international poverty indicator (2.15 USD/day). However it is doubtful that these data are correct, because the national poverty line reported in that same year amounted to 274.6 Lt/day or 2.4 USD/day, and the poverty level reported was 13.1%. It thus appears that the poverty level in Lithuania should have been significantly higher.

So it can be concluded that poverty, income inequality and low living standards are serious problems in Lithuania. Further analysis of the trends of social dimension indicators from the ISED list is outlined below.

The social dimension indicators from the ISED list (#19, #21 and #20) can be used to address the targeted goal of increasing the quality of life.

The main indirect social driving force indicator (#19) is the ratio of disposable income to private consumption in terms of individual income available to groups of the poorest 20% and richest 20% of the population. The monthly disposable income was used in our case study instead of daily disposable income because all statistical data on disposable income, poverty line, expenditures for fuels and energy is provided on a monthly basis. Therefore all social indicators were calculated on a monthly basis in order to be consistent. Indicator (#19), like the Gini index, is relevant to the equity component of sustainable development. Income distribution has a direct impact on the poverty level of the country. Changes in income inequality in Lithuania are presented in Figure 5.38 and Table 5.19. This shows that the poorest 20% had an average income that is less than 20% of the income of the richest 20%. This indicator is similar in Latvia and Estonia.

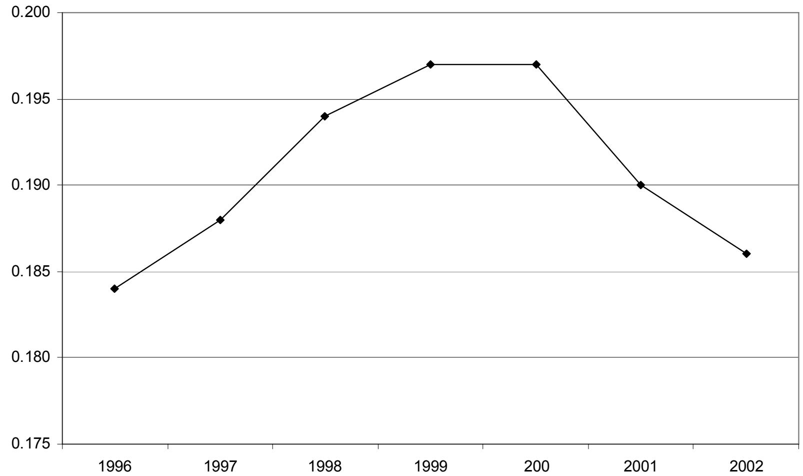

Figure 5.38 Income inequality

TABLE 5.19 INCOME INEQUALITY

	1996	1997	1998	1999	2000	2001	2002
Lithuania	0.184	0.188	0.194	0.197	0.197	0.190	0.186

The direct driving force social indicator (#21), namely the fraction of monthly disposable income/private consumption spent on fuel and electricity, shows the expenditures spent for household fuel and electricity as a percentage of total private consumption per capita per month by the average population, and by a group of the 20% poorest population. This indicator provides a measure of energy affordability for the average population and for the poorest households, indicating income inequality as well. This indicator is supplementary to such a general indicator of welfare as GDP/capita, because income distribution in the country can vary very widely. The low-income population have no possibility of meeting their full needs with commercial energy at current price and income levels.

In Lithuania, official statistics provide this information since 1996, but data sources report the share of average household consumption expenditures on electricity, fuel, water and housing. Data are given for deciles. Deciles are calculated by dividing the population surveyed arranged in an increasing order according to consumption expenditure levels into ten equal parts. The first decile covers households with the smallest expenditure; the tenth decile covers the richest population group. Average data from the two first deciles was employed to define expenditures of the 20% poorest population. Seeking to calculate the share of expenditures spent on electricity, heating and fuels, data on the average consumption structure in the expenditure groups for all deciles was applied.

As shown in Figure 5.39 and Table 5.20, the share of expenditures for electricity and household fuel by the average population is higher than for the group of the 20% poorest population. There is not a big difference between the share of expenditures for electricity and household fuels of the poorest and richest deciles. The biggest share of expenditures for electricity and household fuels correspond to the middle decile. This indicator was decreasing until 1999 but because of the economic recession it has increased since 2000.

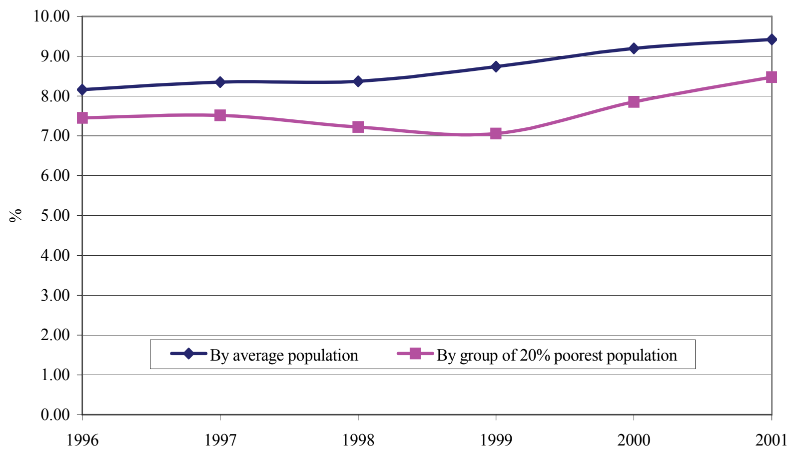

Figure 5.39 The fraction of disposable expenditures spent for household fuel and electricity as a percentage of total private consumption per capita by average population and by group of 20% poorest population

TABLE 5.20 THE FRACTION OF DISPOSABLE EXPENDITURES SPENT FOR HOUSEHOLD FUEL AND ELECTRICITY AS A PERCENTAGE OF TOTAL PRIVATE CONSUMPTION PER CAPITA BY AVERAGE POPULATION AND BY GROUP OF 20% POOREST POPULATION

	1996	1997	1998	1999	2000	2001
By average population	8.16	8.35	8.37	8.74	9.19	9.42
By group of 20% poorest population	7.45	7.51	7.22	7.06	7.85	8.47

The direct driving force social dimension indicator (# 20) is the ratio of monthly disposable income per capita of the 20% poorest population to the prices of electricity and major household fuels. Comparing this indicator with the one for the average population, one can observe that energy affordability for the low-income population is very low (Figure 5.40, 5.41 and 5.42 and Table 5.21). Figure 5.40 provides data based on a ratio of income to price, so it has an axis labeled “kwh/month”; if income is expressed in USD/month and prices of electricity in USD/kWh, the ratio of income to prices is kWh/month, and shows how many kWh of electricity per month is affordable for the average population and the poor. For example, electricity consumption of the low-income population is almost three times below the average. This shows that a socially desirable level of electricity consumption cannot be guaranteed for the low-income population without state aid. The situation is the same with natural gas and heat consumption. One can conclude that high-energy prices compared with low income of population in Lithuania are a serious problem.

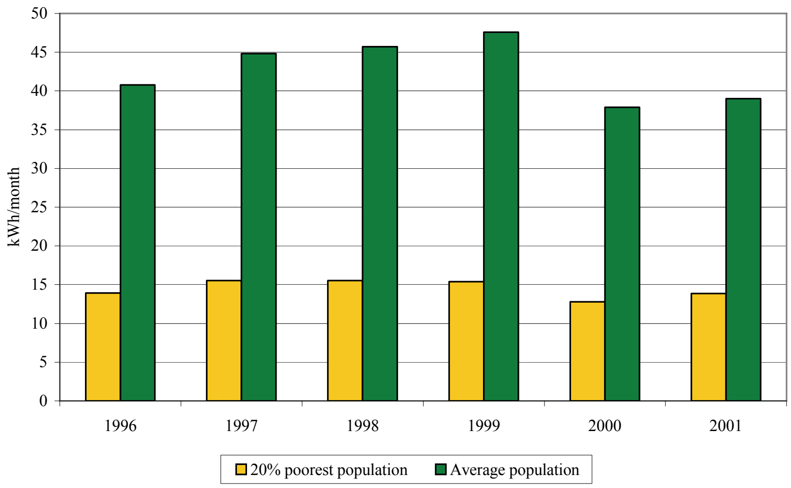

Figure 5.40 The ratio of monthly disposable income per capita of 20% poorest and average population to the prices of electricity

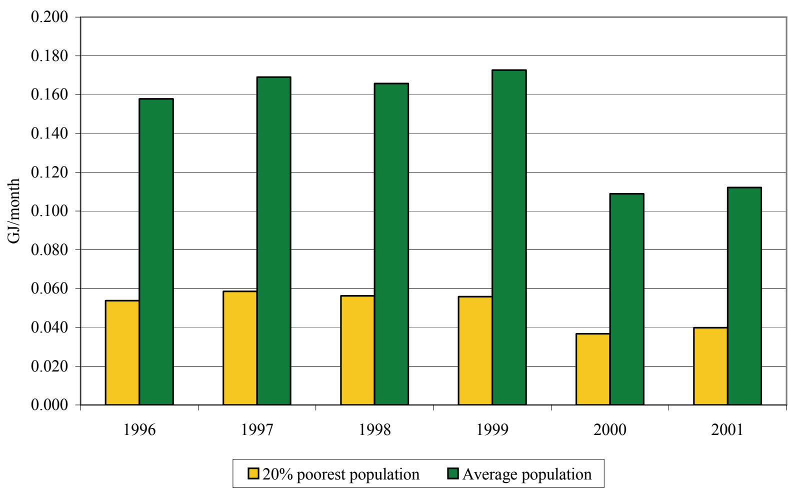

Figure 5.41 The ratio of monthly disposable income per capita of 20% poorest and average population to the prices of natural gas

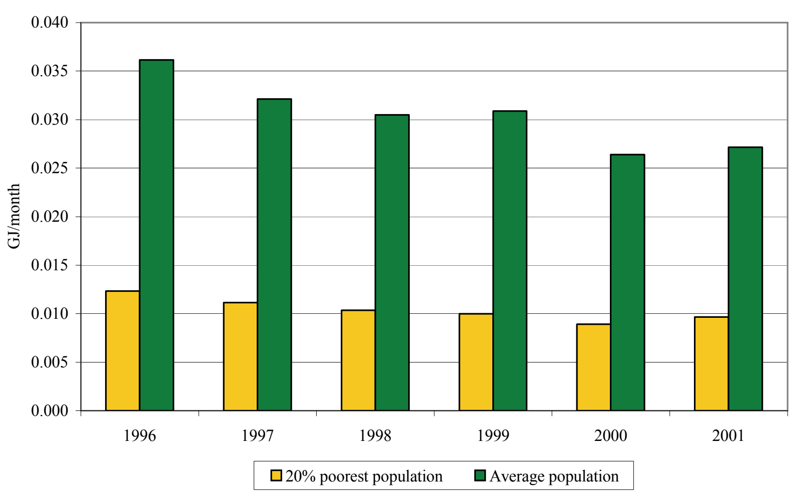

Figure 5.42 The ratio of monthly disposable income per capita of 20% poorest and average population to the prices of district heating

TABLE 5.21 THE RATIO OF MONTHLY DISPOSABLE INCOME PER CAPITA OF 20% POOREST AND AVERAGE POPULATION TO THE PRICES OF ELECTRICITY, NATURAL GAS AND DISTRICT HEATING

Year	Electricity, kWh/month/capita		Natural gas, GJ/month/capita		District heating, GJ/month/capita	
	20% poorest population	Average population	20% poorest population	Average population	20% poorest population	Average population
1996	13.91	40.78	0.054	0.158	0.012	0.036
1997	15.53	44.83	0.059	0.169	0.011	0.032
1998	15.54	45.70	0.056	0.166	0.010	0.030
1999	15.41	47.60	0.056	0.173	0.010	0.031
2000	12.78	37.89	0.037	0.109	0.009	0.026
2001	13.86	38.99	0.040	0.112	0.010	0.027

In order to compare Indicator #20 with the EU-15 average, data for 1996 was used, and a comparison of the ratio of monthly disposable income per capita of average population to the prices of district heating in Lithuania and the EU-15 average was made with the data available for 1995-1996 (EC, 1999).

