MINISTRY OF ECONOMY

STRATEGY
FOR ENERGY DEVELOPMENT
IN THE REPUBLIC OF MACEDONIA
UNTIL 2030

SKOPJE, 2010

CONTENT

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STRATEGY

FOR ENERGY DEVELOPMENT IN THE REPUBLIC OF MACEDONIA UNTIL 2030

EXECUTIVE SUMMARY

INTRODUCTION

The Republic of Macedonia as a candidate country for ***membership in the European Union*** is erected before the challenges of the efficient implementation of serious reforms in the societal system, of which the energy sector is of special significance for Macedonia's overall development.

The Republic of Macedonia signed and ratified the Agreement of the ***Energy Charter, the Energy Community Agreement, the United Nations Framework Convention on Climate Change and the Kyoto Protocol***.

According to the Energy Community Agreement Macedonia harmonizes its national legislation with the existing legislation of the European Union (acquis communautaire) on energy, environment, competition, renewable energy sources, energy efficiency and oil reserves. The strategic commitments of Macedonia in the energy sector, including the commitment to harmonize with the acquis communautaire, have been incorporated in the ***Law on Energy***. For the purposes of implementing the provisions from the Law on Energy, appropriate secondary legislation have been adopted. Numerous laws and bylaws have been adopted in the area of environment protection and other relevant areas. The legislation in the energy sector will be finalized and in some segments it will be improved.

Within the framework of the Government of the Republic of Macedonia, the ministry responsible for the energy sector is ***the Ministry of Economy***. One of the sectors in the ministry is the ***Energy Sector.*** Part of the responsibilities related to energy belong to the Ministry of Environment and Physical Planning as well as to the Ministry of Transport and Communications.

For the purposes of providing support to the Government in the implementation of the energy policy, and ***Energy Agency*** has been formed.

The activities related to regulating specific issues related to the performance of energy activities specified in the Law on Energy are performed by the ***Energy Regulatory Commission (ERC)*** of the Republic of Macedonia.

The council of the ***municipality,*** i.e. the Council of the ***city of Skopje,*** upon a proposal from the mayor, and after acquiring an opinion from the Minsitry of Economy, enacts a energy development program for the municipality or the city of Skopje. They are responsible for the energy activities of public interest and of local significance.

In order to provide for efficient implementation of the new legal framework of the energy sector, which imposes numerous obligations on the ***Energy Sector of the Ministry of Economy, the Energy Regulatory Commission, the Energy Agency and the units of the local self government,*** it is necessary to ***strengthen*** their ***capacities.*** The strengthening of the Energy Sector would largely strengthen the negotiating capacities of the Republic of Macedonia in the area of energy, during the EU accession negotiations.

It is also necessary to strengthen the capacities of the institutions and the companies that perform ***scientific and research activities, applicative and educational activities*** in the field of energy.

In Macedonia there are a number of professional associations and nongovernmental organizations that are active in the energy area.

OBJECTIVES OF THE STRATEGY

The strategy for energy development of the Republic of Macedonia defines the most favorable long term development of the energy sector in the Republic with a view of providing a reliable and good quality energy supply to the consumers.

The following priorities have been taken into account for the realization of the above mentioned core objective:

- Maintenance, ***revitalization and modernization*** of the existing and ***construction of new***, modern ***infrastructures*** for the purposes of energy production and utilization,
- ***Improvement of the energy efficiency*** in the production, transmission, and utilization of energy,
- ***Utilization of domestic resources*** (reserves of lignite, hydropower potential, wind and solar energy) for electricity production,
- Increase of natural gas ***utilization***,
- Increase of the ***utilization of renewable energy sources***,
- Establishment of ***economic energy prices***,
- ***Integrating*** the energy sector of the Republic of Macedonia ***in the regional and European market*** of electricity and natural gas by constructing new connections and by harmonizing the legislation with the existing acquis communitaire for energy, environment, competition and renewable energy sources.

The Strategy addresses the energy, economic, organizational, institutional, legislative and educational dimensions of the energy sector development in the areas of energy production, transmission and utilization.

The Strategy is enacted by the Government of the Republic of Macedonia and its serves as a basis for the preparation of an Action Plan aimed and facilitating the energy sector development in the Republic of Macedonia as a basis for the overall sustainable development of the country and its more efficient inclusion in the European and Atlantic integration processes.

The energy sector faces major changes on the global level. Therefore the strategy is a changing document. When preparing each subsequent Action Plan, the Strategy needs to be innovated appropriately to the new conditions in the energy sector in Macedonia as well as in the wider energy surrounding.

GENERAL PRINCIPLES FOR THE FUNCTIONING OF THE ENERGY SECTOR

Provision of ***energy security*** requires greater diversification of the energy resources by type, sources and suppliers, active role of the regional energy market and the European energy community. This requires maximizing the possible use of the domestic resources and a strategically viable long term connection policy to the main energy ducts in the region and abroad.

Intensified efforts for ***improvement of the energy efficiency*** in production, transmission and consumption of energy, particularly electricity are required.

The maximization of the utilization of the renewable energy sources belongs among the priority activities in the energy field.

All preconditions for ***greater utilization of natural gas*** should be provided for.

The gradual ***shift of the energy sector in Macedonia to market conditions*** of operation is already a reality. The Republic of Macedonia accepted a model of combined ownership in the energy sector. When deciding about the profiling of the future ownership structure in the energy sector of the Republic of Macedonia, one must especially bear in mind the advantages and disadvantages of the state versus private ownership.

The transition to ***market prices for electricity*** will improve the investment climate, will strengthen the interest to introduce renewable energy sources and improve the energy efficiency.

Considering that certain natural monopolies, such as the transmission and distribution of electricity and natural gas and the distribution of heat, will still continue to exist, the ***measures for elimination of the misuse of the monopoly position*** of any entity should be strengthened.

With establishment of a ***competitive national energy market***, and with active participation in the ***regional energy market***, with a good and fair regulation, including concession, efficient protection of ownership rights, as well as improvements of the other segments of the investment climate and considering the obvious energy deficiency of the region, the inflow of foreign capital in the energy sector of the country could be significant. This will lead to a stable and sustainable development of the Macedonian economy.

The Government should develop a special program for ***support of the social category of consumers***.

Environmental protection in the energy sector means acting primarily through energy efficiency, renewable energy sources, selection of fuels and modern technologies which are environmentally friendly, good quality legislation and monitoring, education and public awareness, as well as promotion of positive examples.

EXISTING ENERGY INFRASTRUCTURE

The energy infrastructure of the Republic of Macedonia enables the exploitation of the domestic primary energy, import and export of primary energy, processing of the primary energy and production of final energy, transport and distribution of the energy. The energy infrastructure of the Republic of Macedonia comprises the electricity sector, the coal, oil and petroleum products sectors, the sector for natural gas and the sector for heat production.

Electricity sector

The structure of the electric power system (EPS) of Macedonia comprises:

- ***Hydro power plants*****,** with total installed power of 580 MW;
- ***Thermal power plants*** fueled by lignite with total installed power of 800 MW and fueled by heavy fuel oil fired with installed power of 210 MW;
- Electricity ***transmission system***, power lines with voltage level of 400 kV (594 km), 220 kV (103 km) and 110 kV (1480 km). Macedonia is connected to the transmission lines of Greece, Bulgaria and Kosovo through 400 kV power lines; and

- Electricity ***distribution system***. The distribution network of the Republic of Macedonia comprises 150 km of distribution network at a voltage level of 110 kV, 1000 km at 35 kV, 720 km at 20 kV, 8900 km at 10 kV and 11600 km at 0.4 kV.

The EPS of Macedonia is operated by four entities, namely: **AD ELEM** – Skopje (Electric Power Plants of Macedonia), state owned, shareholding company for production and supply of electricity, **AD MEPSO – Skopje,** (Macedonian Electricity Transmission System Operator), state owned, operator of the electricity transmission system of Macedonia – shareholding company for transmission of electricity and management with the electric and power system of Macedonia, the distribution company **EVN Macedonia AD** and AD "TPP Negotino", state owned shareholding company for production of electricity.

Coal sector

According to their purpose, the existing sites can be subdivided into two groups: mines for production of lignite for purposes of state owned thermal power plants within AD ELEM of Macedonia (surface mines Suvodol and Oslomej) and mines for production of lignite for wide consumption (surface mines BRIK Berovo and Drimkol - lignites) exploited by concessionaires, which are privately owned shareholding companies.

In order to provide for continuity in the operation of the TPP Bitola and TPP Oslomej in the upcoming period, it is necessary, in the shortest possible time to provide for exploitation from the lignite mines in their immediate vicinity (Brod – Gneotino, Suvodol – underlying seams and Popovjani) in accordance with a precisely determined time schedule.

Oil and petroleum products sector

The capacities of the **OKTA** refinery and the oil pipeline OKTA – Thessaloniki port fully satisfy the demand for **petroleum products** in Macedonia, however the refinery needs to be modernized, primarily for the purposes of providing a more efficient environmental protection and improving the efficiency.

Macedonia has available a **refinery for production of bio-diesel fuel** with a capacity of 30 thousand tons per year, owned by the company Makpetrol. The production of bio-diesel fuel uses unrefined beet oil. At this stage the unrefined oil is imported.

The reservoir capacities in the Republic of Macedonia are sufficient to cover 90 days of current average consumption of any type of oil product.

In comparison to the countries from our surrounding, Macedonia has available only a small number of **petrol stations** which are unevenly distributed throughout its territory. The petrol stations are owned by many different companies, including Makpetrol, OKTA and Lukoil Macedonia. In addition to selling fuel on their petrol stations, the companies also participate in the wholesale trading of petroleum products.

Natural gas sector

Macedonia is connected only with one main gas pipeline. The entire quantity of **natural gas** is imported from Russia through the gas pipeline that enters Macedonia at Deve Bair, on the border with Bulgaria and stretches through Kriva Palanka, Kratovo and Kumanovo to Skopje. The main gas pipeline has a capacity of 800 million Nm^3 per year with a possibility to have it increased to 1.200 million Nm^3 per year. At this stage of development of the gasification in the Republic of Macedonia, there practically is no

distribution network. Some direct consumers are in fact connected directly to the transmission network.

Heat sector

Presently the production of **heat** in Macedonia is mostly realized in boilers using liquid petroleum products, natural gas or coal. Most of them are obsolete with low efficiency coefficients.

The total heating consumption connected to the central heating systems in the Republic of Macedonia and delivered to the end users is about 630 MW. The biggest central heating system is the system operated by **Toplifikacija** AD Skopje, which connects about 550 MW. Several smaller systems, two of which are out of Skopje, connect about 80 MW. Considering this level of connectivity we can say that about 10% of the users in the country are connected to central heating systems.

The boilers in many heat generating plants can use natural gas or heavy fuel oil.

The total constructed length of the central heating distribution network (length of the channel distribution including the supply and return pipelines), owned by the Republic of Macedonia is about 185 km (as of 01.01.2008).

Presently there is no clear delineation between heat production, distribution and supply.

Renewable energy sources

Regarding renewable energy sources Macedonia uses primarily hydro power (for production of electricity), bio-mass (mostly wood mass for production of heat in the residential sector), geothermal energy (mostly for heating greenhouses) and some solar energy (for hot water in the residential sector).

The general characteristics of the energy infrastructure in Macedonia are:

- obsolete technologies and lack of investments for maintenance, modernization and expansion of the existing capacities, as well as construction of new capacities;
- high electricity losses (both technical and commercial);
- low energy efficiency;
- unfavorable structure of the energy types (production, import and consumption) from an environmental and economic aspect and from the security of supply aspect;
- Existence of monopolized structures in specific segments of the sector;
- Incomplete delineation of the production, transmission and distribution.

ENERGY CONSUMPTION IN THE PERIOD 1996-2007

Macedonia is strongly energy import dependant. It imports its entire demand for oil and petroleum products and natural gas, and, starting from 2000, electricity. The energy imports have grown during the past period, and during the latest few years the imports of electricity have grown rapidly.

The Republic of Macedonia has exceptionally low energy consumption per capita and exceptionally high energy consumption per unit of GDP in all sectors.

The most used energy resources in the total consumption of primary energy (Figure 1) are coal and crude oil with petroleum products, followed by the biomass, imported electricity, hydro power, natural gas and geothermal energy.

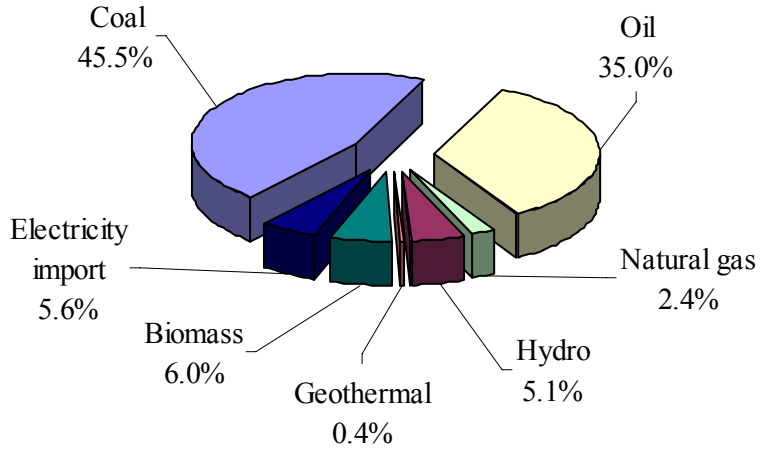

Figure 1. Primary energy consumption in 2006[1]

The energy consumption in Macedonia is concentrated in four sectors: industry, residential sector, transport and commercial and service sector (Figure 2).

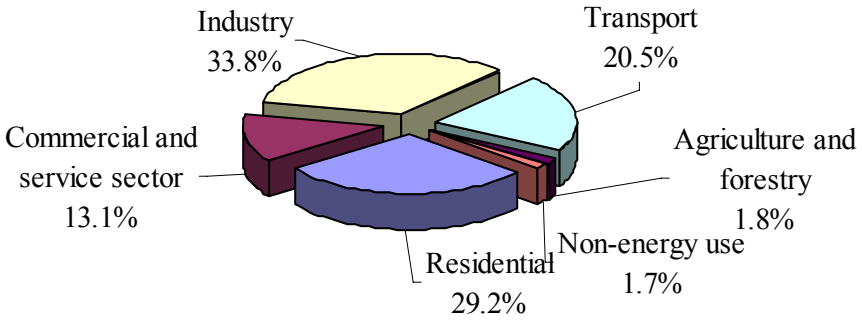

Figure 2. Final energy consumption by sector in 2006[2]

The final energy consumption comprises mostly petroleum products and electricity. (Figure 3).

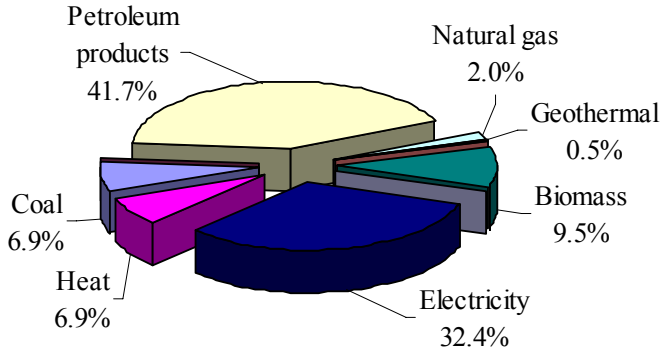

Figure 3. Share of the different fuels in the final energy consumption for 2006[3]

[1] © OECD/IEA, [2008], IEA Online Database: Energy Balances of Non-OECD and OECD Countries and Energy Statistics of Non-OECD and OECD Countries
[2] © OECD/IEA, [2008], IEA Online Database: Energy Balances of Non-OECD and OECD Countries and Energy Statistics of Non-OECD and OECD Countries

In comparison to the developed European countries, the percentage share of natural gas in the final energy consumption in Macedonia is very low while the percentage share of electricity consumption is very high. This particularly applies to the household sector. The consumption of electricity in 2007 comprises the residential sector with 36%, large consumers with 26%, commercial and service sector with 10%, small industry with 9%, and the losses were about 19%.

Having this in mind, it is necessary to reduce the energy import dependency by improving the energy efficiency in the production, transmission, distribution and utilization of energy and by higher energy production from renewable energy sources and other domestic resources. It is necessary to increase the share of natural gas in the energy consumption and reduce the relative share of electricity.

FINAL ENERGY NEEDS IN THE PERIOD 2008-2020

The Strategy analyses two scenarios.

According to the baseline scenario, the total final energy consumption will grow until 2020 with an average annual rate of 2.64% (Table 1 and Figure 4).

According to the scenario involving strengthened energy efficiency measures the final energy demand will grow with an average growth rate of 2.2% (Table 1). This scenario envisages greater usage of natural gas in the residential sector in comparison to the baseline scenario. In the industry, both scenarios envisage maximal possible use of natural gas

Table 1. Projected change in energy consumption and energy indicators

	PEC		FEC		GDP	PEC/GDP		Popu-lation	PEC/inhabit.	
	BS	EEf	BS	EEf		BS	EEf		BS	EEf
	ktoe		ktoe		10^6 $	toe/1000$		10^6	toe/inhabitant	
2006	2810		1818		3952	0.71		2.036	1.38	
2020	4211	3930	2618	2466	8546	0.49	0.46	2.025	2.08	1.94
P1 (%)	2.9	2.4	2.6	2.2	5.7	-2.6	-3.1	0.0	3.0	2.5
P2 (%)	50	40	44	36	116	-31	-35	-1	51	41

PEC – Primary energy consumption; FEC – Final energy consumption; (In PEC and FEC the unidentified consumption of biomass and electricity is included); GDP – Gross domestic product; BS – Baseline scenario; EEf – Scenario with improved energy efficiency; P1 – Average annual growth rate; P2 – Total growth; $ - USA$2000

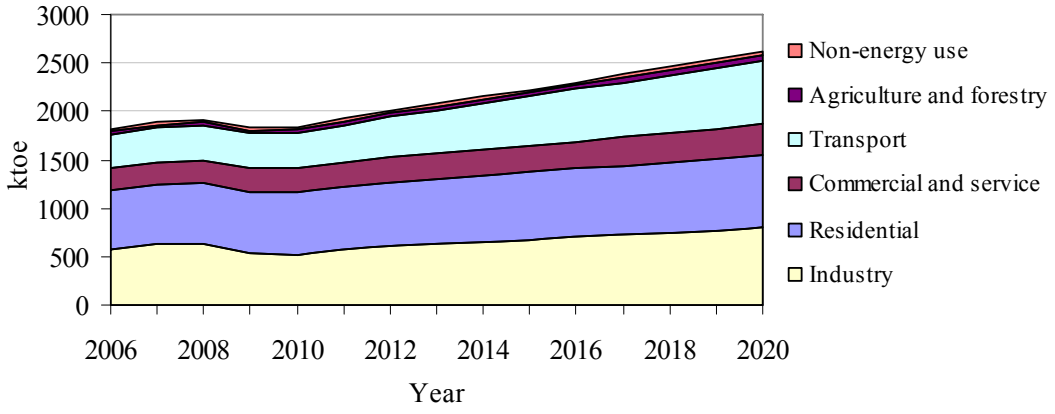

Figure 4. Total final energy demand according to baseline scenario

[3] © OECD/IEA, [2008], IEA Online Database: Energy Balances of Non-OECD and OECD Countries and Energy Statistics of Non-OECD and OECD Countries

The percentage distribution of the final energy demand by fuel types in 2020 will be similar to that in 2006 in spite of the planned penetration of natural gas, solar energy and geothermal energy.

Considering the present very low electricity consumption per capita and the very low energy consumption in transport, the electricity consumption growth with an average annual growth rate of 2.5% and 2% (Table 2) and the growth of the petroleum products consumption together with bio-fuels, with a growth rate of 3.1% and 2.2%, are realistically planned for the baseline scenario and for the scenario with strengthened energy efficiency measures, respectively.

Table 2. Projected consumption of electricity (FCElc)

	FCElc		**GDP**	**FCElc/GDP**		**Popu-lation**	**FCElc/inhab.**	
	BS	**EEf**		**BS**	**EEf**		**BS**	**EEf**
	GWh		**$10^6$$**	**kWh/$**		**10^6**	**kWh/inhabitant**	
2006	7118		3952	1.80		2.036	3496	
2020	10045	9389	8546	1.18	1.10	2.025	4961	4637
P1(%)	2.5	2.0	5.7	-3.0	-3.5	0.0	2.5	2.0
P2(%)	41	32	116	-35	-39	-1	42	33

$ - USA$2000

The heat consumption is not expected to grow significantly. In Skopje, almost 90% of the consumption that is economically justified for central heating has been covered and in the other towns, central heating systems will be built only in areas where this is economically justified, i.e. in areas with high specific heat consumption (more than 25 MW/km^2). According to the baseline scenario, the heat consumption in the period 2006-2020 will increase by 18%, from 1,376 GWh in 2006 to 1,628 GWh in 2020.

The primary energy consumption in 2020 will be 4211 ktoe or 3930 ktoe according to the baseline scenario and the scenario with strengthened energy efficiency measures respectively. The relevant ***specific energy consumption per unit GDP*** in 2020 will be 0.49 and 0.46 toe/1000US$2000 according to the baseline scenario and the scenario with strengthened energy efficiency measures, which is ***an improvement of the energy efficiency in 2006, expressed through this parameter by 31% or 35% respectively*** (Table 1)**.**

Until 2020 it is planned to ***improve energy diversity in the primary energy supply.*** The coal together with oil and oil products will reduce the percentage share from 81% in 2006 to 70.8% in 2020 while the participation of natural gas will increase from 2.4% in 2006 to 16% in 2020 and the participation of the renewable energy sources in the total primary energy during this period will increase from 11.5% to 13.3%.

POSSIBILITIES FOR MEETING THE ENERGY NEEDS IN THE PERIOD 2008-2020

Electricity production. In the Strategy by 2020 four scenarios were analyzed. In the baseline scenario an average annual growth rate of 2.5% is foreseen for the electricity consumption. The others scenarios are analyzed with an average growth rate of 2%, of 2.5% and slower construction of generation capcities and growth rate of 3%.

In the baseline scenario it is foreseen to revitalize and use the existing coal thermal power plants for production of electricity and construction of one new power plant with

power of 300 MW. It is also planned to reconstruct the Negotino thermal power plant which will enable greater flexibility in order to increase its involvement in the electric and power system of Macedonia and to contribute not only to the increased production of electricity but also to the increased reliability of the system by integrating it in the variable regime of work. It is foreseen to finish the revitalization and use the existing hydro power plants and construct new ones (Sv.Petka, Boshkov Most, Galishte, Chebren, Gradec, Lukovo Pole), with total installed power of 690 MW. By the year of 2020 it is foreseen to use the natural gas in three combined heat and power facilities for production of electricity and heat with a total installed power for production of electricity of 564 MW.

Table 3. Time schedule for the construction of the new electricity production capacities (Baseline scenario)

2010	**CHP Skopje, CHP KOGEL. HPP Sv. Petka**
2014	**CHP Energetika**
2015	**HPP Boskov most**
2016	**HPP Galiste, Lukovo pole**
2017	**HPP Gradec**
2019	**TPP Bitola 4, HPP Chebren**

The other three scenarios have the same generation capacities as the baseline scenario, but with different time scedule of commissioning. In the scenario with slower investment, the construction of the HPP Chebren is moved after 2020 and closing of REK Oslomej is foreseen at end of 2016.

The implementation of the foreseen dynamics for construction of new production capacities will improve the diversity and thereby the reliability of the electricity supply. In the recent period, at average hydrology, 80% of the electricity was produced in the coal thermal power plants and 20% from renewable energy sources (hydro power plants). In 2020 the plan is to produce electricity from coal thermal power plants in the amount of 42% – 51% (depending on the scenario), from natural gas and from renewable energy sources – each with 24% - 28% and from heavy oil-powered thermal power plant 2% - 3%.

In accordance with the calculations so far, the conclusion is that the price of electricity that will be produced in the planned coal thermal power plants and natural gas power plants, as well as in the hydro power plants that are planned, will be competitive on the regional electricity market.

The development of the electricity and power system will largely depend also from the obligations Macedonia shall undertake regarding the greenhouse gas emissions.

Transmission of electricity. The Strategy plans 400 kV connections with Serbia and Albania, and additional one with Kosovo. In order to improve the transmission infrastructure in the western part of Macedonia it is recommended to build a 400 kV power grid due to the large concentration of installed power of hydro power plants in that part of the country. It is foreseen to revitalize the existing and build new 110 kV power lines and transformers, as well as construction of transmission grid for the demand of the hydro power plants that are planned.

Distribution of electricity. The distribution is facing heavy losses and insufficient quality of delivered electricity in specific areas, including unsatisfactory reliability in the supply. Therefore additional investments are needed in order to improve this situation. It

is also necessary to emphasize the need to bring to minimum the unregistered and unpaid consumption of electricity.

Heat. Since the CHP Skopje and CHP KOGEL will be put into operation in 2010, and the CHP Energetika of ELEM in 2014 which, together with the spare (existing) boilers of Toplifikacija AD Skopjeshall meet the distribution consumption of heat in Skopje, as well as the capacities of the existing boilers in Macedonia, no problems are expected in the provision of the relevant increase in the heating consumption. It is planned to also build small combined facilities for production of electricity and heat using natural gas and biomass in the cities where there is economic interest. A significant growth of the distributive consumption is not expected in the analyzed period. For heating of the homes it is necessary to provide faster and more significant penetration of the natural gas in all cities in Macedonia.

Coal. The existing quantities of lignite for the current thermal power plants will be provided through surface exploitation of the existing (Suvodol and Oslomej) and new mines (Brod-Gneotino, Suvodol MCS and Popovjani). The adherence to the foreseen dynamics for opening and exploitation of new mines is pre-requisite for smooth operation of the existing thermal power plants. For the demand of the foreseen thermal power plant Bitola 4 it is necessary to open the Zhivojno mine which, according to the current analysis, will be exploited as a pit. The price of the coal obtained from the Zhivojno mine is estimated to be 15 Euros per ton and it is quite lower than the coal price of same quality that would be imported. Besides, this is local energy fuel and this helps reduce the import dependency and increases the employment and the growth of the local economy. The transport of larger quantities of coal from import is a complex problem both from technical and environmental aspect. Since Macedonia has no experience with lignite mines with pit exploitation, and the international experiences are not that big either, it is necessary to start the preparation activities in that direction.

Natural gas. The natural gas would be secured from further development of the transmission grid and with construction of distribution grids. By connecting Macedonia to the planned regional ring or some of the other analyzed gas pipelines, that will enable supply from various different sources we would ensure greater reliability of natural gas supply.

Petroleum products. The required quantity of petroleum products by 2020 is in the frames of the capacity of the OKTA refinery and of the existing oil pipeline. How much oil or petroleum products will be imported will depend on the competitive ability of OKTA.

Renewable energy sources (RES)

Table 4 presents the share of RES and the final energy consumption (FEC) for the lowest limits (LL), the upper limits (UL) and the planned values (PV). The planned values can be achieved with all possible combinations of RES and the final energy consumption within the presented limits. The percentage share of RES in total final energy consumption in Macedonia, according to the real average values will grow from 13.8% in 2005 to 21% in 2020. This percentage corresponds to the obligations of the EU member states. In accordance with the adopted procedure for calculation of the target percentage of RES share in total final energy consumption in 2020 for EU countries, the target percentage for Macedonia will be 21%

Table 4. Share of the renewable energy sources in the final energy consumption (GWh)

	GWh			
	2005	**2020 LL**	**2020 UL**	**2020 PV**
Electricity from RES	**1144**	**2539**	**3482**	**2889**
Hydro power plants	1144	2300	3000	2650
Large hydro power plants	1090	2000	2600	2350
Small hydro power plants	54	300	400	300
Wind power plants	0	180	360	180
Photovoltaics	0	14	42	14
Biomass	0	25	50	25
Biogas	0	20	30	20
Heat from RES	**1872**	**3100**	**3350**	**3210**
Biomass	1756	2640	2740	2700
Solar energy	0	60	90	80
Geothermal energy	116	400	520	430
Biofuels	**0**	**560**	**655**	**600**
TOTAL RES	**3016**	**6199**	**7487**	**6699**
Final energy consumption	**21783**	**32873**	**30825**	**31850**
RES share (%)	**13.8**	**18.9**	**24.3**	**21.0**

Considering an electricity generation growth with an average annual rate of 3%, 2% and 2.5% and electricity generation from RES according to the LL (2539 GWh, Table 5) UL (3482 GWh) PV (2924 GWh) the percentage share of RES in the electricity generation in 2020 would be 20.1%, 31.5% and 24.7% respectively.

|Table 5. Share of the RES in the electricity generation

Electricity from RES	2020 LL	2020 UL	2020 PV
GWh	**2539**	**3482**	**2924**
Total electricity generation with growth rate	3%	2%	2,5%
GWh	**12616**	**11060**	**11842**
RES share (%)	**20.1**	**31.5**	**24.7**

ENVIRONMENTAL IMPACT

The energy sector in Macedonia greatly contributes to the environmental pollution because around 90% of the primary energy is produced from fossil fuels, mainly lignite and heavy crude oil. Therefore, this sector participates with over 70% in the total emission of greenhouse gasses and the participation is the same in the local pollution. The projections for greenhouses gasses emissions, according to the scenario for development of the electrical and power system, based only on coal, show an average annual growth rate of 3.6% in the period 2008-2020. If we analyze the environmentally improved scenarios (introduction of gas power plants for combined heat and power production, the reduction of electricity consumption for the large consumers and the

increased use of renewable sources), the average annual growth rate in the period 2008-2020 will be reduced to 1.4%.