Total expenditures of households in the EU-15 in 1996 amounted to 1963 USD/capita per month. Total expenditures on household energy consumption in the same year amounted to 74.6 USD/capita and represented 3.8% of total household expenditures in this year. Lithuanian total household expenditures in 1996 amounted to 68.7 USD/capita. Total expenditures on household energy consumption in Lithuania amounted to 7.3 USD/capita and represented 10.8% of total household expenditures. So EU-15 average household energy expenditures were more than 10 times higher than in Lithuania. At the same time total household expenditures in EU-15 countries were about 30 times higher compared with Lithuania. However, in Lithuania 10.8% of the total expenditures are for electricity and fuels versus only 3.8% in the EU-15.

Energy use expenditures in EU-15 on space heating amounted to 36.52 USD/capita per month (50% of total energy expenditures). In Lithuania it was 2.32 USD/capita or 31% of total energy expenditures. Natural gas for cooking represented 5.5 USD/capita, or 7.4 % of energy expenditures, in EU-15; and 0.89 USD/capita, or 12% of energy expenditures, in Lithuania. Electricity represented 15.7 USD/capita or 21% of household energy expenditures in EU-15 and 2.04 USD/capita or 27% in Lithuania.

Energy prices in EU-15 for electricity in 1996 amounted to 0.13 USD/kWh, so the ratio of monthly disposable income/private consumption to electricity prices in the same year amounted to 120.8 kWh/capita per month. In Lithuania the ratio of monthly disposable income/private consumption to electricity prices in the same year amounted to 39 kWh or about one-third as much.

Natural gas prices in EU-15 in 1996 were 15.93 USD/GJ, so the ratio of monthly disposable income/private consumption to natural gas prices in the same year amounted to 0.50 GJ/capita per month and in Lithuania the ratio of monthly disposable income/private consumption to natural gas prices in the same year amounted to 0.15 GJ/capita per month and was less than one-third that in the EU-15.

One can conclude that the worst situation with energy affordability in Lithuania is in the heating sector because district heat prices in Lithuania are very high (only about 14% lower than in EU-15 countries) compared to the low disposable income of the population. The amount of heat that could be consumed monthly, or monthly at current consumer prices and available disposal income, indicates that in Lithuania the heat which can be consumed by the average population is about nine times lower than in EU-15. The amount of electricity and natural gas consumed monthly at current electricity and natural gas prices in Lithuania was three times lower compared with the EU-15 average, and electricity prices was 2.3 times and natural gas prices three times higher in EU-15.

In order to ensure energy affordability, social support schemes to low-income population are necessary. The currently applied support system in Lithuania is based on burden limits for a notional amount that the household is "entitled" to spend for heating and hot and cold water is not efficient. First, because according to coverage criteria, it covers only 8% of the population in Lithuania. At the same time the poverty level in the country is about 16%. Second, according to targeting criteria, the scheme also is not good because expenditures of the richest decile for housing, water, electricity, gas etc. are about 13.6 % in all household consumption expenditures and for the poorest decile it is 15.2 % of their total expenditures. Moreover other important expenditures such as payments for house rent, electricity, gas, etc. are not included in the support scheme. The negative social effect of electricity price increases after the closure of Ignalina NPP can be mitigated by integrating expenditures on electricity into the support scheme. Therefore the new support schemes for low-income population should be developed in order to ensure energy affordability.

5.5.6. Security of supply

According to the EC COM (2000) 769 (Green paper *Towards a European Strategy for Security of Energy Supply*)**,** the EU-15 long-term strategy for energy supply security must be geared to ensuring the well-being of its citizens and the proper functioning of the economy, the uninterrupted physical availability of energy products on the market, at a price which is affordable for all consumers while respecting environmental concerns. Security of supply does not seek to maximize energy self-sufficiency or to minimize dependence but aims to reduce risks related to such dependence. Among the objectives to be pursued are those balancing and diversifying the various sources of supply (by product and by geographical region). When preparing an energy sector development strategy for Lithuania, security of supply should be considered as a very important issue and possibilities to increase diversification of fuels should be taken into account.

For the increase of security of supply indicator #18 (net import dependency) and indicator #17 (indigenous energy production) were selected from the ISED list. Both these targeted indicators are state indicators and are affected by the following indirect driving force indicators: energy mix in primary energy supply and electricity generation (indicator #11), and energy supply efficiency (#12).

The net energy import dependency is presented in Figure 5.43 and Table 5.22 for the 1990-2002 period. A net decreasing trend is observed from 72% in 1990 to around 44% in 2002. This trend is the result of a dramatic decrease in total primary energy requirements (about 48%) which allowed a major reduction in imports throughout this time period. Imports of natural gas, crude oil and coal dropped from 12,923 ktoe in 1990 to 4,309 ktoe in 2002. At the same time, there was a considerable increase in domestic oil production and wood waste utilization, although these two sources could cover only about 12% of the TPES in 2002 (see Table 5.1). It is expected that this positive trend in net energy imports will reverse after the total shut down of the Ignalina nuclear power plant by 2009. At that time, an increase in imports may be necessary to cover about 90% of the future primary energy requirements; therefore, additional measures to increase security of energy supply are necessary.

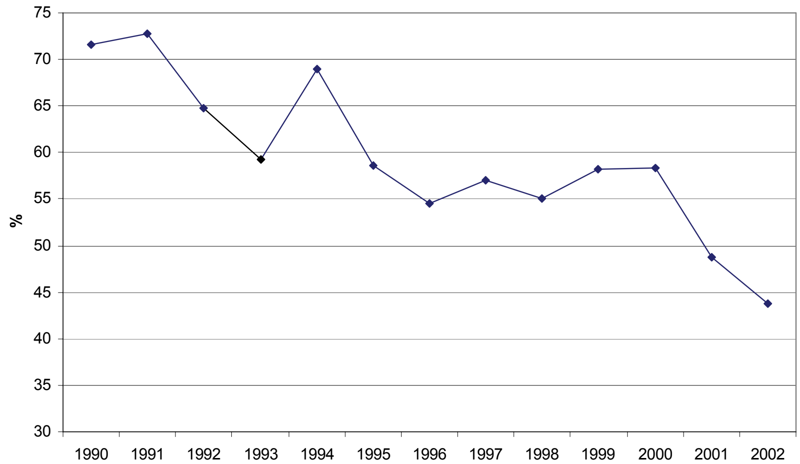

Figure 5.43 Lithuania: energy net import dependency

TABLE 5.22 ENERGY NET IMPORT DEPENDENCY, %

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002
Lithuania	71.65	72.74	64.71	59.31	68.91	58.60	54.52	56.99	55.01	58.15	58.33	52.0	43.8

Indigenous energy production is presented in Figure 5.44 and Table 5.23. The largest contributor, by far, is nuclear with a share of about 76% in 2002. The domestic production of crude oil and wood have increased dramatically while hydro and peat production have remained relatively stable.

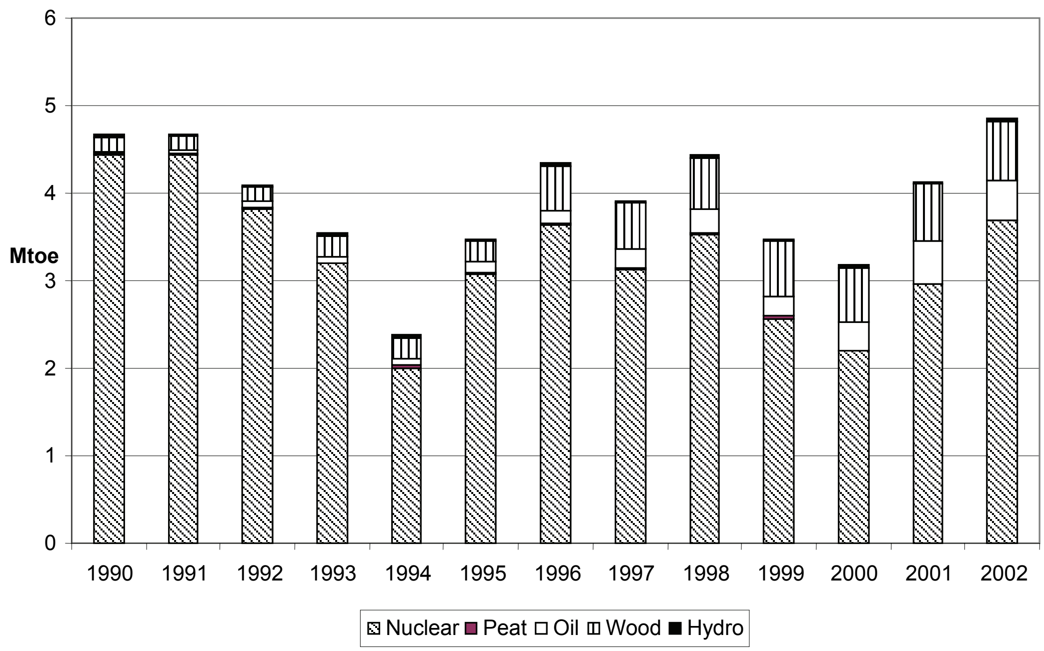

Figure 5.44 The structure of indigenous energy production

TABLE 5.23 THE INDIGENOUS ENERGY PRODUCTION, KTOE

	1990	1994	1995	1996	1997	1998	1999	2000	2001	2002
Nuclear	4,438.5	2,008.1	3,080.5	3,633.0	3,133.2	3,531.9	2,569.8	2,193.8	2,961	3,686
Peat	13.9	21.0	14.2	17.7	20.5	17.2	23.3	11.8	11.2	11.2
Oil	12.0	82.0	115.0	155.4	212.3	277.5	232.5	316.4	475	439.4
Wood	166.6	231.5	236.7	508.2	516.2	575.7	620.6	626.7	654.4	690.2
Hydro	35.7	38.8	31.9	28.0	25.3	35.9	35.5	29.2	28.0	30.4

Table 5.24 presents total primary energy supply mix by fuel types. Nuclear and CRW have gained considerable shares in the TPES against the oil and gas shares. In 2002, nuclear had the largest share at 36%, followed by oil at 28.5% and gas at 25%. .

TABLE 5.24 TOTAL PRIMARY ENERGY SUPPLY MIX BY FUEL TYPES, %

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002
Coal	5.9	4.9	4.4	5.2	4.5	3.2	2.5	2.1	1.7	1.8	1.4	1.1	1.5
Oil	44.1	43.0	38.9	44.5	44.4	38.3	34.1	36.9	40.2	37.2	31.2	31.3	28.5
Gas	28.3	29.3	24.8	15.9	21.5	23.1	23.3	22.7	19.0	23.2	29.0	26.6	25.2
Nuclear	20.5	21.6	30.2	32.5	26.2	32.4	34.3	32.1	32.5	29.8	29.2	32.6	36.3
Hydro	0.2	0.2	0.2	0.4	0.5	0.4	0.3	0.3	0.4	0.5	0.5	0.3	0.4
CRW	1.0	1.0	1.5	2.5	2.9	2.6	5.5	5.9	6.2	7.5	8.7	8.1	8.1

In Figure 5.45 the electricity generation mix by fuel types is presented. The share of fossil fuel in total electricity production in 2002 was 15.%; the share of nuclear was 79.8%. As one can see from Table 5.25, in 2002 electricity from renewable energy sources amounted to 4.4% and this was mainly the share of hydro. The EU-15 target for 2010 is 22.1%. Lithuania agreed with the EU-15 to implement 7% as the target for renewables in electricity generation. Electricity generation in Lithuania is dominated by nuclear fuel. After the closure of the Ignalina NPP in 2010, the structure of fuel consumption will change significantly. Therefore the increased utilization of renewable energy sources in electricity generation is a crucial task for Lithuania.