Regarding the obligations from the environmental aspect, very important for the energy sector are the requirements in the Law on Environment concerning the environmental impact assessment (EIA), system for integrated license for integrated prevention and pollution control (IPPC), environmental plans for management and environmental audits, including eco-labeling. Also, when constructing new energy capacities the obligations from the international conventions, signed by the Republic of Macedonia, primarily the Convention on Environmental Impact Assessment in a Transboundary Context and the Convention on Biological Diversity should be taken into account.

Presently Macedonia has no quantified obligations to reduce the emissions of the greenhouse gasses. However, in the future, it would have to be involved in the common European efforts and goals regarding the climate changes. The specific obligation that can be expected would be in a form of limiting the increasing emissions of the greenhouse gasses. Therefore, when planning the future projects in the energy sector, the following needs to be taken into account: (1) Increased operational costs for the coal thermal power plants due to the obligation to purchases licenses for emission of the greenhouse gasses and (2) Increased investment costs when constructing new and revitalizing coal thermal power plants due to the requirement to use BAT ("clean coal" technologies), i.e. in general, for compliance to the European standards for large plants.

In the meantime, Macedonia must be properly prepared from institutional, legislative and technical aspects. In this sense it is especially important to undertake pilot preparation projects for realization of the emissions trading scheme (ETS) in Macedonian circumstances, by introducing national registers and national plan for allocation of emission licenses between the polluters. Furthermore, it is necessary to work on strengthening of the negotiating capacities of Macedonia in the process of determination of the quantified obligations.

ENERGY PRICING POLICIES

The policies for determination of the prices of the fuels have crucial role in the improvement of the investment climate in the sector and ensuring its uninterrupted functioning and maintenance, as well as long term and sustainable development.

The process of deregulation and liberalization of the market of electricity, natural gas and heat is directly conditioned with the clear distinction of the production, supply, transmission and distribution and the possibilities for supply from different directions and different sources. In such circumstances only the transmission and distribution will remain as entities that have the elements of natural monopoly, and the need for regulation of the price. The regulation of the other parts will be focused in the area of standards - quality, reliability, etc.

The process of deregulation and liberalization of the electricity market is conditioned also with the implementation of the Agreement for Establishment of the Energy Community according to which, starting from 2008, all consumers, except the residential sector should be classified in the category of eligible consumers that independently select their supplier and by 2015 market price for electricity and for the natural gas will be introduced for the residential sector as well.

The processes of deregulation and liberalization of the electricity market on regional level imposed the need for coordinated auctions for transboundary capacities.

By doing so, the transparency of the operations will increase, as well as the competitiveness and reliability in the transmission and supply of electricity.

Since more and more electricity users will be able to freely select their supplier with electricity, and since Macedonia imports large quantities of electricity, Macedonia needs transparent procurement of this fuel. For this purpose it is necessary to establish an electricity stock market as soon as possible.

In the last couple of years, the electricity price slightly increased, but overall it is lagging behind the price of electricity in the EU countries. In 2007 the average price of electricity for the residential sector in the Republic of Macedonia is three times lower than the one for the residential sector sector in the European Union. The price of electricity for the residential sector in the Republic of Macedonia is also lagging behind the prices in the region.

The social aspects, related to the electricity price and the price of other fuels, are under the competence of the Ministry of Labor and Social Policy which needs to resolve these issues in cooperation with the Ministry of Economy. In that sense, The Government of the Republic of Macedonia, in September 2009, adopted ***Social Action Plans***, in which the activities in this sphere have been described in detail**.**

OWNERSHIP STRUCTURE OF THE ENERGY SECTOR

The Republic of Macedonia, who organizationally restructured the electricity sector it privatized the distribution, it privatized the sectors for oil and heat, the production of coal for wide consumption.

Further privatization is not, and it must not be, a purpose for itself. The privatization makes sense only if the energy facilities are unable to work with profitability and efficiently, if they cannot secure sufficient funds for maintenance, modernization and expansion of the facilities.

The above standpoints do not imply that the Republic of Macedonia needs to refrain from attracting foreign capital in the energy sector. On the contrary – the increase of the competitive pressure in the energy sector and increase of its economic efficiency necessarily presuppose an increased activity for attraction of foreign capital in the sector. On one side, this is an imperative for a small country with limited resources - due to the fact that the investments, modernization and development of the energy system require large capital investments. On the other side, the reliance on the foreign capital brings many advantages for the economy. In the meantime, the entry of the private capital (both local and international) in raising new production capacities need to be supported and stimulated also with the measures of the economic policy (especially when it is about the use of renewable energy sources). In this way, in Macedonia, in time, the involvement of the private sector on the energy market of the country will increase.

Macedonia will objectively be forced to use all possible sources of financing in the energy sector: ownership financing, indebtedness, state grants, concessions, public-private partnership and other innovative approaches. The selection of the specific form of financing will depend on the characteristics of the actual project

VISION FOR THE DEVELOPMENT OF THE ENERGY SECTOR BY 2030

Energy needs in the period 2020-2030

According to the baseline scenario, the total consumption of the final energy in the period 2020 - 2030 will increase at an average annual rate of 2.5% while the consumption of electricity will increase at an average annual rate of 2.1%. The largest growth rate can be seen in the natural gas of 9.8%.

In the period 2020 - 2030 there will not be any significant change in the relative participation of the sectors in the energy consumption.

According to the scenario with strengthened energy efficiency measures, the final energy demand will increase at an average annual rate of 2.3%.

The projected consumption of electricity in the baseline scenario is around 12400 GWh (1064 ktoe) in 2030, which is 2300 GWh (198 ktoe) more than the consumption in 2020. In the scenario with strengthened energy efficiency measures, the foreseen consumption of electricity in 2030 is 11% smaller when compared to the baseline scenario.

The ratio of consumption of the final energy to the consumption of the primary energy, according to the baseline scenario (62% in 2020) will gradually increase with the inclusion of the new thermal and hydro power plants with high efficiency rate – it will reach 64% in 2030.

Possibilities for meeting the energy needs in the period 2020-2030

In order to secure the necessary electricity in the analyzed period, three scenarios were analyzed which are based on two possible options for construction of new production plants. The first option foresees two new lignite thermal power plants (Mariovo and Negotino) with power of 300 MW each, while the second option foresees construction of nuclear power plant with power of 1000 MW. In all scenarios it is planned to build a hydro power plant (Veles) with installed power of 89 MW.

Table 6. Time schedule for the construction of new production capacities in Macedonia for all three scenarios

	SCENARIO 1	SCENARIO 2	SCENARIO 3
Consumption growth rate	2.5%	3.0%	3.0%
2021	**HPP Veles**	**HPP Veles, TPP Mariovo**	**HPP Veles**
2022	**TPP Mariovo**		
2024	**TPP Negotino**	**TPP Negotino**	
2026			**NPP_1000**

The thermal power plants will be supplied with lignite from the planned mines with pit exploitation near Mariovo and Negotino whose production price is significantly lower than the imported price of lignite with the same quality.

The price of the electricity produced is around 5.3 c€/kWh for the nuclear power plant and 4 c€/kWh for the thermal power plants. However, we need to take into account that in the option which includes lignite thermal power plants, significant import of electricity will be required, and their price is not expected to be below 8 c€/kWh.

The nuclear option will have even greater advantage in relation to the coal thermal power plants, if the price that will be paid for the emission of greenhouse gasses reaches high values and if the technologies for production of electricity by using coal without emission of greenhouse gases are not commercially available at competitive prices by that period.

The nuclear option will provide greater diversity as well as reliability in the supply of electricity. Around 40% of the electricity could be produced from a nuclear power plant, 23% from the renewable energy sources, 22% from the combined power plants running on natural gas and 15% from the lignite thermal power plants.

The exsisting lignite thermal power plants (Bitola 1, 2, 3 and Oslomej), as well as the heavy crude oil thermal power plant TPP Negotino are about to enter their final period of their life cycle of around 40 years. In this period the expectations are that these

plants will drop out from production, except Bitola 3 which was the one that entered the last in the EPS of Macedonia (1988) and which is expected to work until 2030.

According to the baseline scenario, ***the consumption of heat*** in the period 2020-2030 will increase in total by 1.4% to 3%. Since, by that period the obsolete coal boilers will be replaced with new combined plants running of biomass and natural gas, and in the considered period, the natural gas will be introduced and replace some of the petroleum products, the total coefficient of energy efficiency will increase, so the primary energy consumption for production of heat will remain on almost the same level.

The necessary quantity of ***petroleum products*** is in the frames of the capacity of the OKTA refinery and the existing oil pipeline.

It is estimated that 20% from the total consumption of petrol and diesel fuels will be replaced with biofuels.

The demand for ***natural gas*** will increase up to 1350 million Nm^3 (1083 ktoe) in 2030. This consumption does not take into account the two planned combined heat and power plants using gas – heating plants of Toplifikacija AD, Skopje Sever AD, with total consumption of the natural gas of 390 million Nm^3 (313 ktoe) per year as well as a number of small plants. Since up to that period the regional connection will be implemented with a new gas pipeline, we cannot exclude the construction of the said plants that are planned, which will increase the consumption of natural gas by 2030 to around 1800 million Nm^3 (1445 ktoe) per year.

The consumption of **biomass for combustion,** including the waste biomass for combined heat and power generation in planned amount of 26 ktoe – 40 ktoe, will be 252 ktoe – 258 ktoe (2930 GWh -3000 GWh) in 2030.

The total consumption of the **geothermal energy** is expected to be 53 - 63 ktoe (620 - 730 GWh, 2232 – 2628 TJ) in 2030.

The renewable energy sources for production of electricity are planned at the level of 4600 GWh (396 ktoe) by 2030, of which, more than 90% will come from the hydro potential. The share of RES in the electricity generation in 2030 will be 30.3%.

In addition to the large hydropower plants it is planned to construct ***small hydropower plants*** by 2030 with total capacity of 160 – 240 MW and annual generation of 420 – 620 GWh (36 – 53 ktoe).

The solar energy will be used as heating energy in the total amount from 7.1 ktoe to 13.3 ktoe (80 - 155 GWh) in 2030 for the baseline scenario and for the scenario for increased use of solar energy respectively. When the part of the solar energy for production of electricity of 2.4 – 4.8 ktoe (28 – 56 GWh) is added the total efficiency of utilization of the solar energy in 2030 will be approximately 9.5 -18.1 ktoe (110 - 210 GWh).

It is envisaged that the ***wind energy*** for production of electricity in 2030 will reach nearly 31 – 62 ktoe (360 – 720 GWh).

The Strategy envisages electricity generation from ***biogas*** in amount of 2.6 – 3.9 ktoe (30 – 45 GWh) in 2030.

NECESSARY FINANCING

The reconstruction and construction of new facilities will require funds in the amount of about 4 – 5 billion EUR, depending on the scenario that will be implemented. Therefore, for the purposes of realizing the activities envisaged with the Strategy, it is necessary to increase the participation of the private sector and to attract foreign capital to the energy market of the country, which, on one hand is a necessity for a small

country with limited financial resources, and on the other hand will enable an increase of the investment activity of the country and intensification of the overall economic development.

INTRODUCTION

The Republic of Macedonia as a candidate country for full ***membership in the European Union*** is erected before the challenges of the efficient implementation of serious reforms in the societal system. The aspirations for membership in the European Union necessarily mean awareness of the need to fulfill the standards in multiple areas, of which the energy sector is of special significance for Macedonia's overall social development. The principles of cooperation with the European Union in the energy sector are[4]:

- Formulation and planning of the energy policy, including the modernization of the infrastructure, improvement and diversification in the supply and better access to the energy market, including facilitation of the transit,
- Stimulation of energy saving, improvement of energy efficiency, increased utilization of renewable sources and examination of the influence of energy production and consumption on the environment,
- Formulation of framework conditions for restructuring of the energy facilities and cooperation between the enterprises in this sector,
- Management in the energy sector, training of staff and transfer of technologies and knowledge.

The decision of the Council of the EU from 30th of January 2006 on the principles, priorities and conditions contained in the European Partnership with the Republic of Macedonia, contains the following priorities for the energy sector:

- Harmonization of the legislation of the internal markets of electricity and natural gas, energy efficiency and renewable energy sources with the *acquis* in order to achieve gradual opening of the market to competition;
- Strengthening of the independent of the Energy Regulatory Commission;
- Implementing the Energy Community Agreement;
- Strengthening of the administrative capacity of all energy sectors.[5]

The Republic of Macedonia is a signatory of the ***Energy Charter Agreement*** [6]. Established in the early transitional years, this agreement, among other things, aimed at intensifying the energy sector cooperation between the Western Europe and the eastern former socialist countries. Together with the signing of the Energy Charter Agreement Macedonia also signed a ***Protocol for Energy Efficiency and Relevant Environmental Protection Aspects***.

The energy charter highlights the following core objectives:

- Protection and stimulation of foreign investments in the energy sector – pointing out that the energy sector investments will have positive

[4] Stabilization and Association Agreement between the Republic of Macedonia and the EU, article 99 (http://www.mfa.gov.mk//Upload/ContentManagement/Files/MNR-SSA.pdf)

[5] Decision of the Council of EU from 30th of January 2006 (http://www.sep.gov.mk/content/Dokumenti/MK/Odluka_na_sovetot_za_principite__prioritetite_i_uslovite_sodrzani_vo_Evropskoto_partnerstvo_so_Republika_Makedonija_so_koja_prestanuva_da_vazi_Odlukata_2004-518-EZ(2).PDF)

[6] This agreement was ratified by 51 countries and the European Community. The Republic of Macedonia ratified this agreement with a law in 1998

implications on the employment and intensification of the growth of each country separately as well as the growth of the region as a whole;

- Free trade of energy and energy related materials and goods, based on the rules of the World Trade Organization;
- Free energy transit with oil pipelines, petroleum products and gas pipelines and with the electricity network;
- Ensuring healthy competition in the unique regulated market and using the advantages from economies of scale;
- Reduction of the adverse environmental impacts of energy with the intention of applying the European Environmental Standards – for the existing (old) energy facilities, the standards may be less strict than the European standards, but for the new energy facilities there shall be no exception;
- Increasing energy efficiency;
- Creation of mechanisms to resolve disputes between countries or between countries and investors.

The Protocol for Energy Efficiency and Relevant Environmental Protection Aspects determine the obligations of the signatories to form clear political targets to increase energy efficiency and reduce the adverse influence of the energy processes on the environment. According to the Protocol, two types of energy efficiency reports are prepared for each signatory country, regular and in-depth. The Republic of Macedonia has prepared two regular reports, and the Secretariat of the Energy Charter prepared an in-depth report on the energy efficiency policies and programs in Macedonia.[7]

The Republic of Macedonia signed the ***Agreement for Energy Community***[8]. According to the Agreement for Energy Community the signatories should harmonize their national legislations with the existing legislation in the European Union (acquis communautaire) related to energy, environment, competition, renewable energy sources, energy efficiency and oil reserves (Appendix 2).

The objective of the Energy Community is to establish cooperation among the members and to create a stable regulatory and market framework, conducive to investment in the transit and transmission infrastructure for gas and electricity and in electricity production capacities, so that all party states can have access to stable and uninterrupted gas and electricity supply. The provision of a unique regulatory framework in southeastern Europe creates possibilities for interconnection with the Caspian, North African and Middle Eastern natural gas reserves and for the exploitation of the domestic reserves of natural gas, coal and hydropower potential. Another objective of the Energy Community is the development of competition and liquidity on these markets and utilize economies of scale. The Energy Community Agreements devotes a special section to Environmental protection and promotion with reference to gas and electricity, through improvement of the energy efficiency and the renewable energy sources.

The Republic of Macedonia ratified the ***United Nations Framework Convention on Climate Change*** in 1997, and ratified the ***Kyoto Protocol*** in 2004. The Republic of Macedonia belongs among the countries that are not included in Annex I, i.e. countries that do not have quantified obligations, envisaged with the above mentioned

[7] In-depth Review of Energy Efficiency Policies and Programmes, 2007, www.encharter.org

[8] In addition to Macedonia, the other countries that signed the Agreement for the Establishment of the Energy Community are Albania, Bulgaria, Bosnia and Herzegovina, Croatia, Montenegro, Romania, Serbia, Kosovo and the European Community. Macedonia ratified this agreement with a law in 2006.

international documents. As such, the Republic of Macedonia can use the Clean Development Mechanism (CDM) to attract foreign investments in projects for reduction of greenhouse gasses emissions.

On the 26th and 27th of January 2009, the founding conference of the International Renewable Energy Agency – IRENA was held in Bonn, Federal Republic of Germany. The Republic of Macedonia signed the Statute of IRENA thus becoming one of the founding countries of this international organization. Thus far, the Statute has been signed by 75 countries. The plan is to fully operationalize the agency by 2010. The Republic of Macedonia should take an active role in the preparatory activities for the establishment of IRENA and to get involved in the regular activities after the agency starts to work. The agency is forms with a view of becoming a leading power in the promotion of a rapid shift to widespread and sustainable utilization of renewable energy sources. To that end, IRENA will connect experiences and knowledge and will facilitate the transfer of latest technologies among its members. IRENA will facilitate the access to all relevant information related to the use of renewable energy sources.

The Strategy envisages the fulfillment of all obligations undertaken with the signing of international contracts, agreements and protocols.

Status and strategic commitments

Macedonia is strongly dependent on energy imports. It does not have any sources of crude oil or of natural gas, and in recent years it faces an ever increasing electricity imports. The increase of fuel imports and the increase of fuel prices on the global market greatly contribute to the growth of the trade deficit of the Republic of Macedonia. In the long run, unless the situation improves, energy fuel imports can also have adverse impacts on the inflation, foreign currency reserves and the macroeconomic stability of the country in general.

Since Macedonia became independent, particularly in the period from 1991 to 2008, several energy strategies have been prepared, using foreign financial sources. However, these strategies have not been adopted not realized by the Government of the Republic of Macedonia. The absence of vision and the lack of a long term strategy for the development and operation of the energy sector have led to a strong stagnation in its development and promotion.

All of the above reasons have led to the need to enact an energy development strategy of the Republic of Macedonia. The energy development strategy in the Republic of Macedonia for the period 2008-2020 with a vision to 2030 has been prepared upon request of the Ministry of Economy of the Republic of Macedonia and, according to article 10 of the Law on Energy, of the Republic of Macedonia should be adopted Government of the Republic of Macedonia. The strategy will be used as a basis for preparation of action plans.

Overall, the strategy provides detailed diagnostics of key problems burdening the energy sector in the Republic of Macedonia:

- highlighted energy deficiency;
- long term depressed energy prices, especially electricity prices, and lack of stimuli to save;
- obsolete technologies and lack of investments for maintenance, modernization and expansion of the existing capacities, as well as construction of new capacities;

- unfavorable industrial infrastructure which determines high energy intensity;
- high electricity losses (both technical and commercial);
- low energy efficiency;
- lack of complex programs for saving of energy, especially in the household sector, but also in the other sectors comprising significant consumers;
- unfavorable structure of the energy types (production, import and consumption) from an environmental and economic aspect;
- incomplete harmonization of the legislation with the European standards with respect to price policies, environment etc.

These conditions in the area of the energy sector in the country already deliver major negative economic implications, and in the long run they could be transformed in a serious limiting factor of the economic development. Alternative approaches have been proposed to overcome all of the previously mentioned problems by focusing of their strengths and weaknesses. This will provide the Government with an opportunity to make smart choices and take informed decisions based on scientific and competent analyses.

The Energy Strategy has been conceptualized as a national strategy that takes into account the interests of the Republic of Macedonia and its citizens. Partial, short term and private interests have been incorporated to an extent that does not disrupt the long term national interests. The development of the energy sector represents one of the pillars of a sustainable, economic, technological, environmental and overall societal development of the country, which, together with the increase of the standard of living and, in that context, the emphasized concern for the standard of future generations, will enable the Republic of Macedonia easier and more efficient accession in the European Union. The Strategy is in accordance with the practices and regulations of the EU and complies with all obligations undertaken in the regional and international energy area. The Strategy envisages de-monopolization of the utilization of the energy infrastructure to the largest possible extent, and thus, greater liberalization and competition on the energy market.

For the purposes of providing good quality, stable and economically acceptable supply of energy of any king, and especially electricity, when analyzing the possible scenarios for the Study, attention has been devoted to the Republic of Macedonia's full compliance to the principles of the Agreement for the Energy Community as well as the directives of the EU. In addition, special attention should be devoted towards full transparency, competitiveness and non-discrimination in the energy sector, having in mind the liberalization of the sector both in the field of production, as well as in the field of supplying energy fuels, especially electricity.

When preparing the Strategy the import energy dependency of the country was taken into account, which imposes the need of broader diversity in the ways of securing the necessary energy and fuel quantities, both from domestic and imported sources of fuels and electricity. This is necessary to be had in mind in order to achieve the economically most favorable method of supply of all types of fuels for all types of consumptions in the country. In that context, an energy exchange must be formed as a public platform for realization of the supply and demand of all types of energy fuels in a transparent and non-discriminatory way and under market conditions. This is in accordance with the commitments for forming the so called free regional market for fuels and electricity, as part of the wider European market, i.e. with a view of full

integration of this regional market with the already established European fuel and electricity markets.

The party states to the Agreement for the Establishment of the Energy Community committed themselves to ensuring that all consumers of electricity and natural gas, except the residential sector, become eligible customers within the meaning of Directives 2003/54/EC and 2003/55/EC, from 1st January 2008, and starting from 1st of January 2015 the residential sector will also become eligible customers.

After 2015 and the full establishment of the liberalized energy market, all consumers will have the right to choose their own fuel and electricity supplier under market conditions, and this supplier could be any domestic or foreign supplier that will provide a license for performing this activity. In this way, after 2015, the role of AD ELEM, as a regulated generator, will significantly change. AD ELEM will no longer be a regulated generator. Its competitive abilities will determine how much electricity AD ELEM generates and to whom will it sell the generated electricity under market conditions within or without the country.

Energy should not be treated only as an infrastructural sector, but rather, to a large extent, an economic sector open to both domestic and foreign investments, as a sector where market laws and the processes of de-monopolization, liberalization, strengthened competition and entrepreneurship will be more and more accentuated. Hence, the energy sector has strong induced effects on other sectors of the economy and represents a pillar of the future stable and sustainable development of the Republic of Macedonia. Considering the above and that Macedonia does not have its own production of oil, natural gas and high quality coal, Macedonia should generate electricity (primarily from RES, natural gas and coal) and should use renewable energy sources for heat generation to the greatest economically justified extent. When the domestic generation will not be sufficient to satisfy the total electricity demand in the country or if the conditions for electricity supply on the market are more favorable than the conditions achieved in the country, through domestic generation, then energy imports will always be a significant option for fulfilling the energy demand in the country under most favorable technical and economic parameters.

The role of the Government and the other relevant institutions should continue to involve creating favorable conditions for attracting investors in the energy sector which would reduce the current high trade deficit which, to a large extent occurs as a direct consequence of the electricity import in this country.

Having in mind the strategic commitment of the Republic of Macedonia for full membership on the European Union, the energy policy of the EU is imposed as a strategic energy policy of the Republic of Macedonia.

The objectives proclaimed by the EU in the energy field until 2020 are: improvement of energy efficiency by 20%, provision of energy from renewable energy sources in the amount of 20% of the final energy consumption[9] and at least a 10% share of RES in the final energy consumption in traffic.

A common European goal regarding climate change is to reduce greenhouse gas emissions to 2020 by 20% in comparison to their levels in 1990, and reduce them by 30% until 2030 if the other industrialized countries, including the USA, undertake similar steps[10].

[9] The total final energy consumption comprises final energy consumption together with the energy consumption of the production capacities themselves as well as the transmission and distribution losses.

[10] Climate and renewable energy packet of the European Commission, from 23rd January 2008

The Green Book on Energy Efficiency[11] the Commission assesses that the EU can reduce the energy consumption by 20% until 2020 by undertaking specific measures, especially in the following critical sectors:

- reduction of the consumption in traffic, which accounts for one third of the total consumption, especially the road traffic – in this sphere the EU has adopted a series of measures related to the level of pollution emissions, traffic management and tax measures,
- generation of energy through reduction of losses, in particular in relation to electricity,
- buildings, through the improvement of the energy characteristics of the buildings by improving the thermal insulation, more efficient management of heating and illumination of buildings and increasing the efficiency of the household appliances.

In the fulfillment of the goal of the EU for providing 20% of the energy from renewable energy sources by 2020, the focus is placed to using renewable energy sources for production of electricity, air-conditioning and bio-fuels[12]. The measures proposed by the Commission relate to removing the barriers to development of renewable energies in the sectors for electricity, air-conditioning, measures to stimulate and promote renewable energy sources, as well as better integration of these sources in the energy network.

The objectives proclaimed by the Republic of Macedonia in this strategy are based on the EU objectives, taking into account the specificities of the country. Macedonia features exceptionally low energy consumption per capita in all sectors[13]. The final energy consumption per capita in Macedonia in 2006 was three times lower than the consumption in the European countries members of the Organization for Economic Cooperation and Development. Hence, it is not realistic to expect a reduction of the total energy consumption in the upcoming period. To the contrary, the energy demand, in the analyzed period until 2030 will grow and that will mean larger production and/or import. On the other hand, Macedonia is strongly energy import dependent and features a relatively high trade deficit, in which the import of energy accounts for a very large share. This means that Macedonia should utilize its domestic capacities for energy production to the highest possible extent, with full compliance of the market rules where the external factors will have an increasing role. However, at the same time Macedonia also features exceptionally low energy efficiency in all sectors.

Considering the above, it is necessary to significantly increase energy efficiency in the production, transmission, distribution and utilization of energy, as well as increase the energy production from renewable energy sources and other domestic resources.

This Strategy analyzes two scenarios. The baseline scenario envisages certain measures that will contribute to the improvement of the energy efficiency each of the sectors. The second scenario envisages additional measures for reducing the energy consumption for energy efficiency improvement.

One unforeseen thing that happened during the preparation of this Strategy was the global financial crisis. This crisis affected Macedonia more and more. Therefore, the initial estimates for the GDP growth during the period between 2009 and 2020 of 6.7%

[11] COM (2005) 265 final

[12] Proposed new directive (Directive establishing renewable energy targets for 2020) to substitute the Directives 2001/77/EC and 2003/30/EC

[13] Traffic, the residential sector, commercial and service sector, industry, agriculture and forestry

were corrected to 5.8% and accordingly new analyses and estimates for the energy consumption were prepared.

With a projected average annual GDP growth rate of 5.8% during the period 2009-2020 (5.66% in the period 2006-2020), the specific energy consumption per unit of GDP, in 2020, according to the baseline scenario will be 0.49 toe/1000US$2000. In 2006 the specific energy consumption was 0.71 toe/1000US$2000 (Table 1). This represents an improvement of the energy efficiency, expressed through this parameter, by 31%. The specific energy consumption per unit of GDP in 2020, according to the scenario with intensified energy efficiency measures would be 0.46 toe/1000US$2000. According to this scenario, the energy efficiency in 2020, in comparison to 2006, expressed through this parameter, would improve by 35%, which is additional 4% more than the baseline scenario.

During the final stage of the preparation of this Strategy, it became clear (in spite of the fact that all international forecast models failed) that the crisis is deeper (the depth of the crisis varied from day to day) and that it is quite possible to see a smaller growth of GDP in Macedonia in for the period 2009 – 2020. In that case, the forecasted growth of the energy consumption would not change significantly. In some sectors the energy consumption will decline in comparison to the forecast; however the investments in energy savings and energy efficiency improvement will also decline. The net result would be greater specific energy consumption per unit of GDP in 2020 in comparison to the planned consumption. Still, our calculations show that even in that case the energy intensity until 2020 will be at least 30% less that the energy intensity in 2006.

Considering the above, this Strategy sets targets to reduce energy intensity by at least 30% by 2020 in comparison to the energy intensity in 2006. This means that efforts have to be made to implement the measures from the scenario with high energy efficiency.

The share of the renewable energy sources in 2020 is planned to be more than 20% (21%) of the total final energy consumption. In addition, the share of RES (primarily bio-fuels) in the total final energy consumption in traffic is planned to reach at least 10% by 2020.

Regarding the greenhouse gas emissions, the target set for 2020 is to ***reduce the CO_2 equivalent emissions by 30%*** in comparison to the value attained with the scenario based only on coal[14]. In addition, ***the specific emission of greenhouse gasses from the electrical and power sector (the grid factor)*** will be reduced by 22% by 2020 in comparison to 2006.

The Strategy envisages to ***improve the energy diversity in the primary energy supply***. Coal together with oil and petroleum products will decrease their percentage share from 81% in 2006 to 70.8% in 2020, while the share of natural gas will increase from 2.4% in 2006 to 16% in 2020, and the share of renewable energy sources in the total primary energy, will increase from 11.5% to 13.3% during this period.