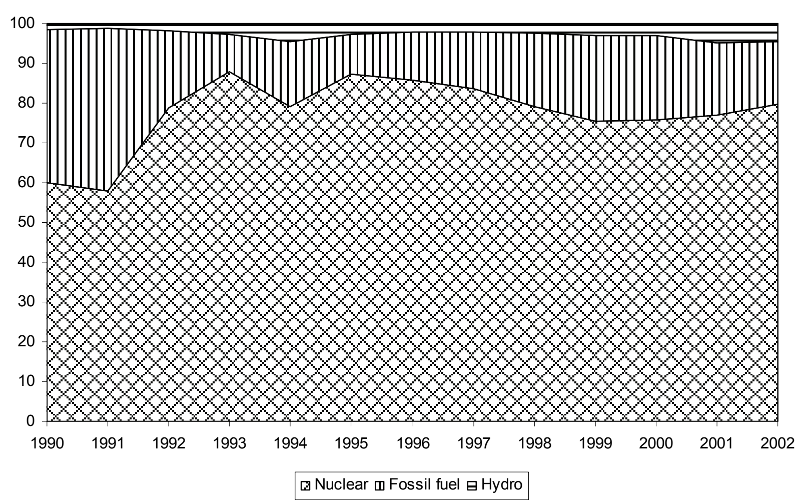

Figure 5.45 Electricity generation mix by fuel types

TABLE 5.25 ELECTRICITY GENERATION MIX BY FUEL TYPES, %

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002
Nuclear	60.0	57.9	78.9	88.0	79.0	87.4	85.8	83.6	79.0	75.4	75.7	77.1	79.8
Fossil fuel	38.6	41.0	19.4	9.2	16.4	9.8	12.1	14.4	18.6	21.5	21.2	18.2	15.8
Hydro	1.5	1.2	1.7	2.8	4.6	2.8	2.0	2.0	2.4	3.2	3.0	4.7	4.4

In Figure 5.46 and Table 5.26 the share of renewables in electricity generation in Lithuania and EU-15 is presented. As one can see from Figure 5.46, the share of electricity from renewables to total indigenous electricity production is very small in Lithuania, about 3%. In EU-15 this indicator is high, more than 14%.

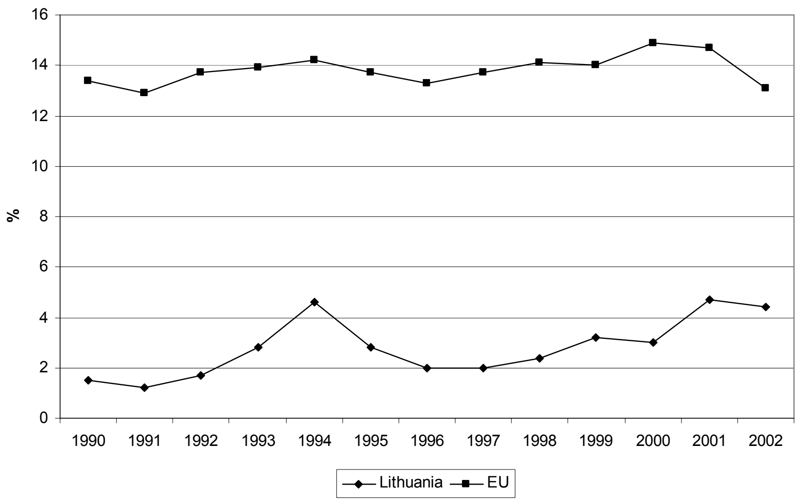

Figure 5.46 Renewable contribution to total electricity generation

TABLE 5.26 RENEWABLE ENERGY CONTRIBUTION TO TOTAL ELECTRICITY GENERATION, %

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002
Lithuania	1.5	1.2	1.7	2.8	4.6	2.8	2.0	2.0	2.4	3.2	3.0	4.7	4.4
EU-15	13.4	12.9	13.7	13.9	14.2	13.7	13.3	13.7	14.1	14.0	14.9	14.7	13.1

Energy supply efficiency (#12) (i.e., the ratio of final to primary energy consumption) has a significant impact on net energy import dependency because an increase of energy supply efficiency helps to reduce energy import dependency. Energy supply efficiency in Lithuania was 65% in 1990 and 47.6 % in 2002**.** A comparison of Lithuanian and EU-15 energy supply efficiency is presented in Figure 5.47 and Table 5.27. From 1990 to 2000, the energy supply efficiency has decreased. Energy supply efficiency is very low and indicates that twice as much primary energy resources are needed to cover domestic final demand. Policy measures aiming to increase energy supply efficiency (i.e., reducing losses in gas and oil transportation, electricity transmission and distribution, increasing efficiency of electricity generation, etc.) are necessary.

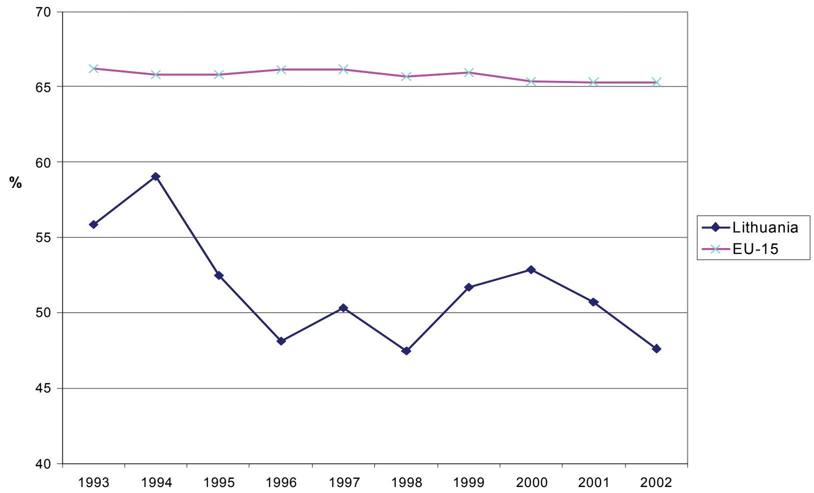

Figure 5.47 Energy supply efficiency in Lithuania and EU-15

TABLE 5.27 ENERGY SUPPLY EFFICIENCY IN LITHUANIA AND EU-15, %

	1990	1994	1995	1996	1997	1998	1999	2000	2001	2002
Lithuania	56	59.0	52.4	48.1	50.3	47.4	51.7	52.9	50.8	47.6
EU-15	65	65.8	65.8	66.1	66.2	65.7	65.9	65.4	65.3	65.3

The European Commission has developed programmes to encourage use of renewable energy in European countries. Lithuania has very limited domestic energy resources, and only biofuels, hydro and wind power can be considered as potential renewable energy sources for reaching the EU-15 target (Lithuanian Ministry of economy, 2001). An efficient policy to promote renewable energy sources, especially within the power sector, is therefore necessary in order to reach EU-15 targets (Baltic Environmental Forum, 2000).

5.5.7. Environmental energy situation

To express pollution reduction targets in relation to the final closure of the Ignalina NPP, two targeted environmental dimension indicators were selected:

- Quantities of CO_2 emissions from the power sector (Indicator #26);
- Quantities of air pollutant (SO_2 and NOx) emissions from the power sector (Indicator #23).

5.5.7.1. Reduction of CO_2 emissions

Most countries that signed the UN Framework Convention on Climate Change agreed upon the Kyoto Protocol in 1997. Lithuania signed the Protocol in 1998 and has thereby committed itself to reducing the emission of GHG in 2008-2012 by 8% compared to the 1990 level of emissions.

The designation GHG comprises CO_2, CH_4, N_2O, HFC's, PFC's and SF_6. They are measured as CO_2 equivalents according to their global warming potentials as defined by IPCC. A survey of the current emission of GHG in Lithuania compared with the Kyoto commitment is presented in Table 5.28. These data were derived from official GHG inventories presented to the UNFCCC secretariat. Official inventories of GHG in Lithuania are available only for the years 1990 and 1998. Inventory data for the year 2002 are preliminary in nature.

TABLE 5.28 COMMITMENTS AND EMISSIONS ACCORDING TO 1ST NATIONAL COMMUNICATION AND INVENTORY 2000 (BALTIC ENVIRONMENTAL FORUM, 2000).

	Aggregate (CO_2 equivalent) emissions excl. LUCF*		Aggregate (CO_2 equivalent) emissions incl. LUCF*	
	Mton	% Of base-year	Mton	% Of base-year
Base year, 1990	54.6	100	42.700	100
Kyoto commitment, 2008-12	50	92	39.284	92
Emissions, 2002	20.2	37	13.74	32

*- LUCF is an abbreviation of Land Use Change and Forestry.

According to the Kyoto Protocol, emissions and removals of CO_2 by sinks from Land Use Change and Forestry (e.g. through forestation and reforestation) are to be included in the national inventories of GHG emissions. However, agreement on guidelines and rules for how to include - and to which extent - removal of CO_2 by sinks has not yet been reached among the parties.

The EU-15 member states have made a burden sharing agreement, which “overrules” the 15 countries' individual Kyoto commitments. Instead of individual commitments, the EU-15 member states have as a whole accepted a reduction of 8%. Thus, some member states have accepted to undertake a larger reduction than 8%, while others will be allowed to reduce emissions by less than 8%.

It is not considered likely that the burden sharing agreement will be adjusted in connection with negotiations with accession countries. Therefore, it is expected that Lithuania will have to comply with its Kyoto commitment of reducing greenhouse gases by 8%.

The Framework Convention on Climate Change was ratified by the Parliament of Lithuania in 1995. Countries signing the Convention should prepare national or regional strategies for the reduction of greenhouse gas emissions. Lithuania prepared the National Strategy in 1996, as well as the First National Communication on Climate Change in 1998. In the National Climate Change Strategy (Lithuanian Ministry of Environment, 1996a) some steps were foreseen for improving the integration of Lithuania into the climate change regulation process. The steps are to improve data collection, to continue inventory of greenhouse gas emissions, to compare data received during the emission inventory with data from other studies, etc. Further, the strategy describes how the economy of the country would be affected by the climate change and greenhouse gas emissions and what measures could be implemented for the climate change mitigation.

To express the GHG pollution reduction target, indicator #26 (quantities of CO_2 emissions from power sector) was selected from the ISED list. Emissions of CO_2 accounted for about 97% of total GHG emissions in the power sector in 2002. In Figure 5.48 and Table 5.29 CO_2 emissions from the power sector are presented. This is the targeted indicator. The equivalent Kyoto target for CO_2 emissions from the power sector is about 16 Mt. The Kyoto target is being applied here in proportion to the power sector’s share in the base year’s emissions. As one can see from Figure 5.48, currently emissions from the power sector are significantly below the Kyoto target but this is related to the operation of the Ignalina NPP. As both units of Ignalina NPP will be closed by 2010 and CO_2 emissions from the power sector will increase significantly, additional policy measures to combat GHG emissions will be necessary.

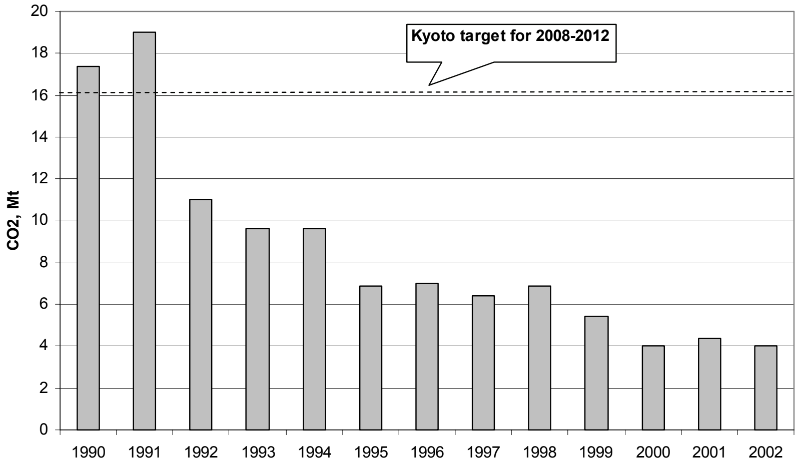

Figure 5.48 Lithuania: CO_2 emissions from power sector

TABLE 5.29 CO_2 EMISSIONS FROM POWER SECTOR, MT

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002
Lithuania	17.4	19.0	11.0	9.6	9.6	6.9	7.0	6.4	6.9	5.4	4.0	4.4	4.0

In Figure 5.49 and Table 5.30, CO_2 emissions per kWh from the power sectors in Lithuania and EU-15 are presented for further analysis in order to relate trends in CO_2 emissions to implemented energy policies (IEA, 2001b). As one can see from Figure 5.49, CO_2 per kWh in Lithuania is significantly lower than in EU-15 countries. This is related to the electricity production structure by fuel. In Lithuania about 80% of electricity is being produced at its nuclear power plant. This causes very low CO_2 emissions from the power sector. In 1994, CO_2 emissions per kWh amounted to 280 g/kWh and since 1995 it significantly decreased, down to 155 g/kWh. This is related to the changes of electricity generation structure by type of fuel in 1994. In 1994, fossil fuel provided 17% and nuclear 75%. Since 1995 the share of nuclear in total electricity production has increased, and therefore GHG emissions have decreased.