The implementation of the envisaged dynamic of construction of new production facilities ***will improve the diversity and, in turn the security of supply of electricity***. In the past period, assuming average hydrologic conditions, 80% of the electricity was produced in coal fired thermal power plants and 20% from renewable energy sources (hydro power plants). The plan for 2020 is to have 42% – 51%, depending on the scenario, of the electricity generated from coal fired thermal power plants, 24% – 28%

[14] Second national communication under the United Nations Framework Convention on Climate Change, the Ministry of Environment and Physical Planning, UNDP-GEF, November 2008

of the electricity to come from natural gas and renewable energy sources and 2% – 3% from heavy fuel oil fired thermal power plants.

Legislation and institutional framework

The strategic commitments of Macedonia in the energy sector, including the commitment to harmonize with the acquis communautaire, have been incorporated in the ***Law on Energy***[15]. For the purposes of implementing the provisions from the Law on Energy, as well as the Laws indirectly connected to the energy sector, appropriate secondary legislation has been adopted. In addition to the Law on Energy, the following laws and bylaws related to the energy sector have been adopted:

- Rulebook on the Transformation of "Elektrostopanstvo na Makedonija"[16]
- Rulebook on the Establishment of the Energy Agency of the Republic of Macedonia[17]
- Rulebook on Marking the Energy Efficiency on the Household Appliances[18]
- Rulebook on Energy Efficiency of Buildings[19]
- Rulebook on Renewable Energy Sources for Electricity Generation[20]
- Rulebook on the Method For Issuing Guarantees of Origin of the Electricity Generated From Renewable Energy Sources as well as the Content, the Form and the Method For Maintaining the Registry of Issued Guarantees of Origin of the Electricity Generated From Renewable Energy Sources[21]
- Rulebook on the Methods and the Conditions For Regulation of the Electricity Price
- Rulebook on the Conditions, Methods and Procedure for Issuing, Changing and Revoking Licenses for Performing Energy Activities
- Grid Code for transmission of electricity[22]
- Grid Code for distribution of electricity[23]
- Grid Code for distribution of thermal energy for heating provided by Toplifikacija AD - Skopje

The legislation in the energy sector will be finalized and in some segments it will be improved.

Numerous laws and bylaws have been adopted in the area of environment protection and other relevant areas.

The proposing of legislative measures and implementation of the Law on Energy, as well as the laws on planning, investments and other laws is the responsibility of the ***Government*** of the Republic of Macedonia. The Government also has a responsibility to create the policy for facilitating investments, development of competition, connection of

[15] Official Gazette of the Republic of Macedonia no. 63/06, 36/07 and 106/08
[16] Official Gazette of the Republic of Macedonia no. 36/07
[17] Official Gazette of the Republic of Macedonia no. 62/05
[18] Official Gazette of the Republic of Macedonia no. 85/07
[19] Official Gazette of the Republic of Macedonia no.143/08
[20] Official Gazette of the Republic of Macedonia no. 127/08
[21] Official Gazette of the Republic of Macedonia no.127/08
[22] Official Gazette of the Republic of Macedonia no. 95/06
[23] Official Gazette of the Republic of Macedonia no. 83/2008

the energy system of the Republic of Macedonia with the EU, the region and the systems of other countries, ensuring transparency and preventing monopolies on the energy market, ensuring security of supply of fuels and protection of the fuel consumers. The government encourages the development of the private sector in the area of energy and implements the privatization of state owned companies. A special function of the Government is to support the scientific and technological development in the energy sector, in the utilization of renewable energy sources, in the production of equipment and the development of science. This function is part of the obligations of the Government with direct interventions from the budget or through the application of tax or other measures to stimulate the scientific and technological development.

The functioning of the energy market not only does it not exclude the need for state planning, but it emphasizes this need even further, especially as a response to the challenge related to the application of the European and international norms and standards and the development of the energy sector as a requirement for an overall social and economic development, harmonized with the requirements for human development and environmental protection.

The Government of the Republic of Macedonia, on its session held on 1st of October 2009, adopted ***an Action Plan*** for further harmonization of the national legislation with the acquis communitaire in the segment of electricity and natural gas.[24] The Action Plan addresses the necessary changes and additions to the Law on Energy that should provide a realistic trading and competition platform as well as further opening of the electricity and natural gas markets, increased transparency, and fair treatment and equal position of all participants in the energy market, clear delineation between the regulated and non-regulated activities, precise definition of the public service criteria and obligations, quality of supply with energy and protection of end users of energy.

The action plan also includes the bylaws which have to be enacted or harmonized with the Law on Energy and the envisaged changes. Some of the more important bylaws that have to be enacted are: the Rulebook on Monitoring, Disclosure, and Protection of Data, the Market Rules and the Methodology for Balancing, Rules of Supply, Rules for Allocation of Cross-Border Electricity Capacities, Selection of a Supplier of Last Resort, Changes to the Grid Code, Rulebook for Electricity Prices as well as Modernization of the Electricity Tariff System.

In Addition to the activities related to legislation, appropriate measures of organizational and technical nature have been envisaged for the purposes of opening of the markets of electricity and natural gas. The objective of these measures is to ensure smooth functioning of the markets.

In order to protect the socially vulnerable categories of consumers while setting a realistic electricity price for tariff customers, the Action Plan calls for measures which will ensure that these customers are financially assisted to cover their basic needs for electricity. In that regard, the Government of the Republic of Macedonia, in September 2009, adopted ***Social Action Plans,*** which provide detailed descriptions of the activities in this field.

Within the framework of the Government of the Republic of Macedonia, the ministry responsible for the energy sector is ***the Ministry of Economy***. One of the sectors in the ministry is the ***Energy sector*** whose main tasks are strategic planning and development of the legislation in the energy sector, implementation of the energy policy

[24] Action plan for further harmonization of the national legislation with the Acquis Communitaire in the segment of electricity and natural gas, Government of the Republic of Macedonia, 1st October 2009.

including the policies for energy efficiency and renewable energy sources, as well as the use of new technologies. This sector is responsible for collecting relevant data about the energy production, supply, demand etc. Part of the responsibilities related to energy belongs to the Ministry of Environment and Physical Planning as well as to the Ministry of Transport and Communications.

For the purposes of providing support to the Government in the implementation of the energy policy, ***Energy Agency***[25] has been formed. It is responsible for the preparation of medium term and long term strategies and development plans, preparation of long term and short term programs, energy efficiency and utilization of renewable energy sources, preparatory and coordinative activities for implementation of investment projects, regional cooperation and coordination of regional projects, preparation of proposals of laws and bylaws and technical regulations in the area of energy, as well as other activities in the area of energy specified by law.

The activities related to regulating specific issues related to the performance of energy activities specified in the Law on Energy are performed by the ***Energy Regulatory Commission (ERC)*** of the Republic of Macedonia. The Energy Regulatory Commission works and decides independently within the framework of the competences determined in the Law on Energy. The Energy Regulatory Commission has the status of a legal entity.

The council of the ***municipality,*** i.e. the Council of the ***city of Skopje,*** upon a proposal from the mayor, and after acquiring an opinion from the Ministry of Economy, enacts an energy development program for the municipality or the city of Skopje. These programs are enacted for a period of five years and they should be harmonized with the Strategy for Energy Development of the Republic of Macedonia. They determine, the method and conditions regarding the performance of energy activities of public interest of local significance, the need and the sources of funding for new facilities and reconstruction and upgrading of existing facilities, plants and installations for performing energy activities of public interest of local significance, the quantities of natural gas and heat required to satisfy the demand of the citizens and other consumers in the area of the municipalities and the city of Skopje and the measures and activities for increasing the energy efficiency and production of energy from renewable energy sources.

In order to ensure efficient implementation of the new legislative framework of the energy sector which imposes numerous obligations, it is necessary to ***strengthen the capacities*** of the above mentioned institutions.

It is also necessary to strengthen the capacities of the institutions and the companies that perform ***scientific and research activities, applicative and educational activities*** in the field of energy. In Macedonia these activities are performed by the Research Center for Energy, Informatics and Materials (ICEIM) at the MASA, the Faculty for Electrical Engineering and Information Technologies and the Mechanical Faculty at the University "Sv. Kiril i Metodij", Skopje, the Technical Faculty at the University "Sv. Kliment Ohridski" - Bitola, the Faculty for Natural and Technical Sciences at the University "Goce Delchev" – Shtip and the Mining Institute in Skopje. Research and applicative activities in the field of energy are also performed by the large companies working in the area of energy, through their research and development sectors as well as a number of small private companies.

The major professional associations and nongovernmental organizations working the field of energy include the Macedonian National Committee at the World Energy

[25] Official Gazette of the Republic of Macedonia no. 65/05

Council (WEC), the Association of Energy Experts of Macedonia (ZEMAK) with their numerous activities and the journal "Energy" the Energy Efficiency Center of Macedonia (MACEF) with the regular publication of the monthly electronic newsletter and other activities, the Macedonia Geothermal Association (MAGA), the Macedonia Committee for Large Electric Systems (MAKO - CIGRE).

1. OBJECTIVES OF THE STRATEGY

The Energy Development Strategy of the Republic of Macedonia defines the most favorable long term development of the Energy Sector in the Republic of Macedonia in order to ensure reliable and good quality energy supply to the consumers while caring about the environmental impact.

The following priorities have been taken into account in the realization of the above mentioned core aim:

- Maintenance, ***revitalization*** and modernization of the existing and construction of new, modern infrastructures for the purposes of energy production and utilization, by complying with the EU standards for environmental protection,
- Improvement of the ***energy efficiency*** in the production, transmission, and utilization of energy, in parallel with specific programs for reduction of the final energy consumption in all sectors,
- Utilization of ***domestic resources*** (reserves of lignite, hydropower potential, wind and solar energy) for electricity production,
- Increase of ***natural gas utilization***,
- Increase of the utilization of ***renewable energy sources***,
- Preparation and realization of programs for supporting the welfare category of consumers and gradual increasing of the electricity price to market values by 2015,
- Finalization of the reforms in the energy sector of the Republic of Macedonia and its integration in the ***regional and European electricity and natural gas market***.

The Strategy addresses the energy, economic, organizational, institutional, legislative and educational dimensions of the energy sector development in the areas of energy production, transmission and utilization.

The Strategy is enacted by the Government of the Republic of Macedonia and its serves as a basis for the preparation of an Action Plan aimed and facilitating the energy sector development in the Republic of Macedonia as a basis for the overall sustainable development of the country and its more efficient inclusion in the European and Atlantic integration processes.

2. GENERAL PRINCIPLES FOR THE FUNCTIONING OF THE ENERGY SECTOR

Reliable and good quality supply of specific energy types to the consumers in the Republic of Macedonia

Energy security means regular fulfillment of the energy demand in sustainable, environmentally acceptable conditions and at prices which do not impede economic development and do not pose a threat to the standard of living of the citizens. Provision of energy security requires greater ***diversification*** of the energy resources by type, sources and suppliers, ***active role of the regional energy market and the European Energy Community***. The greater diversification will increase competition, which in turn will ensure reliable energy supply and sustainable fuel prices. This requires ***maximizing the possible use of the domestic resources*** (renewable energy sources and coal) and a strategically viable long term ***connection policy to the main energy ducts in the region and abroad*** (gas pipelines, oil pipelines and power lines), building of business and friendly relations with all strategically important countries such as the European Union, Russia, USA and all of the countries in the region.

In order to achieve energy security, four core challenges have to be addressed:

- Commercial access to energy for all
- Political and legal stability on local and regional level
- Promotion of renewable energy sources utilization and
- Increase of efficiency through competition and technological diffusion.

Increase of energy efficiency and greater utilization of renewable energy sources

The policy of increasing the utilization of the renewable energy sources is implemented by the Government of the Republic of Macedonia though the Ministry of Economy with the support of the Energy Agency in cooperation with the other Ministries which have some energy related responsibilities. The feed-in tariffs for production of electricity from small hydropower plants, wind power plants, photovoltaic plants and biogas from biomass, are defined by the Energy Regulatory Commission.

The utilization of the renewable energy sources in Macedonia is supported more and more with numerous measures and the envisaged targets are expected to be fulfilled. The legislation is expected to be finalized and the administrative barriers eliminated.

Using economic measures Macedonia should stimulate the production of biomass for biofuel, production of biofuels and utilization of biofuels in traffic.

The set of competences of the local self government includes the policy for utilization of geothermal energy, biomass, biogas, earth gas and solar energy, and this is specified in a program which has been previously agreed with the Ministry of Economy and which is harmonized with the Strategy for Utilization of the Renewable Energy Sources.

Macedonia belongs among the countries with high primary energy consumption per unit of GDP. With a value of 0.70 toe/1000US$2000, for 2006, Macedonia had a specific primary energy consumption almost 4 times greater than that of the developed European countries. In particular, electricity has an exceptionally high share. With a consumption of 1.80 kWh/US$2000 in 2006 Macedonia had almost 5.5 times greater specific electricity consumption than the developed European countries. As a result Macedonia has a poorer ratio between final energy consumption and primary energy

consumption (0.65 for 2006) in comparison to the developed European countries (0.72 for 2006).

In that context, Macedonia should intensify its efforts towards improving energy efficiency in production, transmission and consumption of energy, particularly electricity, maximal utilization of the hydropower potential, implementation of a special program for utilization of renewable energy sources (small hydropower plants, solar energy, wind energy, geothermal energy and biomass) and to create appropriate conditions for greater utilization of natural gas. In addition to electricity production in combined heat and power production facilities using natural gas, with high energy conversion efficiency, natural gas should be highly used in the residential sector, and in the commercial and service sectors, as well as in the small and medium enterprises with possible combined heat and power production in small capacity facilities. Energy efficiency will be further improved by the construction of lignite thermal power plants with high levels of efficiency and with pollutant emissions compliant with the strictest European standards. The increase of the energy conversion efficiency of the thermal power plants, higher level of penetration of the natural gas, utilization of renewable energy sources, reduction of the transmission and distribution losses, will help achieve reduction of the specific emission of greenhouse gasses. Connection to the new gas pipeline systems, especially in the regional network, is also one of the measures that requires accelerated and more organized efforts with a previously determined strategy.

Macedonia has a lot of potential for energy savings. In that context, it is especially important to enact a National Energy Efficiency Action Plan as soon as possible and to implement this plan consistently.

Macedonia also has a lot of potential for energy efficiency improvements in the industrial, household, commercial and service sector and traffic consumption. The following areas are of special interest: support for increasing energy efficiency and reducing the consumption of energy in energy extensive industries, utilization of thermal pumps, greater share of renewable energy sources, gas and heating oil in comparison to electricity, improvement and enforcement of the primary and secondary legislation regarding the introduction of energy more efficient devices, improvement of the insulation of the facilities etc. The state institutions should lead the improvement of the energy characteristics of public buildings: the buildings of the ministries, faculties, schools etc.

In addition to the investments aimed at reducing the technical losses of electricity in distribution, additional efforts are needed from all stakeholders to minimize the unaccounted for and unpaid for electricity consumption.

The energy efficiency can change significantly only if the Government implements a wide complex of measures of political, economic, technical and administrative nature.

Political measures – The emphasized energy intensity of Macedonia, on one hand, as well as the energy deficiency in the country and in the region, on the other hand, require the need to increase the energy efficiency to be set as a significant national priority – this is also done by more developed countries than Macedonia. This presupposes the determination of appropriate quantitative targets for the energy efficiency increase in the production, distribution and the most significant consumption sectors and promotion and implementation of policies to increase energy efficiency.

Economic measures – The most significant items from an economic point of view are real economic prices of fuels, good and fair economic regulation of the energy sector, reduction of taxes for less polluting fuels, reduction of taxes and customs duties for energy efficient equipment, as well as creation of conditions that will facilitate the

access to such equipment – earmarked loans, budget guarantees for loans in the state owned energy facilities etc.

Technical measures – This is a wide complex of measures, starting from standardization of the equipment, education of design staff, evaluation and review of the designs from energy efficiency point of view, through introduction of the necessary energy efficiency standards in the area of construction (thermal insulation of buildings, allowed heat consumption per square meter of buildings etc.), quality standards of household electric appliances with mandatory labeling of the energy consumption, energy savings measures for illumination in buildings and homes etc. Considering the fact that the household sector in Macedonia is a large energy consumer (the irrational energy consumption is particularly expressed through the overuse of electricity for heating of homes, which makes the reorientation to greater gas utilization, a priority), there is a need to prepare a special study to raise energy efficiency in this sector.

Legal and administrative measures – There is a need to complete the legislation from the point of view of energy efficiency awareness raising, with a tendency to incorporate and enforce the European standards.

Media campaign – This measure is used in many countries. The main aim is to raise the awareness of the citizens and commercial entities that energy is a rare and expensive resource and to educate the consumers, in a clear, concise and popular manner, about the numerous approaches and possibilities for energy saving.

Economic price for the energy sold at regulated prices

The transition to market prices for electricity will improve the investment climate, will strengthen the interest to improve energy efficiency and to introduce renewable energy sources that are not subject to feed-in tariffs (solar energy for production of heat. This, as well as the opening of the natural gas market, will lead to greater competition in the energy production and supply sectors, which in turn will provide for reliable energy supply at competitive prices. Considering that certain natural monopolies, such as the transmission and distribution of electricity and natural gas and the distribution of heat, will still continue to exist, the measures for elimination of the misuse of the monopoly position of any entity should be strengthened. This will require improvement of the legislation with a view of providing greater independence of the Energy Regulatory Commission. The functions and positions of the Energy Regulatory Commission should be strengthened with respect to market monitoring with a view of developing competition in the energy market.

Correlation between the economic capabilities of the consumers and the realistic energy price with a special emphasis to the social category of consumers

The increase of the energy price, especially the electricity price, must be correlated with the prices of other fuels, as well as with the growth of the standard of living in Macedonia and with the improvement of the end user energy efficiency. The Government should develop a special program to support the social category of consumers, but also programs for improvement of the energy efficiency in the middle class households, in order not to deteriorate the already very low standard of living. This also applies to the programs for improvement of energy efficiency of the small and medium enterprises in order not to deteriorate the competitive capabilities on the regional and European markets, which are already relatively weak.

Environmental protection standards in accordance with the current legislation

Environmental protection in the energy sector entails acting primarily through energy efficiency, renewable energy sources and environmentally friendly modern technologies, good quality legislation and monitoring, education and public awareness, as well as promotion of positive examples. The Government should give high priority to the environmental impacts and climate change related to the energy production and utilization. Specifically, the efforts should be focus on the following areas:

- Implementation of the National Environmental Action plan, as well as adoption and implementation of the intersectoral plans for air quality management with quantitative targets and adequate monitoring;
- Application of the relevant regional and international agreements, primarily the EU standards (including the EU Directive on Large Combustion Facilities) and the urban pollutant limits, as well as the Transboundary Air Pollution Convention;
- Use of best available technologies and practices in the lignite thermal power plants;
- Implementation of the climate change mitigation plan from the Second National Communication to the Convention on Climate Change; realization of as many CDM projects as possible; institutional, legislative and technical preparation for participation in the European Emission Trading Schemes; strengthening of the negotiation capacities in the process of determination of quantified obligations for reduction of the emissions of greenhouse gasses.

Transformation of the ownership capital in the energy sector in market operating conditions

The de-monopolization, liberalization and increase of the competitive pressure in the energy sector is a global economic process that commenced during the 1980s, first in the highly developed countries and then in the developing countries and the transition countries. Macedonia started this process by restructuring the former ESM (splitting the production, transmission and distribution), privatizing the electricity distribution, accepting the international obligations deriving from the Athens Electricity and Gas Memoranda (2002 and 2003), signing the Energy Community Agreement, establishing modern legislation (Law on Energy, Law on Concessions etc.), accepting part of the EU Energy Directive etc., which facilitates a new approach in the functioning of the energy market, creation of conditions for realistic fuel prices and securing investment funds, as well as opening of the energy sector to foreign capital. Hence, the gradual transition of the energy sector in the country to market operating conditions is already a reality for Macedonia. If the Republic of Macedonia establishes a competitive national energy market, actively participates in the establishment of a regional energy market, establishes a good and fair regulation, including concession, efficient protection of ownership rights, as well as improvements of the other segments of the investment climate, considering the obvious energy deficiency of the region, the inflow of foreign capital in the energy sector of the country could be significant. This will lead to a stable and sustainable development of the Macedonian economy.

3. EXISTING ENERGY INFRASTRUCTURE

The energy infrastructure of the Republic of Macedonia enables the exploitation of domestic primary energy, import and export of primary energy, processing of primary energy and production of final energy, transport and distribution of energy. The energy infrastructure of the Republic of Macedonia comprises coal, oil and petroleum products, and natural gas sectors, as well as the electricity sector and the heat production sector.

3.1. COAL SECTOR

Regarding fossil fuels, the Republic of Macedonia has available only low calorie coal – of the type lignite. All other types of fossil fuels (oil, natural gas and other types of coal) are provided from imports.

According to their purpose, the existing sites can be subdivided into two groups: mines for production of lignite for purposes of state owned thermal power plants within AD ELEM of Macedonia (surface mines Suvodol and Oslomej) and mines for production of lignite for wide consumption (surface mines BRIK Berovo and Drimkol - lignites) exploited by concessionaires, which are privately owned shareholding companies.

The surface mine Brod-Gneotino is currently being opened and prepared for exploitation for the purposes of the TPP Bitola. Another potential mine that could be opened and exploited for the purposes of TPP Bitola is the surface mine Suvodol – underlying seams.

Other major coal sites that could be used for electricity are Zhivojno, Mariovo, Popovjani and Negotino.

The surface mine ***Suvodol*** is the most important coal mine in the Republic of Macedonia, which, since 1982, continually supplies lignite type coal to the TPP Bitola. The annual production of coal in the Suvodol mine ranges between 6 and 7 million tons. The total remaining exploitation reserves of the surface mine Suvodol – main coal seam are about 36 million tons (as of 30th of June 2008).

The coal demand of TPP Oslomej are satisfied from the exploitation of the surface mine ***Oslomej –*** west. According to the energy balance of the Republic of Macedonia, during the period from 1996 to 2007, the annual coal production from SM Oslomej – east and SM Oslomej west, after 2002/2003, ranged from 530 thousand to 1.07 million tons of coal. The remaining total exploitation reserves of coal from SM Oslomej – west are estimated at approximately 11 million tons of coal.

The surface mine ***BRIK Berovo*** is located in close proximity to the city of Berovo. The total exploitation reserves are estimated at approximately 1 million tons. The annual exploitation is a function of the improvement and ranges between 35 to 70 thousand tons. The lignite is crushed and separated and used for industrial purposes and wide consumption.

The surface mine ***Drimkol – ligniti*** is located west and close to the dam on the Globochica reservoir. The annual exploitation is almost identical to that of BRIK Berovo and ranges from 40 to 70 thousand tons of coal. The coal is lignite with an exceptionally higher carbonification level in comparison to the other lignite types in the Republic of Macedonia, which brings it closer to brown coals. The total quantities of coal are crushed and separated in separate classes, which are used for industrial purposes and wide consumption.

In order to provide for continuity in the operation of the TPP Bitola and TPP Oslomej in the upcoming period, it is necessary, in the shortest possible time to provide for exploitation from the lignite mines in their immediate vicinity (Brod – Gneotino, Suvodol – underlying seams and Popovjani) in accordance with a precisely determined time schedule.

The more significant coal sites that could be used for new thermal power plants include Zhivojno, Mariovo and Negotino. These mines will make use of pit exploitation. Macedonia does not have experience in this field and it is necessary to begin the activities for introducing this exploitation technology.

3.2. ELECTRICAL AND POWER SYSTEM

The core function of the electrical and power system (EPS) of Macedonia is production, transmission and distribution of electricity.

The structure of the EPS of Macedonia comprises:

- Hydropower plants with total installed power of 580 MW,
- Lignite and heavy fuel oil fired thermal power plans with total installed power of 1010 MW and
- Electricity transmission and distribution system.

The EPS of Macedonia is operated by four entities, namely: AD **ELEM** – Skopje (Power Plants of Macedonia), state owned, shareholding company for production and supply of electricity, AD **MEPSO – Skopje,** (Macedonia Electricity Transmission System Operator), state owned, Macedonian's transmission system operator – shareholding company for transmission of electricity and management with the electricity and power system of Macedonia, the distribution company **EVN Macedonia** AD and AD **TPP Negotino**, state owned, shareholding company for production of electricity.

3.2.1. Power plants of Macedonia, AD ELEM

The shareholding company for electricity production and supply Power Plants of Macedonia includes the large hydropower plants in Macedonia and the lignite thermal power plants. Table 3.2.1.1 provides the basic parameters of the lignite fired TPPs in Macedonia.

Table 3.2.1.1. Basic parameters of lignite fired TPPs

TPP	Number of aggregates	P_{inst} [MW]	Commissioning in EPS [year]
Bitola	3	675	1982 / 1984 / 1988
Oslomej	1	125	1979
Total	**4**	**800**	

Table 3.2.1.2 provides the basic technical parameters of the HPPs in Macedonia included in ELEM.

ELEM also includes two small HPPs with total installed power of 0.34 MW, i.e. HPP Modrich with 0.15 MW and HPP Oslomej with 0.19 MW.

Table 3.2.1.2. Basic parameters of HPPs

HPP	Drainage - basin	Number of aggregates	Q_{inst} / agg. [m^3/s]	H_{gross} [m]	Volume [10^6 m^3]	P_{inst} [MW]	Commissioning in EPS [year]
Vrutok	Mavrovo	4	9	574	277	172	1957 / 1973*
Tikvesh	Crna Reka	4	36	100	272	116	1966 / 1981*
Globochica	Crn Drim	2	27	110.9	228	42	1965*
Shpilje	Crn Drim	3	36	95	212	84	1969*
Kozjak	Treska	2	50	100	260	80	2004
Raven	Mavrovo	3	10.6	66	0	21.6	1959 / 1973*
Vrben	Mavrovo	2	4.6	193	0	12.8	1959*
Total						**528**	

** Under the project entitled Project for Improving the EPS of the Republic of Macedonia, for the period 2001-2005, the first stage of revitalization of the six large hydropower plants was realized with funds from the International Bank for Reconstruction and Development (IBRD) – the World Bank (WB).*

The long term stimulation of the so called welfare price of electricity for the purposes of preserving the social and political peace and stability of the country, permanently damaged the mechanisms for revitalization of the existing electricity sources, or the mechanisms for replacement of such sources with more efficient ones and for construction of new capacities. The Republic of Macedonia today is left, practically, with the same power facilities as before the 1990s, and these facilities are now two decades older. In order to sustain the fitness of the existing lignite fired thermal power plants, it is necessary to revitalize the equipment of the TPP Bitola and TPP Oslomej. In the upcoming period, it is necessary to complete the revitalization of the hydropower plants.

3.2.2. Macedonia Electricity Transmission System Operator MEPSO

The Macedonian Electricity Transmission System AD MEPSO is a shareholding company for transmission and management of the EPS, including the dispatching system. The transmission grid of Macedonia, which is managed, maintained, planned and constructed by AD MEPSO, comprises power lines with voltage levels of 400 kV, 220 kV and 110 kV (Figure 3.2.2.1).

Table 3.2.2.1 provides the basic technical parameters of the power lines in the EPS of Macedonia.

Table 3.2.2.1. Basic parameters of high voltage power lines in the EPS of Macedonia

Voltage [kV]	400	220	110
Length [km]	594	103	1480

AD MEPSO is also the electricity market operator on the territory of the Republic of Macedonia.

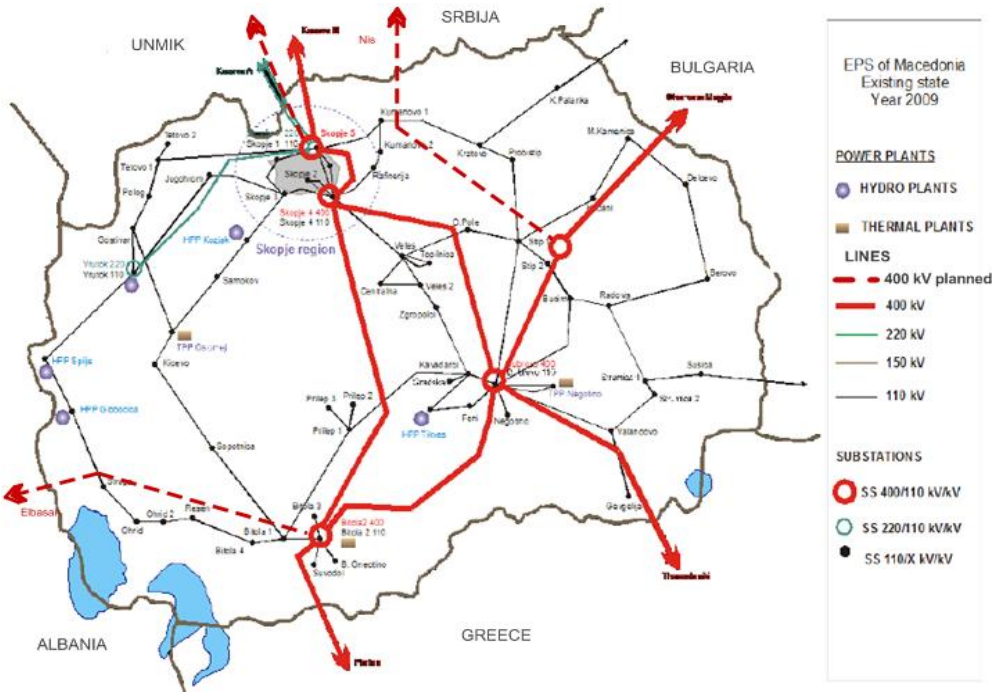

Figure 3.2.2.1. Existing and planned structures of the transmission system of the Republic of Macedonia

With the connection of the new 400 kV power lines with Greece and Bulgaria, Macedonia improved its interconnectivity in the regional electric and power system, however it is necessary to connect to Serbia and Albania and an additional connection to Kosovo in order to achieve full integration in the regional system. When analyzing the transmission network at the voltage level of 400 kV one notices a lack of connection in the western part of the country which features significant consumption and a large number of hydropower plants. Investments are needed in the revitalization and replacement of parts on the remainder of the network and substations.