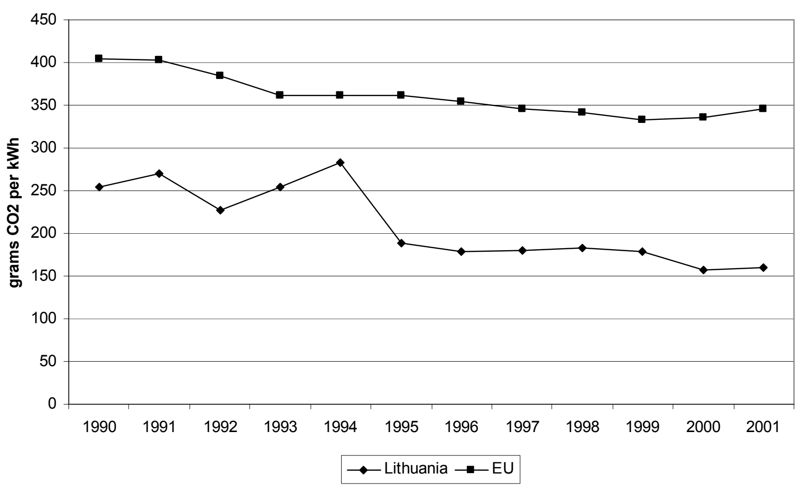

Figure 5.49 CO_2 emissions per kWh from power sector in Lithuania and EU-15

TABLE 5.30 CO_2 EMISSIONS PER KWH FROM POWER SECTOR, GRAMS CO_2 PER KWH

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001
Lithuania	254.8	269.6	227.4	254.3	283.1	188.7	177.9	179.5	183.5	178.3	154.8	160.5
EU-15	405	403	385	361	362	361	355	346	342	333	336	346

In Figure 5.50 and Table 5.31, growth indices for electricity consumption and CO_2 emissions from the power sector are presented.

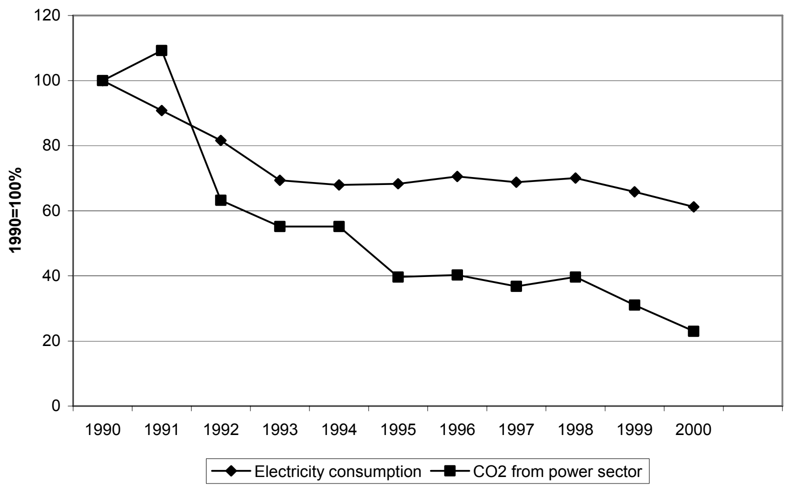

Figure 5.50 Decoupling – electricity consumption and CO_2 emissions from power sector growth index

TABLE 5.31 ELECTRICITY CONSUMPTION AND CO_2 EMISSIONS FROM POWER SECTOR GROWTH INDEX

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
Electricity consumption	100	90.79	81.59	69.33	67.95	68.29	70.54	68.76	70.05	65.82	61.19
CO_2 from power sector	100	109.20	63.22	55.17	55.17	39.66	40.23	36.78	39.66	31.03	22.99

A significant decrease in CO_2 emissions was stipulated by the steady decrease of electricity demand when the economic recession began in 1990. The structure of the economy has also changed significantly since 1990, influencing electricity consumption patterns as well as CO_2 emissions from the electricity sector. Some decoupling of electricity consumption growth and CO_2 emissions growth can be noticed because CO_2 emissions have fallen more sharply than electricity consumption has fallen.

In Figure 5.51 the relationship between emissions per kWh and electricity consumption per capita are presented for Lithuania and the EU-15 for comparison. As one can see CO_2 emissions per kWh are significantly higher in EU-15 than in Lithuania and electricity consumption per capita is higher. The declining trend of CO_2 emissions with an increase in electricity consumption per capita or a decoupling of electricity consumption per capita from CO_2 emissions per kWh can be observed. In Lithuania there is a decline in electricity consumption per capita and at the same time a net decline in CO_2 emissions per kWh for the same period. If applied to the electricity sector, the Kyoto Protocol target would imply CO_2 emissions for the period 2008-2012 of 230 g/kWh (reduced by 8% CO_2 emissions from power sector divided by forecasted electricity production levels in 2008-2012). Projections of per capita electricity consumption for Lithuania for that period indicate future electricity consumption of about 5,500 kWh per capita. It is not clear whether Lithuania will be able to maintain CO_2 emissions per kWh below the Kyoto target for 2010, given the expected increase in per capita electricity consumption and the expected retirement of the country's only nuclear power plant. Policy measures are needed to maintain the low CO_2 emissions/kWh in the future as kWh per capita is expected to increase to levels closer to the EU-15 levels.

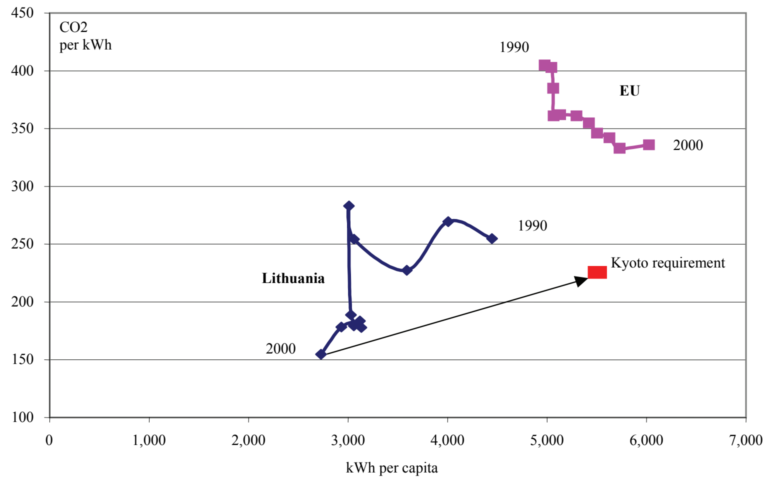

Figure 5.51 CO_2 emissions per kWh and electricity consumption per capita in Lithuania compared with EU-15

Since the Ignalina NPP is currently operating, GHG emissions are not a serious problem for Lithuania. After the closure of the nuclear power plant these emissions will increase significantly, however, and GHG mitigation policies should be implemented in Lithuania.

5.5.7.2. Reduction of SO_2 and NO_x emissions

The Long Range Transboundary Air Pollution Convention (LRTAPC) was signed by Lithuania in 1994 and its extension, the Protocol to Abate Acidification, Eutrophication and Ground-level Ozone (known as the Gothenburg Protocol), was expected to be signed in 2004. The Protocol sets emission ceilings for 2010 for four pollutants: sulfur, NO_x, VOCs and ammonia. These ceilings were negotiated on the basis of scientific assessments of pollution effects and abatement options. Parties whose emissions have a more severe environmental or health impact and whose emissions are relatively cheap to reduce will have to make the biggest cuts. In Table 5.32 national emission ceilings for 2010 for Lithuania, as established by the Gothenburg Protocol, are presented. These ceilings are the same as established by European Commission directive 2001/81/EC on national emission ceilings for certain atmospheric pollutants.

TABLE 5.32 NATIONAL EMISSION CEILING IN 2010 FOR LITHUANIA ESTABLISHED BY GOTHENBURG PROTOCOL

Pollutant	Actual total emissions		National emission ceiling for 2010 according to Gothenburg Protocol
	1990	1999	2010
SO_2 (tonnes per year)	222,000	70,000	145,000
NOx (tonnes per year)	158,000	54,000	110,000

To address the targets for the reduction of atmospheric emissions, Indicator #23, quantities of air pollutant (SO_2 and NO_x) emissions from power sector, was selected. Table 5.33 shows SO_2 and NOxcemissions from the power sector from 1990 to 2002.

For the power sector, the Gothenburg Protocol requirement is not to exceed 70 kt of SO_2 emissions. As shown in Figure 5.52, in 2000 SO_2 emissions were significantly lower than the Gothenburg Protocol requirement and amounted to 19.4 kt. This is related to the electricity production structure by fuel. After the closure of both units at the Ignalina NPP, sulfur dioxide emissions would increase but implementation of the EU directive requirements targeting large combustion power plants will prevent significant increases of pollution.

TABLE 5.33 DYNAMICS OF SO_2 AND NO_X EMISSIONS FROM POWER SECTOR, KT

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002
SO_2	105	112	65	60	55	58	58	51	69	45	19.4	26.5	26.2
NO_x	47	46	28	25	24	19	19	17	20	15	11.2	8.0	9.6

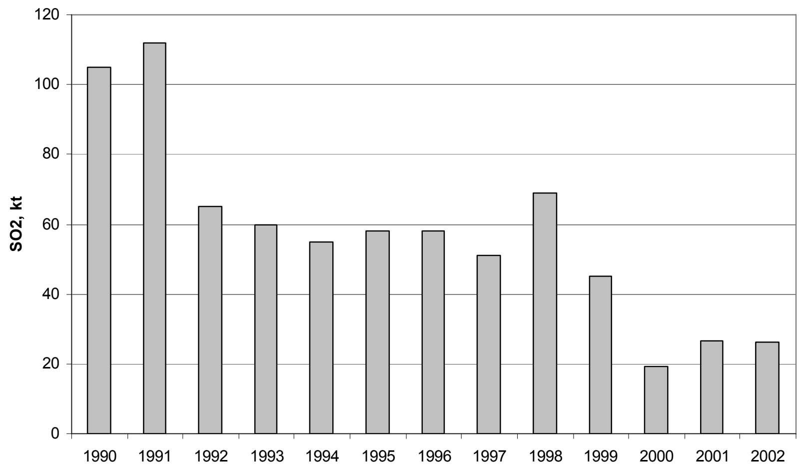

Figure 5.52 Changes of SO_2 emissions from power sector

In Figure 5.53 changes of NO_x emissions from the power sector are presented. The Gothenburg Protocol target as applied here is in proportion to the power sector's share in the base year's emissions.

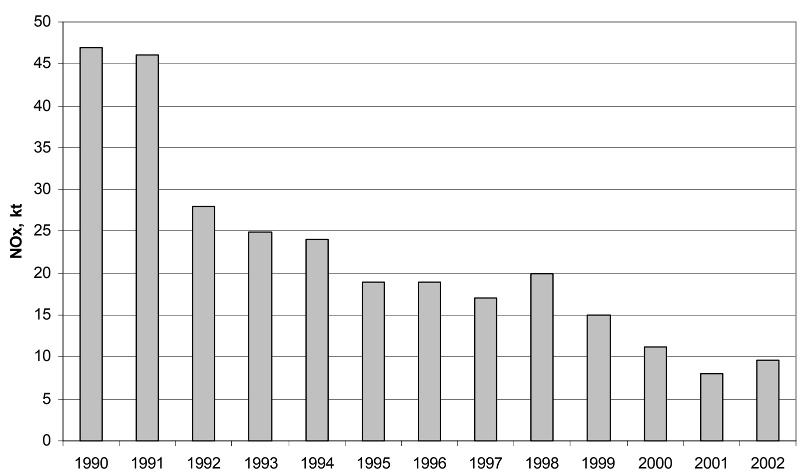

Figure 5.53 Dynamics of NO_x emissions from power sector

Since 1992 emissions of NO_x from the power sector are significantly lower than the Gothenburg protocol targets. Of course after the closure of the Ignalina NPP, NO_x emissions will tend to increase but implementation of more stringent NO_x emission standards for Large Combustion Plants (LCP) since 2008, imposed by the LCP directive mentioned above, will force large power plants to implement low NO_x burners. The smaller power plants will switch to less polluting fuels.

5.6. Assessment of Current Energy Policies in Priority Areas

The main policies currently being implemented in the selected priority areas (energy intensity, security of supply, energy prices and affordability, and emissions into the atmosphere) are addressed below.

5.6.1. Energy intensity

The efficient use of energy resources and energy conservation is being guaranteed in Lithuania by constantly updating the National Energy Efficiency Programme (Lithuanian Ministry of Economy, 2001). The main directions of the energy saving policy are:

- Improvement of legal and normative basis;
- Introduction of modern technologies and energy conservation measures;
- Introduction of a pricing system stimulating energy conservation;
- Creation of favorable conditions for investments in the energy conservation field;
- Introduction of economic measures promoting the domestic production of energy saving devices;
- Energy auditing of manufacturing and buildings;
- Preparation of specific programmes of actions for each branch of the economy with concrete financing schemes.

The programme is the main tool for the integration of environmental policies. Most important are pricing issues for stimulating efficient energy use. The effect of this policy is positive and resulted in a decrease of energy intensities in all branches of the economy over the last decade.

5.6.2. Energy prices

Since 1997 energy prices were increased in Lithuania to cover all necessary production and supply costs. The currently valid electricity, gas and district heating tariff calculation methodologies are based on cost-of-service principles. All the fixed and variable costs incurred from the production (or for gas, from the state border) to the final consumer are calculated. By adding some rate of return (the Government Decree requires that the state capital should earn at least a 7% rate of return) and dividing the total sum by the planned useful output (electricity, gas or heat), an average tariff is ahieved. This tariff is differentiated among different consumer categories, consumption volumes and time, etc.

Since 2000, 27,000 household consumers living in the area around the Ignalina NPP received a preferential electricity tariff (reduced by 50%) and all households received lower VAT rates (reduced by 50%) for district heating. However, there are still some support measures to producers and consumers of fossil fuel, nuclear energy and electricity. All of these support measures can be treated as environmentally harmful energy subsidies.

From a purely economic point of view, the best way of protecting social welfare in the face of energy price increases is to support consumers' incomes through social welfare payments (i.e., the social safety net) rather than through the prices they pay. Income support is preferred for two reasons: a subsidized price will encourage unnecessarily high consumption, and subsidizing energy prices benefits all consumers rather than just those who find it difficult to afford the service.

The only economically worthwhile reason for preferring price support to income support is when the costs of administering income support greatly exceed those of price support. In Lithuania the main support of incomes for the low-income population is income support to cover heating costs. The first system was introduced in Lithuania in 1993. This system limited payments for heat to 20% of a family's monthly income. The system was modified in 1999 with a similar system described below.

The Law on Compensation of Flat (Individual House) Heating, Cold and Hot Water Costs for Households Having Low Incomes was adopted in May 1999. According to the Law, if consumption of heat, and hot and cold water corresponds to the norm, compensation is foreseen for the low-income population:

- For the share of expenses related to flat heating exceeding 25% of their income;
- For the share of expenses related to cold water consumption exceeding 2% of their income;
- For the share of expenses related to hot water consumption exceeding 5% of their income.

These compensations are paid from the municipality budget. According to official statistics, in 2000 these support schemes were applied to 6 − 7% of the population in Lithuania. Since the financial situation is difficult in Lithuania, the state budget is not able to ensure sufficient compensation measures for the low-income population.

The effect of energy price increase and removal of subsidies has a positive impact on efficient use of energy and conservation, but on the other hand it has caused an energy affordability problem because support for low-income population has not been effective.

5.6.3. Security of supply

There are only a few direct support measures or tax incentives to encourage use of renewable energy sources available in Lithuania. These measures apply to biofuels. The reduced VAT of 9% is applied to denaturised dehydrated ethyl alcohol and methyl and ethyl ester produced from rapeseeds up to 31 December 2002. Since 1 January 2003 on, denaturised dehydrated ethyl alcohol and methyl and ethyl ester have been exempted from VAT. People using biofuels who can present the documents proving the use of biofuels are exempted from the tax for pollution from mobile pollution, which is based on the fuel consumption and is levied per tonne of fuel consumed.

The provisions on green electricity from the decision of the National Control Commission for Prices and Energy Concerning Prices for Public Service Obligations in the Electricity Sector (11 February, 2002) sets the average purchase prices for electricity produced from renewable and waste energy sources:

- 5.8 EURct/kWh for hydropower
- 6.4 EURct/kWh for wind power
- 5.8 EURct/kWh for power plants using biomass

The Lithuanian Electricity Act and a couple of Lithuanian regulations establish some prioritisation rights for electricity generated from local, renewable and waste energy resources in a manner that appears to be roughly consistent with the option listed in the existing EC Electricity Directive. At present, national rules imposing purchase obligations favouring electricity producers using renewable energy sources are within an area of Community law where wide discretion is available to the Member States.

There are several types of capital support for renewable energy source utilization available in Lithuania: investment subsidies, soft loans, interest subsidies, loan guarantees. The intermediate financing type between support and credits is risk capital. Available direct support for renewable energy source utilization is state aid investment support for any undertaking authorized to pursue the economic activity and National Energy Efficiency program financing provision for demonstration projects. Soft loans, interest subsidies, loan guarantees and risk capital are available for any RES-related small- and medium-sized business from the special closed stock company based on state capital and Small- and Medium-Sized Business Support Programs governed by Municipalities or County Chief Administrations.

The dominating form of support in Lithuania is indirect support. The reason is that once the renewable energy sources are used for energy production, they cannot be directly supported by the state because it distorts the markets and impinges on free competition. Lithuania is obligated to obey the respective provisions of the EU Treaty and bilateral or international agreements on free trade. Without limitations, direct support may be provided to demonstration and pilot projects in the RES field.

5.6.4. Reduction of atmospheric emissions

Reduction of energy consumption was followed by a reduction of emissions into the atmosphere. This process was accompanied by the introduction of new stricter standards for emissions into the atmosphere caused by fuel combustion.

In 1996 the Government of Lithuania approved new normative values for emissions from steam and water heating boilers, which were reduced on an average by 1.5 times compared with 1993 norms. The pollution norms of the EU-15 were taken as a basis. The new stricter standards were introduced in January 1996 and amended in 1998. The new standards for large combustion power plants are seven times more stringent than the current ones and will be implemented in 2008.

The main environmental regulation tool in the energy sector is pollution charges. The pollution charges should carry out their main functions: incentive, compensation and accumulation. The pollution charge system implemented by the Law on Pollution Charges in 1991 was not able to carry out the main functions it was designed to accomplish.

The new improved system of pollution charges was elaborated from 1993 to 1996, and the new Law on Environmental Pollution was adopted on 13 April 1999. The new system is considerably simplified, and pollution taxes are applied for the significantly reduced number of pollutants (from 151 to 18). The individual tariffs have been established only for principal pollutants (in the case of air pollutants for SO_2, NOx, V_2O_5 and dust), which are easier to control. The tariffs were established in order to achieve determined pollution reduction aims. The remaining pollutants were grouped according to the level of toxicity into classes (in the case of air pollutants, into IV classes) and the same tariff for each class was defined. Another important feature of the tax system reform is that the tariffs are not a linear function of emissions and norms. Only two tariffs apply for each pollutant and pollution source: a basic tariff (for emissions lower than established norms) and a penalty tariff (for emissions exceeding norms). The size of the fine is defined using a constant multiplier for the basic tariff, but these coefficients depend on the toxicity of the pollutant. New pollution tax rates were increased by a factor of four on average.

Excise taxes for fuels also have been increased continuously in Lithuania in order to achieve EU-15 levels. The excise tax for gasoline was increased from 300 EUR/t up to 400 EUR/t in January 2004. The excise taxes for gasoils and lubricants were increased at similar rates.

This environmental policy has a positive impact on the reduction of atmospheric pollutants from the energy sector. Atmospheric pollution from stationary pollution sources in Lithuania has declined more than four-fold compared with 1990 levels even though energy consumption has decreased by only a factor of two.

5.7. Strategies for Improvements in Priority Areas

5.7.1. Impacts and linkages among indicators in the implemented ISED framework

The implemented ISED framework, focused on Lithuanian energy sector development priorities, consists of economic, social and environmental indicators which are linked to each other. Figure 5.54 provides a graphic illustration of the impacts and linkages among indicators selected in this case study. The scheme is based on the general scheme of interlinkages among key indicators from the ISED list.

Relevant policy actions based on the analysis conducted in previous sections were selected for the targeted indicators.

The main policies were developed for the following energy priority areas:

- Structure of economy;
- Energy intensity;
- Security of energy supply;
- Energy prices and hence energy affordability; and
- Environmental situation improvements.

The structure of the economy is tightly related to energy intensity of GDP. Further optimization of economic activity levels in Lithuania through reducing share of energy intensive sectors and industries in GDP value added should be implemented. For a country which does not have plenty of natural resources, the structure of the economy should be as low energy intensive as possible. The commercial sector and low energy intensive industries (food and light industry, electronics, IT) should be developed in the future.

5.7.2. Policies to reduce energy intensity

The main policy measure or response action to reduce energy intensity is to increase end-use energy efficiency. An energy efficiency improvement programme is a good tool for achieving this. This programme has been continuously revised since 1996. Integration of energy efficiency in all sectoral policies is a very important tool. Implementation of legal and regulatory frameworks enabling environment-friendly energy conservation and efficiency is crucial in this sense. First of all, energy efficiency should be increased in the household sector in Lithuania. There are still many areas for improvement, in particular household consumption, which reflects patterns (and wastefulness) induced by a long period of very cheap energy. Heating is a key problem. As household consumption is a large share of total final energy consumption in Lithuania, overall energy efficiency is still quite low and far behind levels in the European Union. The transport sector is also an area for concern; old and inefficient motor vehicles result in an increase in energy consumption and pollution. In addition, despite the positive energy efficiency trends, delayed reforms in the energy sector, which can be noted in Lithuania, may cause higher-than-necessary energy use and related pollution, a slower-than-possible turnover of the energy-relevant capital stock, and higher energy supply costs. Therefore it is necessary to strengthen the legal and regulatory environment, favoring market formation activities and investments. In general in Lithuania the transport sector contributes less and household and industry contribute more to energy consumption compared to EU-15 Member Countries. This will change in relation to the increasing number of private cars and growing freight transport activity between Eastern and Western Europe.

Some energy support measures still exist in Lithuania (e.g. reduced VAT for district heat, exemptions from environmental standards etc.). Removal of these subsidies would provide further incentives to increase energy efficiency and reduce energy consumption. The introduction of a CO_2 tax or an increase in excise taxation (Council directive 2003/96/EC on restructuring the Community framework for the taxation of energy products and electricity) are very important as economic incentives to reduce energy intensity. Therefore to reduce energy intensity, the main policy actions are related to end-use energy efficiency improvements (affected by energy pricing policy as well) and to implement measures foreseen in the National Energy Efficiency Improvement Programme.