3.2.3. EVN Macedonia AD

EVN Macedonia AD is a company for electricity distribution, management of the distribution system and supply to tariff customers connected to its distribution network on the territory of the Republic of Macedonia. EVN Macedonia also owns 11 small hydropower plants.

The distribution network in Macedonia is privately owned by EVN Macedonia AD. This company owns 150 km of distribution network at a voltage level of 110 kV, 1000 km at 35 kV, 720 km at 20 kV, 8900 km at 10 kV and 11600 km at 0.4 kV[26]. EVN Macedonia AD supplies a total of 720000 consumers with electricity. Recently EVN made a new reorganization whereby the distributive consumers were divided into 19 Electricity User Centers.

The distribution of electricity in Macedonia faces high loses and insufficient quality of the delivered electricity in certain areas and an unsatisfactory security of supply.

EVN Macedonia AD also owns 11 small hydropower plants with 25 production units with a total power of 45 MW (Table 3.2.3.1) which have generated 124 GWh in

[26] http://www.evn.com.mk

2006. The distribution network of EVN also includes the small hydropower plants owned by private generators, mainly water management organizations.

Seven of the small hydropower plants of EVN Macedonia, are in the ROT program until 2009[27] ***according to which they are used by the company HIDROPOL from the Czech Republic and it has an obligation to revitalize them and transfer them back.***

Table 3.2.3.1. Small HPPs in the network of EVN Macedonia

Small HPP		P_{inst} [MW]
MAK ROT Program	Sapunchica	2.9
	Kalimanci	13.8
	Zrnovci	1.4
	Doshnica	4.1
	Pesochani	2.7
	Matka	9.6
	Pena	2.5
Other EVN	Babuna	0.7
	Belica	0.3
	Turija	2.2
	Popova Shapka	4.8
Other companies	Strezevo	3.4
	Komunalec	1.2
	Standard	
Total		**49.6**

3.2.4. TPP Negotino

The only heavy fuel oil fired TPP in Macedonia, Negotino was put into operation in 1978, and after 2006 it functions as a separate entity within the EPS of Macedonia. This production capacity uses heavy fuel oil, for which there is a transport railway infrastructure. The installed power of this capacity is 210 MW and it has the possibility to work either with 1 or 2 boilers, i.e. in the range from 70 MW to 105 MW it works with one boiler, and, in the range from 140 MW to 210 MW it works with two boilers.

TPP Negotino was used very little in the past period. ***It requires reconstruction which would provide for greater flexibility.*** No changes to the legal status of the AD TPP Negotino are envisaged in the Strategy, nor will the fuel used by this power plant change

3.3. OIL AND PETROLEUM PRODUCTS SECTOR

This sector involves import and export of crude oil and petroleum products, processing of crude oil, production of bio-fuels, distribution and sale of petroleum products.

3.3.1. Oil refinery

The OKTA refinery was constricted in 1980 and started to work in 1982. The designed capacity is 2.5 million tons per year while the maximum capacity achieved is 1.36 million tons during 1988.

[27] Program for rehabilitating, operating and transfer of small hydropower plants

In 1999 this company became a company with a privately owned majority shares package, owned by the strategic investor EL.P.ET Balkanika, Republic of Greece.

The OKTA Refinery produces: 95 octane unleaded engine petrol with – Euro V, 98 octane unleaded engine petrol – Euro V, 96 octane leaded engine petrol with 0.15 g/l led, diesel fuel with 50 ppm sulfur – Euro IV, diesel fuel with 10 ppm sulfur – Euro V, jet engine fuel - JET A-1, liquid petrol gas (LPG) – mix of propane and butane gas and commercial butane. Combustion oils include: heavy fuel oil with 2% sulfur content and 3% content and extra light fuel for the residential sector with 1000 ppm sulfur.

The total capacity of the oil and petroleum products reservoirs is 382 thousand m^3.

The oil pipeline Thessaloniki – Skopje started to work in 2002 (213 km) and has a capacity of 2.5 million tons of oil per year.

The control and monitoring over the work of the oil pipeline is realized using a SCADA monitoring system. The oil pipeline is jointly operated by the Macedonian – Greek company VARDAX whose main office is in Thessaloniki and it has branch offices in OKTA.

The capacities of the OKTA refinery and the oil pipeline OKTA – Thessaloniki port fully satisfy the demand for petroleum products in Macedonia, however the refinery needs to be modernized, primarily for the purposes of providing a more efficient environmental protection and improving the efficiency.

3.3.2. Petrol pumping stations

In Macedonia there are currently about 260 petrol pumping stations. In spite of the fact that today the ownership structure in the retail sector is significantly different, still Makpetrol is dominating both by the number of petrol stations (116), as well as by the scope of sale on those petrol stations (44%). It is followed by OKTA Brend with 36 petrol stations and 14% of the sale on the petrol stations and Lukoil Makedonija with 10 petrol stations and 4% sales. The remaining 99 petrol stations with 38% of the sales are privately owned by multiple domestic small companies.

In comparison to the countries from our surrounding, Macedonia has available only a small number of petrol stations which are unevenly distributed throughout its territory. Most of them are concentrated in Skopje and in the major cities like Tetovo and Kumanovo.

It is worth noting that the companies that own petrol stations, in addition to their core activity to sell fuel on their pumping stations, also play the part of wholesale traders, i.e. they sell part of the liquid fuels they procure, directly to the final users rather than through their petrol stations. The main companies that participate in the wholesale trade of petroleum products are the OKTA Oil Refinery AD Skopje, the company Makpetrol and the company Lukoil Macedonia.

3.3.3. Refinery for production of biodiesel fuel

The refinery for production of biodiesel fuel is owned by the company Makpetrol. ***This refinery began production in 2007 and its capacity is 30 thousand tons per year. The production of bio-diesel fuel uses unrefined beet oil. At this stage the unrefined oil is imported.***

3.3.4. Storage area

Having in mind the instable fuel flows in the world, it is very important to form oil and petroleum products reserves and therefore to have appropriate storage capacities available.

The reservoir capacities in the Republic of Macedonia are sufficient to sustain 90 days of current average consumption of all types of petroleum products. These capacities comprise the storage reservoir area of the OKTA Refinery, the storage reservoir area of the Makpetrol company, the reservoir storage area of the company Lukoil Macedonia, reservoir storage area of the state commodity reserves of the Republic of Macedonia and the reservoir storage area of smaller private and state owned companies.

The formation, storage, renewal and utilization of the mandatory oil and petroleum products reserves is regulated with the Law on Mandatory Reserves of Oil and Petroleum products[28] and the EU directives[29].

The formation, storage, renewal and utilization refer to: crude oil, all types of engine and avionic fuels, all types of diesel fuels and kerosene, EL-household oil, LPG and heavy fuel oil.

3.4. NATURAL GAS SECTOR

This sector performs transmission, distribution and sale of natural gas. Natural gas is an exceptionally useful fuel since it has a wide range of uses, from the residential sector, through industrial and transportation use to electricity and heat production. In addition, not only does it not pose any storage problems or any adverse environmental influences, but, in some circumstances, the use of natural gas means additional financial effects of projects from the point of view of global atmosphere pollution reduction by reducing the specific emission of greenhouse gasses. The natural gas is the most favorable fuel to be used in meeting the urban environment requirements.

Macedonia does not have any gas sites and is connected only with one main gas pipeline. ***The entire quantity of natural gas is imported from Russia through the international corridor 8*** that passes through Ukraine, Moldavia, Romania and Bulgaria. The main gas pipeline enters Macedonia at Deve Bair on the border with Bulgaria and runs over Kriva Palanka, Kratovo and Kumanovo to Skopje with a length of 98 km. ***The main gas pipeline has a capacity of 800 million Nm^3 per year with a possibility to increase to 1200 million Nm^3 per year*** after the construction of a compression station at the beginning of the main gas pipeline. This would certainly mean additional costs for the transport of gas. The maximal permeability of the main gas pipeline is 145 thousand Nm^3/h.

There are five main measuring and control stations constructed on the main gas pipe line. In addition connecting points for distribution gas pipelines to: Veles, south Serbia, Romanovce and Gostivar, are constructed on the main gas pipeline.

In addition to the main gas pipeline there are six distribution branches with a total length of 25 km. Their basic characteristics are shown in table 3.4.1.

Table 3.4.1. Characteristics of the distribution gas pipelines

Distribution pipeline to	Kriva Palanka	Ginovci	Kratovo	Kumanovo	Skopje-South	Skopje-North
Length [km]	1,5	1,7	4,6	6,97	8,3	1,8
Diameter [mm]	108	108	108	219	426	325

[28] Official Gazette of the Republic of Macedonia, no. 84 from 11.07.2008
[29] Directive 98/93/EC; Directive 2003/17/EC; Directive 2006/67/EC

In this stage of development of the gasification of the Republic of Macedonia, parts of city distribution networks have been constructed in several cities (Table 3.4.2).

Table 3.4.2. Total length of the network by city

	Skopje	Kumanovo	Kratovo	Kriva Palanka
Total length[m]	25870	5570	5900	920

Most of the gas infrastructure in the country was built in the period between 1993 and 1997. The utilization of natural gas began in the Republic of Macedonia in October 1997. ***The gas pipeline, in the past 11 years, was used less than 10% of its capacity, and in 2008 the level of transport reached 15% of full capacity.***

Currently the transmission network is operated by AD GAMA, according to the license issued by ERC. AD GAMA is a shareholding company with two shareholders, each having 50% of the shares. One of the shareholders is the state, and the other is AD Makpetrol.

In this stage of development of the gasification in the Republic of Macedonia, there practically are no distributive networks. Certain number of direct consumers are connected directly to the transmission network.

3.5. HEAT PRODUCTION SECTOR

Heat is produced (2006) in heating plants (55%), individual boiler rooms that produce heat for their own purposes (37%) and combined heat and power plants that generate heat and electricity for their own needs (8%). The fuel used includes petroleum products (71%), natural gas (19%), coal (8%) and biomass (2%). ***A large portion of the boilers is obsolete with low efficiency coefficient.***

Central heating systems

The total heating consumption connected to the central heating systems in the Republic of Macedonia and delivered to the end users is about 630 MW.

The biggest central heating system is the system operated by Toplifikacija AD, which connects about 550 MW. Several smaller systems, two of which are out of Skopje, connect about 80 MW. Considering this level of connectivity we can say that about 10% of the users in the country are connected to central heating systems. The central heating system of the city of Skopje has been operational since 1965. During the past period, the central heating system has been expanded and satisfies the heating demand of more than 40% of the city.

The heat produced in heating plants is realized using boilers that use mostly natural gas or heavy fuel oil.

The heating service is paid on the basis of the measured delivered energy at the entry point of the building. The regulation and the metering of the delivered energy to every building are performed from a central dispatching system.

From the point of view of ownership structure of the central heating systems, it is important to mention that, in most cases, these capacities are privatized. Toplifikacija AD, which controls more than 90% of the central heating systems in the country, is 100% privately owned. Its shares have been listed on the stock exchange for more than 8 years and they fulfill the strictest norms for listed companies.

The distribution network can be used by any heat producer. Currently the distribution network is operated by Toplifikacija AD which has signed a contract for use

with the state. The pumping stations in the buildings are owned by the buildings together with the connection of the building after the last man hole of the building. This ownership structure of the central heating system eliminates the possibility for monopolistic behavior and different companies can perform any of the activities of production, distribution and supply.

Four central heating plants currently functions within the system of Toplifikacija AD – Skopje. These are distributed throughout the city. They are:

- Central heating plant "Istok" with five boilers with a total of 279 MW installed hot water boiler capacity and 14.8 MW steam boiler capacity;
- Central heating plant "Zapad" with five boilers with a total of 171 MW installed hot water boiler capacity and 11.9 MW steam boiler capacity;
- Central heating plant "11 Oktomvri" with three boilers with a total of 28.2 MW installed hot water boiler capacity;
- Central heating plant "Skopje - Sever" as a separate commercial entity with 2 boilers installed with total capacities of 40 - 46 MW.

Currently the central heating plants "Istok", "11 Oktomvri" and "Skopje – Sever" are completely adapted so that they can utilize both types of fuel (heavy fuel oil and natural gas), while the central heating plant "Zapad", because of the absence of a gas pipeline in its proximity, is incapable of combustion natural gas. This is expected to change within the next 1 to 2 years when the operator GA-MA completes the gas network ring around Skopje.

The total constructed length of the distributive central heating network (length of channel distribution including supply and return pipelines), which is owned by the Republic of Macedonia is about 185 km (as of 1.01.2008).

The total installed heat consumption connected to the network is about 650 MW. There a total of almost 3 thousand buildings connected with a total heated surface of about 4.5 million m^2. The total active heat consumption connected to the network is about 550 MW.

The second major central heating system is the branch office "Energetika" of AD ELEM with steam boilers with a total installed power of 96 MW. In the past period "Energetika" increased the annual heat production from 18000 MWh in 2000 to 40000 MWh in 2007. This capacity is fueled with natural gas.

Currently, in Macedonia there is no clear delineation between heat production, distribution and supply.

3.6. RENEWABLE ENERGY SOURCES

The renewable energy sources used in Macedonia include primarily hydropower (for electricity production), energy from biomass (mostly wooden mass in the residential sector), geothermal energy (mostly for heating greenhouses) and some solar energy (in the residential sector). The utilization of renewable energy sources is supported with a whole host of measures (the most significant of which is the stimulation of electricity generation from renewable energy sources through the use of feed-in tariffs) and their use is expected to increase in the future. In that context it is necessary to finalize the legislation and eliminate the administrative barriers. Since renewable energy sources are an area of special interest, a separate study examining the use of RES will be prepared.

3.6.1. Hydropower

The Republic of Macedonia has available hydropower potential. This issue is treated in the chapters that look at the present and planned electricity production.

3.6.2. Biomass for combustion

The types and regional distribution of the sources of biomass in Macedonia depend on the features of each individual region. Biomass is mostly available is the agricultural and forest regions of the country. Out of the total biomass used for energy purposes, wood and wood coal account for 80%. The Republic of Macedonia also makes use of the grape vine branches, rice shells and fruit tree branches for energy purposes. However most of the straw is used as fertilizer, fodder and cellulose production. Therefore it is not available for energy purposes.