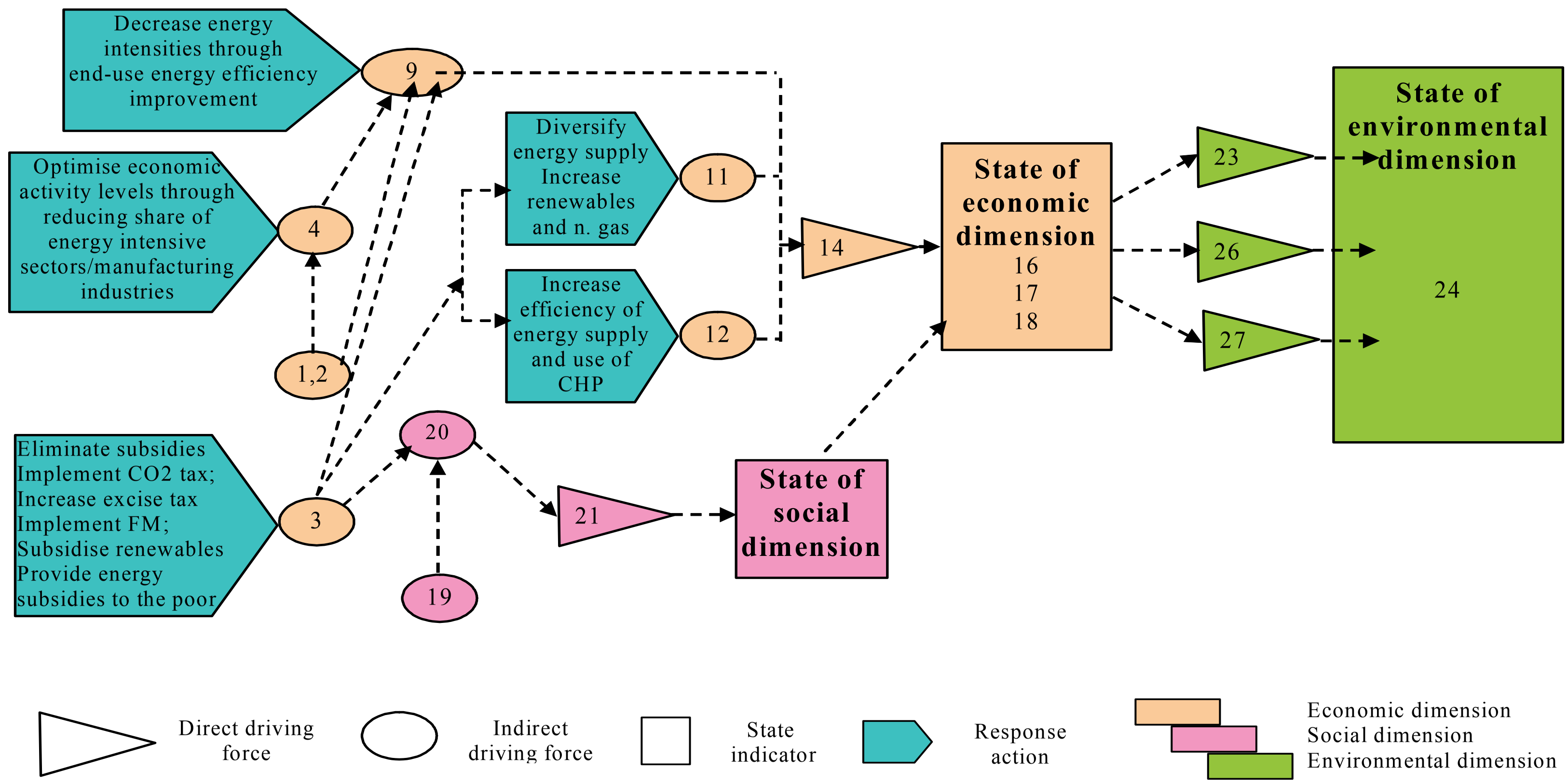

Figure 5.54 Linkages between indicators and relevant policy actions on targeted indicators

5.7.3. Policies to increase security of supply

In the field of security of supply, the main policy actions selected for targeted indicators for Lithuania are:

- Enhance the diversity of fuels in the energy mix;
- Improve maintenance and upkeep of existing energy infrastructure;
- Eliminate constraints hampering modernization and investment in new facilities;
- Increase efficiency of energy supply in electricity generation;
- Increase fraction of electricity produced by CHP;
- Increase share of renewable and energy sources in energy mix.

A very important issue is to ensure that, after the closure of the Ignalina NPP, all of the biggest power producers in Lithuania use the three major types of fuel available - natural gas, heavy fuel oil and Orimulsion – and that flue gas desulphurization equipment is installed in Lithuanian thermal power plants, Vilnius CHP, Kaunas CHP and Mazeikiai CHP. The funding for this equipment should be from the Ignalina NPP decommissioning fund established by the EU and other country donors.

Though net energy import dependency has decreased considerably in Lithuania, after the closure of both units at Ignalina NPP, it is expected to increase to almost 90%. The closure of the Ignalina NPP by 2009 even poses the threat of power shortages in the country as well. For security of supply and integration in the EU electricity market, it is necessary to build a power bridge between Lithuania and Western Europe. The EU Commission has already promised to support a power bridge of 1,000 MW between Lithuania and Poland, which might at least partially guarantee energy independence in the Baltic region. For energy infrastructure upgrading in Lithuania, foreign and local investments are needed. Restructuring and privatization of the energy sector will create a favorable environment for investments in the energy sector. The State policy aiming to eliminate constraints hampering modernization and flow of investments into the energy sector is crucial in this sense.

Efficiency of energy supply needs to be increased in Lithuania. High losses and low efficiency levels are characteristic of the power sector, which result from obsolete electricity grids and other infrastructures. The current privatization of electricity transmission networks will enable the upgrading of grids and equipment. Privatization of electricity and heat generating plants will also serve to increase electricity generation efficiencies. Though reforms in the energy sector were quite slow during the last decade, some positive results were achieved —but further measurements are necessary in order to ensure that the Lithuanian energy sector is modern and competitive in the EU energy market.

Policies to support the use of renewable energy sources should be continued in order to maintain positive trends in the use of renewable energy sources in Lithuania. The most important task is to promote renewable energy sources in the power sector (LEI, 2003). Lithuania has implemented a direct price support scheme for electricity generated from renewable energy sources. The average purchase prices for electricity produced from renewable and waste energy sources are set by the National Control Commission for Prices and Energy. New support schemes can be introduced in Lithuania based on provisions of Council directive 2001/77/EC for the promotion of electricity produced from renewables in the internal electricity market and on the experience of other countries. Flexible market-based support measures are green certificates. Currently Sweden is among the very few countries having already adopted the electricity certificates system. It is hoped that, in a few years, a large market for trade in green certificates will have developed and converged into a well-functioning tool. Lithuania can also adopt a system with the features that have proven to be most efficient. This system will ensure that electricity production from renewable energy sources will not be dependent on financial support from the state, but will be responsive to the deregulated market. The use of renewable energy sources can be supported in Lithuania also by implementing new environmental taxes (for example CO_2 or product taxes on fuels based on the carbon content in the fuel). The green budget reform analysis is necessary to evaluate the impact of a pollution tax increase in Lithuania.

CHPs are the most efficient energy generation sources. Lithuania's energy and sustainable development strategy set as an objective to ensure that the share of CHP will be 35% of total electricity production by 2020. Implementation of this goal would significantly increase the electricity supply efficiency of the Lithuanian power system. Implementation of requirements and measures foreseen in the forthcoming EU directive on CHP support should help to achieve this quite ambitious target because, currently, electricity produced by CHP is only about 18% of total electricity generation in Lithuania.

5.7.4. Policies to get prices right

A number of international initiatives were taken recently to support national efforts for improving the environment by reforming energy pricing. It is widely recognized that prevailing pricing, fiscal and financing mechanisms in Central European countries do not support energy conservation or the wider use of new and renewable energy sources. Promotion of energy efficiency and conservation, increased production and use of cleaner energy sources and internalization of environmental externalities in energy prices are major approaches to breaking this trend. The increase in energy prices, however, should be followed by improving support schemes for low-income populations to ensure energy affordability.

In the field of energy prices and energy affordability, the following policy measures were selected:

- Eliminate energy subsidies which still exist;
- Introduce CO_2 tax and green budget reform;
- Increase excise taxes based on rates established by EU directive 2003/96/EC;
- Implement green certificates to promote use of renewable energy sources;
- Implement flexible mechanisms under the Kyoto Protocol;
- Improve system of energy price support for low-income population.

There are only a few direct energy price subsidies in Lithuania. Since 1997 energy prices have been increased to cover all the necessary production and supply costs. Only 27,000 household consumers living in the area around the Ignalina NPP received the alleviated electricity tariff (reduced by 50%) on the basis of the Law on Nuclear Energy (1996). The reduced VAT of 9% was applied for heating since January 1, 2000. There are some indirect support measures (such as temporary exemptions from environmental standards, custom duties for imported fuels, etc.) which act as subsidies, and these should be removed in the future in order to increase energy efficiency and reduce environmental pollution.

Some analysis of green budget reform costs/benefits was conducted in Lithuania. The Lithuanian Energy Institute applied the International Atomic Energy Agency (IAEA) analytical tool MESSAGE for the energy sector, in order to analyze the effects of the implementation of a CO_2 tax, an increase of excise tax on fuels and an increase of other pollution taxes (LEI, 2003). Results of the study indicated that, when emission taxes for SO_2 and NOx were increased, besides the expected increase in price of electricity and heat, as well as a clear shift to natural gas in the primary energy balance, there was also a major impact on refinery operations that significantly reduced oil refining and the export of oil products. A tax on CO_2 would cause smaller changes in the Lithuanian energy sector in comparison with increased taxation of SO_2 and NOx. However, it would lead to the highest electricity and heat price increases. The introduction of a CO_2 tax (at 13.3 Euro/t) would reduce CO_2 by about 6% compared with the status quo scenario. It has no significant impact on the utilization of renewable energy resources because of their low availability, but it would lead to a further shift from oil to natural gas and the import of electricity, and consequently to a more negative trade balance. From the point of view of security of energy supply in Lithuania, this measure would be considered negative because it favors the dominant position of imported natural gas in the primary energy balance.

Nevertheless, this measure reduces CO_2 and allows a significant supplementary income to the state budget.

The introduction of higher excise taxes reduces CO_2 by about 6% and SO_2 by about 4% and leads to significant additional income to the state budget—but at the same time, it causes some of the highest levels of electricity and heat prices. The results of the analysis indicated that emission taxation schemes, especially increased SO_2 and NOx taxes, seem to be the least economically attractive (or even negative) options of all the promotion schemes analyzed (lei, 2003).

Lithuania has no provision for a system of certificates of origin, as required by Article 5 of the Renewables Directive on Electricity (2001/77/EC). It needs to develop a mechanism based on the experiences of other EU-15 and candidate countries and to tailor it to the Lithuanian situation. Under a green certificates system, RES-E is sold at market prices. In order to finance the additional costs of producing RES electricity, and to ensure that the desired RES electricity be generated, an obligation should be placed on all consumers to purchase a certain amount of Green Certificates from RES-E production according to a fixed percentage, a quota, of their total electricity production. Since consumers wish to buy these certificates as cheaply as possible, a secondary market of certificates develops where RES producers compete with one another for the sale of the Green Certificate.

The Kyoto Protocol allows the use of three Flexible Mechanisms (FM): International emissions trading, Joint Implementation (JI) and Clean Development Mechanisms (CDM). International emissions trading allows Parties to the Protocol who reduce emissions below their assigned amount to sell part of their emissions allowance. Those who cannot meet the targets can buy the extra allowances from the Parties who have spare capacity and are willing to sell. Joint implementation is a specific form of emissions trading at the project level. Annex I Parties to the Convention can undertake projects (e.g. fuel switching for a power station) with other Annex I Parties, which result in additional emissions reductions in the country where the project is located. Those reductions can be used to increase their emissions allowance of the Party financing the project, while the emissions allowance of the Party where the project is carried out would be correspondingly reduced. Lithuania, as a country in transition, lacks financial resources and is able to benefit from International Emissions trading (IET) and Joint Implementation (JI), having lower emission abatement costs and attracting capital and technology transfer sponsored by developed countries in exchange for GHG emission credits. FM will permit more ways to get new, cleaner technologies adopted sooner in Lithuania because encouraging investments in cleaner technologies will enhance the rate of technology development and these developments also permit economies of scale, which will enhance the speed of commercialization.

JI frequently has been regarded as a first step towards IET. JI is based on a baseline and credits system. For IET another type of GHG trading (cap-and-trade system) is characteristic. In both schemes the generic term for the unit of trade is an emissions permit.

A “cap and trade” system starts by defining an aggregate, legally binding emissions limit for a group of polluters, i.e. countries or companies for a given period. This limit is a cap. The emissions authorized by this cap should be allocated to eligible participants in the trading system. The emissions permits should be allocated by the regulatory authority and are termed emissions allowances. In principle all allowances can be traded. The main feature of cap-and-trade schemes which are comprehensive by their nature is that they require an extensive regulatory involvement and efforts at the beginning to set them up. It is often considered that IET is more efficient in the context of CO_2 emissions from the power sector.

Preparation for the implementation of flexible mechanisms under the Kyoto Protocol is necessary for Lithuania. For the application of FM in Lithuania it is necessary to implement careful energy planning, GHG emissions monitoring, inventory, reporting and verification procedures assuring that claimed reductions have indeed been achieved.

In order to ensure energy affordability, social support schemes for the low-income population are necessary. A number of alternative mechanisms to support the low-income population and to ensure the socially desirable level of energy consumption can be evaluated (World Bank, 2000). Based on the analysis of different support schemes using appropriate criteria (coverage, targeting, predictability, welfare costs, and administrative costs), the conclusion can be drawn that the support system currently being applied in Lithuania should be replaced by “earmarked cash transfers”. The introduction of this support scheme will allow increased targeting and coverage of the support scheme. Moreover, other important expenditures such as payments for house rent, electricity, gas etc., are not included in the support scheme. This scheme is popular in transition countries (Poland, Latvia, and Estonia).

The major difference between "earmarked cash transfers" and the burden limit scheme is the focus on residual income instead of on the share of expenditure on the utility. In terms of coverage, the scheme should do better than the burden limits because it should pick up all households falling in the poor category as far as income is concerned, whereas the burden limits scheme will exclude households that spend too low a share of income on the utility. In practice, however, unreliable income data means that coverage is not complete. Furthermore, not all households will apply. Likewise, the scheme is better at targeting the poor. It is not possible to apply unless you are demonstrably in the poor income group. This scheme merits a similar score for predictability as the burden limits schemes. The key issues are uncertainty regarding qualification and how low-income reports will be treated by the assessors. The welfare costs of this scheme are substantial because of the burden it places on the public budget. The scheme also suffers from the same problem as the actual payment version of the burden limits scheme – i.e. there is an open-ended subsidy to the utility. Such a subsidy can, however, be capped, by declaring a utility expenditure norm as in the burden limits case. In this analysis we assumed that this is the case, and thus compared the other earmarked transfer scheme with the burden limits scheme with expenditure norms. However, because coverage is expected to be better with the earmarked transfers, the revenue needs and, therefore, the welfare costs are expected to be higher. The scheme has similar administrative costs as the burden limits scheme.

5.7.5. Environmental policies

Though currently, with the Ignalina NPP operating, GHG and other emissions do not seem a serious problem for Lithuania, after the closure of the nuclear power plant these emissions will increase significantly. New policy options to deal with increased atmospheric pollution will be necessary.

5.7.5.1. GHG mitigation policies

In general terms, there are two basic ways of accomplishing the GHG mitigation: by increasing efficiency; or by switching to a fuel with lower carbon content. GHG mitigation options in the electricity and heat sector can be supply- or demand-side oriented. Supply-side oriented GHG mitigation options in the power sector include: improvement of combustion efficiency, re-powering, fuel switching, reduction of transmission and distribution losses, dispatch modifications; and others. The second GHG mitigation option is power system expansion with new generating technologies. There are many options for new generating technologies: advanced fossil fuel systems (combined cycle), non-fossil fuel systems (hydro, renewables, nuclear).

GHG mitigation options on the demand side are typically related to the introduction of CO_2 tax rates. Integrating environmentally related economic instruments into economic decision-making is a new concept in Lithuania, though pollution charges have been applied for years. During the initial stage of the new tax system preparation (implemented in 1999), the tax rate for CO_2 (as principal pollutant) emissions equal to 5 USD/t was introduced using the experience of foreign countries, but later during the consideration stage of the law this tax was eliminated from the environmental tax system. Taking into account the poor economic situation of the country, implementation of a high CO_2 tax is unrealistic for Lithuania. As business standards are raised, there are new opportunities for new instruments, like product charges and tradable permits in Lithuania.

Seeking to implement Kyoto requirements, some GHG mitigation options were prepared for the Lithuanian power sector in 2001 (LEI, 2001b) using the ENPEP model developed by the International Atomic Energy Agency, which is able to simulate energy markets and determine energy supply and demand balance over a long-term period:

- Switching from heavy fuel oil (HFO) to less polluting fuels by modernizing the largest thermal power plant and introducing additional gas turbines;

- Introduction of new generating technologies: combined cycle gas turbine (CCGT) and CHP;
- Small scale nuclear power plant.

For an analysis of the GHG mitigation options within the electricity and heat production sector, three GHG mitigation scenarios were designed. These were based on the power sector expansion plan (LEI, 2001b) obtained by running the IAEA's WASP-IV model during the preparation of the National Energy Strategy in 1999. The main assumptions for the scenarios were:

Scenario 1. It was assumed that the remaining lifetime of five not-earlier-refurbished units at the Lithuanian TPP would be approximately 5-8 years. It was assumed that after five years, the 300 MW units could be re-powered by installing additional gas-turbines. The total installed capacity of one unit would then be 400 MW. These re-powered units will be fired with natural gas (gas turbine) and gas or heavy fuel oil (i.e., steam boiler).

Vilnius CHP and Kaunas CHP can be operated until 2008 without additional investments, and after 2008 only flue gas desulfurization would be necessary. After 2005 the gasification of Mazeikiai CHP will be performed and it will operate on HFO and natural gas.

Of new generating capacities, 10 units (each 60 MW capacity) of new CCGT would enter into operation in 2005. After that, one unit each year (i.e., five units, each 50 MW) of new gas turbines (GT) would enter into operation by 2010. Modular CHP of 100 MW capacity will enter into operation in 2003.

Scenario 2. The main assumptions for this scenario are the same as for scenario 1, but it also includes additional new generating capacities: two units (each 350 MW capacity) of new CCGT.

Scenario 3. The main assumptions for this scenario are the same as for scenario 2, with additional new generating capacities: new small-scale modular nuclear power plant of 95 MW capacities.

In all these scenarios the structure of electricity generation will change significantly after the closure of the Ignalina NPP. In the case of scenario 1, the share of electricity generated by the Ignalina NPP will be replaced by electricity produced at modernized Lithuanian TPP. The share of electricity produced at Lithuanian TPP will make up to 50% in 2020 and the share of CCGT about 23%. In the case of scenario 2, the share of electricity generated at Lithuanian TPP will be about 30% in 2020, because its capacities will be replaced by CCGT of 350 MW. This new power plant would produce 27% of total electricity generated in 2020. In the case of scenario 3, the share of the closed Ignalina NPP will be replaced by electricity generated at new CCGTs at 50% and new small-scale modular nuclear power plant at about 10%. Modernization of Lithuanian TPP is not included in this scenario. In the cases of scenario 2 and scenario 3, gas turbines are used only for peak demand. In all these scenarios electricity generation at existing CHP would stay the same.

The fuel consumption structure will change significantly too, according to expected results in different scenarios. In 1999 the share of nuclear fuel in electricity generation was 67.5%, the share of natural gas was 16.8% and the share of HFO was 15%. In 2020, according to scenario 1, the share of natural gas will amount to 72%, and the share of HFO to 25%. In the case of scenario 2 the share of natural gas will be 77%. And in the case of scenario 3, natural gas would be 70%, HFO 17% and nuclear fuel about 10% of all fuel consumed for electricity generation.

The analysis of the GHG mitigation options in the electricity and heat production sector according to baseline and three mitigation scenarios on the supply side is presented in Figure 5.55. The sharp increase of CO_2 emissions is obvious in 2005 and 2010 because of the subsequent closure of two units at the Ignalina NPP.

According to scenario 1, in 2016 CO_2 emissions in the electricity and heat production sector will reach 16.1 Mt and the Kyoto target will not be met without additional GHG mitigation measures. In the case of scenario 2, CO_2 emissions at the end of the study period will reach 15.7 Mt. According to scenario 3, which includes additional new generating capacities (CCGT and new small scale modular nuclear power plant), CO_2 emissions will be 14.7 Mt in 2020. As one can see from Figure 5.55, only in the case of GHG mitigation scenario 2 and scenario 3 will Lithuania be able to fulfill the Kyoto commitments because CO_2 emissions values according to these two scenarios will be below the Kyoto target.

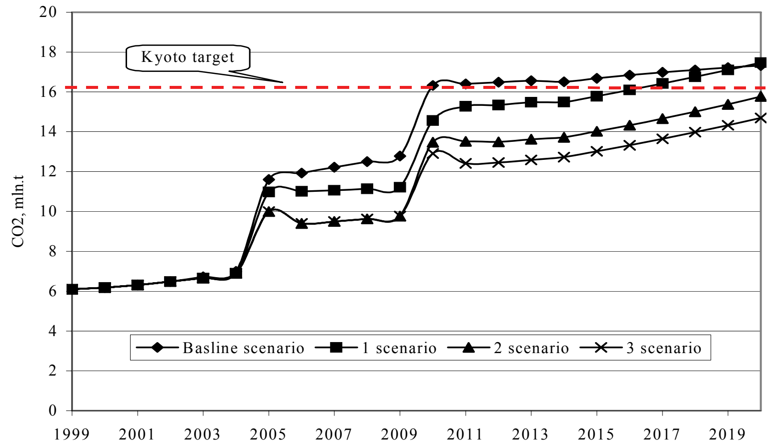

Figure 5.55 Forecast of CO_2 emissions in electricity and heat production sector according to three mitigation scenarios (scenarios 1, 2, 3)

Preparation for the implementation of flexible mechanisms under the Kyoto Protocol (as mentioned before) is necessary for Lithuania. International GHG emission reduction measures (i.e., the flexible mechanisms) and local GHG mitigation measures (i.e., green budget reform, which encompasses the introduction of a CO_2 tax) were presented in the previous section because these policies have an impact on energy prices, and affect GHG emission reductions through energy price increases (Lithuanian Ministry of Environment, 1996b).

5.7.5.2. Atmospheric pollution reduction

The closure of the Ignalina NPP could cause a significant increase of SO_2 and NOx emissions because its capacities will be replaced by capacities primarily burning fossil fuel. The increase of these pollutant emissions, however, is prevented by the implementation of stricter environmental standards. The implementation of these standards will be enforced by two EU directives.

The first directive - Directive 1999/32/EC relating to a reduction in the sulfur content of certain liquid fuels (Sulfur directive) - is to ensure that, as from 1 January 2004, the HFO used within territories of EU Member States does not exceed the sulfur content of 1.00 % by mass. This requirement shall not apply to HFO used in (large and small) combustion plants where the emissions of sulfur dioxide from the plant are less than or equal to 1,700 mg/Nm3, and for combustion in refineries, where the monthly average of emissions of SO_2 averaged over all plants in the refinery shall not exceed 1,700 mg/Nm3. According to the requirements of EU Directive 88/609/EEC, it is possible to burn HFO with a sulfur content exceeding 1% if it is co-combusted with either natural gas or with biomass. Thus, HFO having a sulfur content of 2.2% can be used by LCP's if it is co-combusted with at least 55% natural gas or 55% biomass (in terms of energy input). In this case, the concentration of SO_2 in the flue gas will be kept below 1,700 mg/Nm^3. Similarly, Orimulsion should be used with at least 75% natural gas.

In addition, after 2008 the new norms for SO_2 emissions will be established for large combustion plants (LCP) based on the second directive - Directive 2001/80/EC on the limitation of emissions of certain pollutants into the air from large combustion plants (LCP Directive). Therefore SO_2 emissions will not increase significantly in Lithuania because, in order to comply with the requirements of Sulfur and LCP directives, such emission abatement measures as flue gas desulphurization equipment will be installed in the biggest Lithuanian power plants. According to the requirements of Directive 2001/80/EC, after 1 January 2008 seven times more stringent standards for SO_2 emissions should be applied for combusting HFO in the biggest Lithuanian power plants. During negotiations with the EU, Lithuania succeeded in receiving a transitional period for Vilnius, Kaunas and Mazeikiai CHP until 2015 for the implementation of these requirements in order to have more time to prepare for such new requirements. The smaller large combustion sources will switch to gas or wood in order to meet the sulfur and LCP directive requirements.

The analysis of increased emissions tax rates on SO_2 (from current rates of 85 EUR/t to 90 EUR/t) and NOx (from current rates of 140 EUR/t to 170 EUR/t) showed that, besides the increased price of electricity and heat and a clear shift to natural gas in the primary energy balance, such a reform will reduce oil refining activities and the export of oil products from Lithuania (LEI, 2003). Therefore the increase of these taxes is the least economically attractive option, as noted earlier.

5.8. Conclusions

In this case study the following priority areas were selected, based upon National Energy Strategy targets:

- Energy consumption;
- Energy intensities;
- Structure of economy;
- Energy prices;
- Energy security;
- Environmental energy situation.

Energy consumption. Final energy consumption per capita in Lithuania is less than half of that in the EU-15, and was continuously decreasing through 2000. Only since 2001 has this trend reversed. This is associated with the high rates of GDP growth since then (6.5% in 2001; 6.7% in 2002; and 6.8% in 2003). At the same time final energy consumption per capita has been slowly increasing in the EU-15. Thus, it will take some time before these indicators will converge. Low final energy and electricity consumption per capita rates reflect the low income and low living standards in Lithuania, and raise questions about energy affordability. Noting the quite low final energy consumption per capita in Lithuania, but comparable levels of TPES per capita in Lithuania and the EU-15, one can conclude that there is rather low energy conversion efficiency within the Lithuanian energy system.

Energy intensities. In the EU-15, positive trends decoupling final energy and electricity consumption per capita from final energy and electricity intensity can be observed. In Lithuania, final energy and electricity intensity of GDP is decreasing more slowly than final energy and electricity consumption per capita. Primary energy intensity of GDP is especially high (more than twice as high as the EU-15 average). In order to define the impact of changes in the structure of the economy on the decline in energy intensity, a less aggregated analysis of energy intensity was performed.

The structure of economy has dramatically changed in Lithuania since 1990. The share of value added from manufacturing decreased, while that from the commercial sector (which is the least energy intensive) increased. In general, energy intensity has decreased in all branches of the economy since 1990. All of these trends have an impact on the decline in final energy intensity of GDP in Lithuania. These trends should be maintained in the future by implementing energy efficiency policies in all sectors.

Energy prices. Household energy prices are very high in Lithuania when compared with income. Energy affordability can be considered a major social problem in Lithuania. The worst situation with energy affordability in Lithuania is in the heating sector, because district heat prices in Lithuania are very high (only about 14% lower than in EU-15 countries) compared with low disposable income of population (about 30 times lower than in EU-15). The amount of heat that could be consumed monthly at current consumer prices and income indicates that in Lithuania the heat which could be consumed by the average population is roughly one-ninth that in the EU-15. The amount of electricity and natural gas consumed monthly at current electricity and natural gas prices in Lithuania was only a third of the EU-15 average, and electricity prices were 2.3 times and natural gas prices 3 times higher in the EU-15. In order to ensure energy affordability, social support schemes to low-income population are necessary.

Security of supply. The net energy import dependency in Lithuania was 44% in 2002, and in 2010 when the Ignalina NPP will be closed, it will increase dramatically up to 90%. As the Lithuanian energy sector highly depends on energy imports, it is necessary to increase indigenous energy production and the utilization of renewable energy sources and increase the energy supply efficiency. Development and upgrading of energy infrastructure is also crucial. Opening the electricity market and successful competition in EU electricity and gas markets would help to increase the security of energy supplies. Though renewables will never be able to replace nuclear capacities, enhancement of the utilization of this energy source in Lithuania is among the priorities of energy policy. In 2002 indigenous or renewable energy sources in total primary energy mix amounted to 9.2%. The target for 2010 is to reach 12%. The share of indigenous electricity to total electricity production is very small in Lithuania, about 3%. Lithuania agreed with the EU to implement a 7% target by 2010. In order to achieve this target, additional policies promoting use of renewables in Lithuania are necessary.

Environmental energy situation. EU-15 CO_2 emissions per kWh are twice as high as those in Lithuania, and electricity consumption per capita is also more than twice as high. A trend of declining CO_2 emissions along with increasing electricity consumption per capita can be observed in the EU-15. In Lithuania, other trends can be noticed: the decline in electricity consumption per capita also resulted in a decline in CO_2 emissions per kWh, but since 2001 this trend has changed. The Kyoto target of 230 g/kWh should not be surpassed with the expected increase in electricity consumption per capita level. Only in the case of implementation of appropriate GHG mitigation measures will Lithuania be able to fulfill the Kyoto commitments after the closure of the Ignalina NPP. SO_2 and NO_x emissions will also tend to increase, but implementation of stringent NO_x and SO_2 emission standards for large combustion plants after 2008, imposed by the EU directives, should mitigate these trends. The smaller power plants have also switched to less polluting fuels because of the sulfur directive requirement since 2004.

In general, positive trends in relation to sustainable development can be noticed in the Lithuanian energy sector; although, compared with the EU-15, some issues require additional attention. These include energy intensity, renewable energy sources and energy affordability. New policies to address these problems should be implemented, such as: new support schemes for the low income population to increase energy affordability, new measures to enhance utilization of renewable energy sources, reduction of energy transformation losses in the system, and local and international climate change mitigation measures.

Though energy statistics capabilities are adequate to conduct energy policy analysis, some information on environmental issues related to the energy sector is lacking. This information (wastewater discharges, land area taken by energy facilities, intensity of use of forest resources, etc.) needs to be addressed in energy statistics.

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ANNEX 5.1

Number	Indicators	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002
#2	GDP/capita adjusted at PPP in USD'95	9,635.4		7,032.5	5,906.6	5,346.4	5,532.9	5,802.9	6,233.8	6,557.8	6,306.7	6,556.7	6,985.1	
#3	Current end-use energy prices, in USD'95													
	Electricity	0.0001	0.0002	0.001	0.014	0.02	0.04	0.05	0.05	0.0412	0.0412	0.052	0.035	0.053
	Heat	0.018	0.09	0.36	2.7	14.4	33.3	64.8	80.1	94.5	97.2	103.5	138	142.8
	Natural gas	0.003	0.007	0.099	2.2	3.6	4.8	5.7	5.8	5.6	5.6	8.8	11.1	11.1
#4	Shares of sectors GDP adjusted at PPP in USD'95 value added, %													
	Manufacturing	40	47	39	38	34	33	33	33	34	32	31	31	31
	Agriculture	15	16	13	14	11	12	13	13	12	11	11	7	7
	Commercial	37	30	39	38	46	46	45	45	45	47	47	50	49
	Transportation	8	8	9	10	10	9	10	10	9	10	11	12	13
#9	Final energy intensity of economic branches (GDP adjusted at PPP in USD'95), toe/thou USD													
	Manufacturing	0.284	0.198	0.274	0.153	0.169	0.159	0.142	0.132	0.121	0.113	0.109	0.104	0.117
	Agriculture	0.167	0.157	0.134	0.113	0.113	0.079	0.075	0.058	0.054	0.044	0.039	0.038	0.042
	Commercial	0.164	0.140	0.106	0.091	0.084	0.073	0.067	0.057	0.049	0.049	0.042	0.042	0.042
	Transportation	0.600	0.594	0.485	0.537	0.584	0.606	0.544	0.552	0.579	0.487	0.394	0.430	0.444
#11	Energy mix													
	TPES, %													
	Coal	5.9	4.9	4.4	5.2	4.5	3.2	2.5	2.1	1.7	1.8	1.4	1.1	1.8
	Oil	44.1	43.0	38.9	44.5	44.4	38.3	34.1	36.9	40.2	37.2	31.2	31.3	28.5
	Natural gas	28.3	29.3	24.8	15.9	21.5	23.1	23.3	22.7	19.0	23.2	29.0	26.6	25.2
	Nuclear	26.8	27.8	34.2	34.0	25.0	35.1	39.1	35.6	38.2	32.7	30.8	32.6	35.9
	Hydro	0.2	0.2	0.2	0.4	0.5	0.4	0.3	0.3	0.4	0.5	0.5	0.3	0.4
	CRW	1.0	1.0	1.5	2.5	2.9	2.6	5.5	5.9	6.2	7.5	8.7	8.1	8.2
	Electricity, %													
	Nuclear	60.0	57.9	78.9	88.0	79.0	87.4	85.8	83.6	79.0	75.4	75.7	77.1	79.8
	Fossil fuels	38.6	41.0	19.4	9.2	16.4	9.8	12.1	14.4	18.6	21.5	21.2	18.2	15.8
	Hydro	1.5	1.2	1.7	2.8	4.6	2.8	2.0	2.0	2.4	3.2	3.0	4.7	4.4
	Electricity net import													

Number	Indicators	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002
#12	Energy supply efficiency, %	56	55	59	55.9	59.0	52.4	48.1	50.3	47.4	51.7	52.9	50.8	47.6
#14	Energy intensity of GDP (adjusted at PPP in USD'95	0.30	0.26	0.28	0.23	0.24	0.22	0.21	0.19	0.18	0.17	0.16	0.14	0.13
	TPES/GDP, toe/thou USD	0.46	0.51	0.42	0.43	0.40	0.43	0.43	0.38	0.38	0.34	0.31	0.27	0.27
	FEC/GDP, toe/thou USD													
#16	Energy consumption per capita	2.91	2.35	1.94	1.38	1.29	1.22	1.22	1.22	1.20	1.10	1.03	1.08	1.12
	FEC/capita, toe/capita	4.46	4.60	2.98	2.51	2.16	2.36	2.50	2.38	2.50	2.12	2.02	2.31	2.48
	TPES/capita, toe/capita													
#18	Net energy import dependence	71.65	72.74	64.7 1	59.31	68.91	58.60	54.52	56.99	55.01	58.15	58.33	52.0	
# 19	Income inequality, %							0.184	0.188	0.194	0.197	0.197	0.190	0.186
#20	1. Ratio of monthly disposable income per capita (in USD'95) of 20% poorest households to the prices of major energy sources													
	Electricity, kWh/month/capita							13.91	15.53	15.54	15.41	12.78	13.86	
	Natural gas, GJ/month/capita							0.054	0.059	0.056	0.056	0.037	0/040	
	District heat, GJ/month/capita							0.012	0.011	0.01	0.01	0.009	0/01	
	2. Ratio of monthly disposable income per capita (in USD'95) of average households to the prices of major energy sources													
	Electricity, kWh/month/capita							40.78	44.83	45.70	47.60	37.89	38.99	
	Natural gas, GJ/month/capita							0.158	0.169	0.166	0.173	0.109	0.112	
	District heat, GJ/month/capita							0.036	0.032	0.03	0.031	0.026	0.027	

Number	Indicators	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002
#21	1. Fraction of disposable income per capita (in USD'95) spent on fuel by average population, %							8.16	8.35	8.37	8.74	9.19	9.42	
	2. Fraction of disposable income per capita (in USD'95) spent on fuel by 20% of poorest population, %							7.45	7.51	7.22	7.06	7.85	8.47	
#23	Quantities of SO2 and NOx emissions from power sector, kt	105	112	65	60	55	58	58	51	69	45	19.4	26.5	26.2
#26	Quantities of CO_2 emissions from power sector, Mt	47	46	28	25	24	19	19	17	20	15	11.2	8.0	9.6