The Forestation Fund, which functioned until 1990, helped afforest more than 140000 ha of barren land, which in turn increased the area under forest with an index of 1.6. Out of the 10000 afforested hectares a year in the seventies and the eighties of the past century, afforestation in the last ten years declined to about 2000 hectares a year. Out of that, about 75 % are evergreen and the remainder are deciduous trees. The afforestation activities that are implemented in the last few years in cooperation with the Government of the Republic of Macedonia and the nongovernmental sector are encouraging.

The forest land in the Republic of Macedonia accounts for 11600 km^2 (1.16 million ha) of which the total surface area under forests is 960,000 ha (as of 31.12.2006). The total wooden mass is about 74 million m^3, and the total annual growth is 1.85 million m^3 with an average annual growth per hectare of 2.02 m^3.

The state owned forests account for 90.14 % of the total surface, while their total share of wood reserves is 92.2 %. Private forests account for 9.86 % (104 thousand ha) of the total afforested surface area and they participate with 7.8 % in the total wood reserves. Private forests have relatively small surface area, smaller than 1 ha, and they are fragmented in individual or grouped plots which represent enclaves in the state owned forests.

Out of the total surface area under forests and forest land, about 8% is unregulated (without commercial bases).

Forestry in the Republic of Macedonia is a commercial branch which participated with 0.3% – 0.5% in the gross national product. However this contribution is significantly bigger, if the general benefits to society are taken into account.

Forestry participates in the national economy mainly through the work of the Public Enterprise "Makedonski Shumi", which was established by a governmental decision on 15.12.1997. The core function of this enterprise is to manage the state owned forests, including usage, cultivation and protection of the forest. After 2001, this enterprise supplies the market with 600 thousand m^3 – 720 thousand m^3 fire and technical wood a year[30], and the private forests supply an additional 120 thousand m^3 – 180 thousand m^3. About 90% of that are deciduous, and the remainder are evergreen trees.

The total volume of cut wood in Macedonia is presented in table 3.6.2.1.

[30] Statistical yearbook for the Republic of Macedonia, 2007.

Table 3.6.2.1. Cut wood in the forests in the Republic of Macedonia [31]

In thousand m^3					
Year	2002	2003	2004	2005	2006
State forests	657	764	724	682	821
Private forests	153	166	121	139	80
Technical wood	133	142	141	158	162
Firewood	602	709	642	600	662
Residuals	75	79	62	63	77
Total wood mass	**810**	**930**	**845**	**821**	**901**

Having in mind that, according to their form of cultivation, 65% of forests are low height forests that do not have any technical mass, it logically follows that they will be used for firewood production. Out of the total production of forest assortments, firewood accounts for 70% to 75%. However this piece of information cannot be considered as accurate since a large portion of the population acquires firewood through illegal tree cuttings and therefore this firewood supply cannot be registered.

3.6.3. Geothermal systems

So far on the territory of the Republic of Macedonia there are 18 known geothermal fields, with more than 50 geothermal sources and wells. The total outflow is about 1000 l/s, with temperatures from 20ºC – 78ºC.

The utilization of thermal waters in the Republic of Macedonia comprises few geothermal projects and several spas. All of these have been completed and are operational since the 1980s.

The investigated geothermal potential shows that Macedonia does not have any sources that will facilitate electricity production. This requires geothermal water at a temperature of 120^{o}C in order for the project to be feasible.

This potential is being used locally, mainly to satisfy heating demand. This potential is mainly (mostly) used to heat greenhouse complexes. In the industry (in Kochani) it was used for heating of administrative buildings and for preparation of hot water in the paper factory (which has not been operational for a longer period of time now).

A very small amount of energy is used to heat buildings (several administrative buildings in Kochani, the hotel complex "Car Samuil" with the surrounding facilities, as well as the facilities in "Negorski Banji").

In the last few years the utilization of this type of fuel declined from the regular 500 TJ – 600 TJ (11.9 - 14.3 ktoe) to about 420 TJ - 430 TJ (10 - 10.3 ktoe)..

Lately there are some activities for modernization of the geothermal system Geoterma in Kochani. These activities are being implemented with financial assistance from the Austrian government. Currently a new exploitation well is under construction as well as new investigative drillings in the Kochani field region. Additional capacities are planned for the Strumica area pending additional investments in investigations. In addition, there are plans to recover part of the used geothermal water (reinjection) through the existing wells in the Bansko spa, with previously eliminating the colloid material accumulated in the water.

Geothermal water is also significantly used in balneology.

[31] Statistical yearbook for the Republic of Macedonia, 2007.

3.6.4. Solar thermal collectors

In 2006, in Macedonia there were 4280 solar collection systems, with a total installed capacity of 12 MW_{th} and collector surface area of 17 thousand m^2 which delivered 7.4 GWh (0.6 ktoe)[32] of heat.

[32] Weiss W, Bergmann I, Faninger G.: Solar Heat Worldwide - Markets and Contribution to the Energy Markets and Supply 2006, Edition 2008. AEE INTEG, IEA Solar Heating and Cooling Programme, May 2008. p. 7- 13 , http://www.iea-shc.org/publications/statistics/IEA-SHC_Solar_Heat_Worldwide-2008.pdf

4. ENERGY CONSUMPTION IN THE PERIOD 1996-2007

The analysis of the energy consumption during the period 1996-2007, as a basis for defining the baseline and the change trends, has been implemented using the data from the State Statistical Office of the Republic of Macedonia, the International Energy Agency (IEA[33]), the Ministry of Economy, data obtained from ELEM, MEPSO, EVN Macedonia, OKTA and other relevant sources. Considering that the definition of complete relevant input data is a prerequisite for preparing and good quality development strategy, special attention has been devoted to this part. Through a detailed analysis of the data, it was concluded that the data obtained from the IEA are the most appropriately processed and best presented data. Having this in mind, as well as the fact that IEA obtains its statistical information for the Republic of Macedonia from the State Statistical Office of the Republic of Macedonia, it was decided that this Strategy will use IEA's data as a starting point. Considering that during the preparation of the Strategy, neither IEA nor the State Statistical Office of the Republic of Macedonia had published statistical data for 2007 it was decided to take 2006 as a baseline year, except for the sections where the authors had sufficiently reliable, relevant data for 2007. The data for 2007 are mostly taken from the Energy Balances of the Ministry of Economy of the Republic of Macedonia[34].

In specific cases, an analysis was performed of the energy consumption in a longer period of time, i.e. from 1990 to 2006, in order to get additional information about the development of consumption.

4.1. TOTAL PRIMARY AND FINAL ENERGY CONSUMPTION

Figure 4.1.1 provides the total primary energy consumption, the primary energy production and net imports as well as the energy quantities which replenished or depleted (-) the energy reserves in the country during a given year. The same figure also shows the final energy consumption. There is an obvious mild growth of the primary and final energy consumption during the last years. However, if one looks at a longer period of time, the energy consumption practically does not change, with the exception of some downward and upward oscillations. The TPEC/TFEC efficiency is within the limits of 55% to 62%. In the developed European countries, in particular the European countries members of the Organization for Economic Cooperation and Development (OECD)[35], 72% of the total primary energy consumption are transformed into final energy. This points to the low efficiency of our energy sector regarding energy transformation and transmission of energy to the end users.

There is a notable increase of imports in the past period. Since 1999, when the total primary energy consumption was equal to the consumption in 2006, the energy imports relative to the primary energy consumption has grown from 37% to 48%. This puts Macedonia in the group of countries which are strongly dependent on energy imports. Macedonia imports its total demand for oil and petroleum products and natural gas and, since 2000, electricity. The only existing energy resources in Macedonia are

[33] © OECD/IEA, [2008], IEA Online Database: Energy Balances of Non-OECD and OECD Countries and Energy Statistics of Non-OECD and OECD Countries

[34] Energy balance of the Republic of Macedonia for 2008, Ministry of Economy

[35] © OECD/IEA, [2008], IEA Online Database: Energy Balances of Non-OECD and OECD Countries and Energy Statistics of Non-OECD and OECD Countries

lignite, hydropower, and biomass, as well as, to a smaller extent, geothermal, solar and wind energy.

The developed European countries are also strongly dependant on energy imports, and import 45% of their primary energy[36].

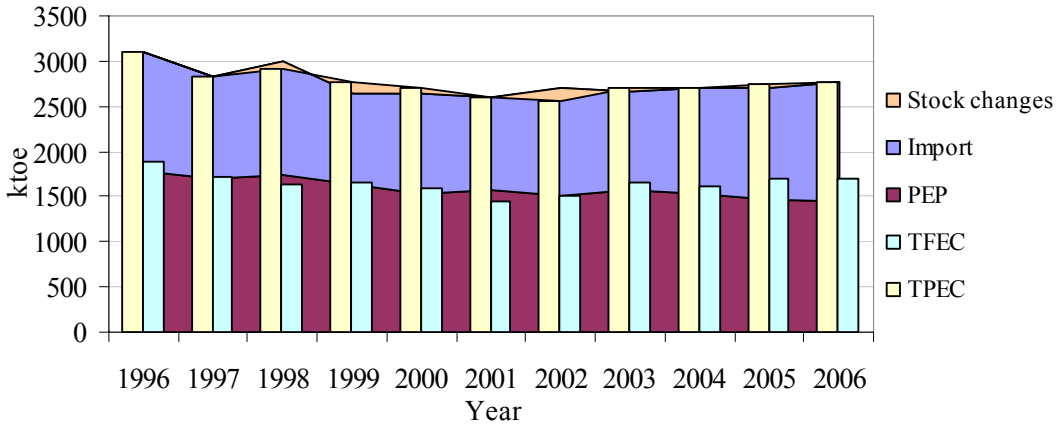

Figure 4.1.1. Total primary and final energy consumption (TPEC and TFEC), primary energy production (PEP), net import and change in the domestic reserves during the period 1996-2006[37]

The Republic of Macedonia consumes very little primary energy per capita. The final energy consumption per capita is also small (Figure 4.1.2).

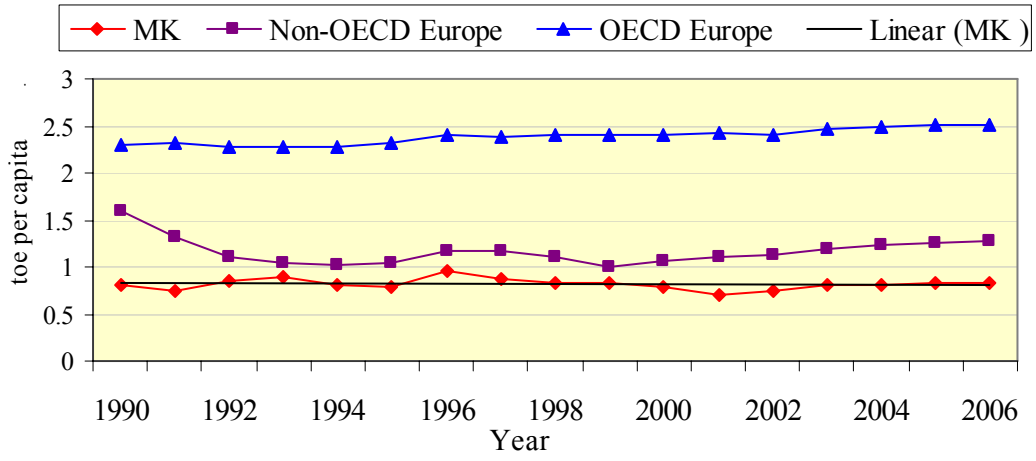

Figure 4.1.2. Final energy consumption per capita[38]

The final energy consumption per capita shows a mild upward trend in 2001, but when one looks at the entire period from 1990-2006, it is virtually constant. The final energy consumption per capita in Macedonia in 2006 is three times lower than the average consumption in the European countries members of the Organization for Economic Cooperation and Development (OECD Europe) and 35% less than the average

[36] © OECD/IEA, [2008], IEA Online Database: Energy Balances of Non-OECD and OECD Countries and Energy Statistics of Non-OECD and OECD Countries
[37] © OECD/IEA, [2008], IEA Online Database: Energy Balances of Non-OECD and OECD Countries and Energy Statistics of Non-OECD and OECD Countries
[38] © OECD/IEA, [2008], IEA Online Database: Energy Balances of Non-OECD and OECD Countries and Energy Statistics of Non-OECD and OECD Countries

of the European countries that are not members of the OECD (non-OECD Europe). This parameter will remain low in 2020 even if Macedonia achieves a 3% growth of the final energy consumption per year. In that case, the final energy consumption per capita in Macedonia in 2020 will be equal to that of the less developed European countries (non-OECD Europe) in 2006 and 2 times less than that of the developed European countries (OECD Europe) in 2006.

As a result of the exceptionally low gross domestic product (GDP) per capita, Macedonia belongs to the group of countries with high primary and final energy consumption per unit of GDP, in spite of the low energy consumption per capita. Since 1996, this value decreases but not fast enough. The primary energy consumption per unit of GDP in 2006 was 3.7 times greater than the average in the developed European countries (Figure 4.1.3).

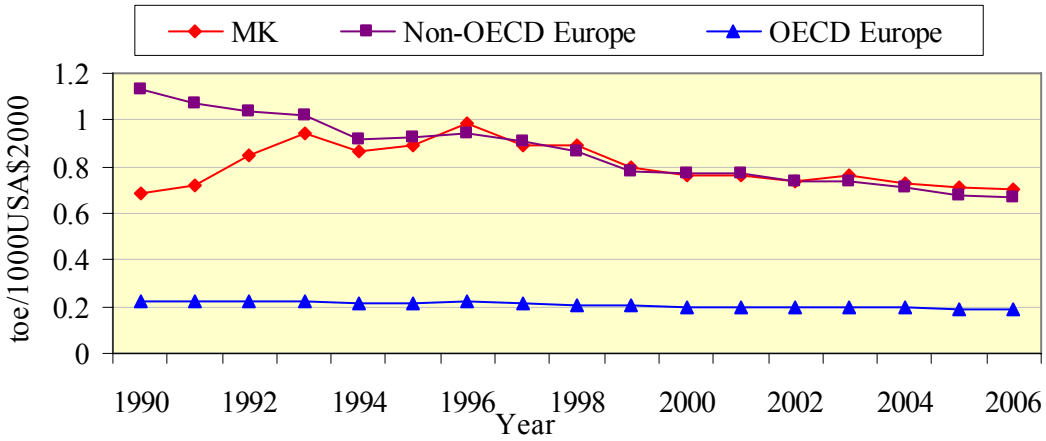

Figure 4.1.3. Primary energy consumption per unit of GDP in Macedonia[39]

When calculating GDP using purchasing power parity the situation is more favorable (Figure 4.1.4), but still not good enough. In 1990 we were at the level of the developed European countries, whereas in 2006 Macedonia had an even higher value than that in 1990, and the developed European countries reduced their specific primary energy consumption by about 25%.

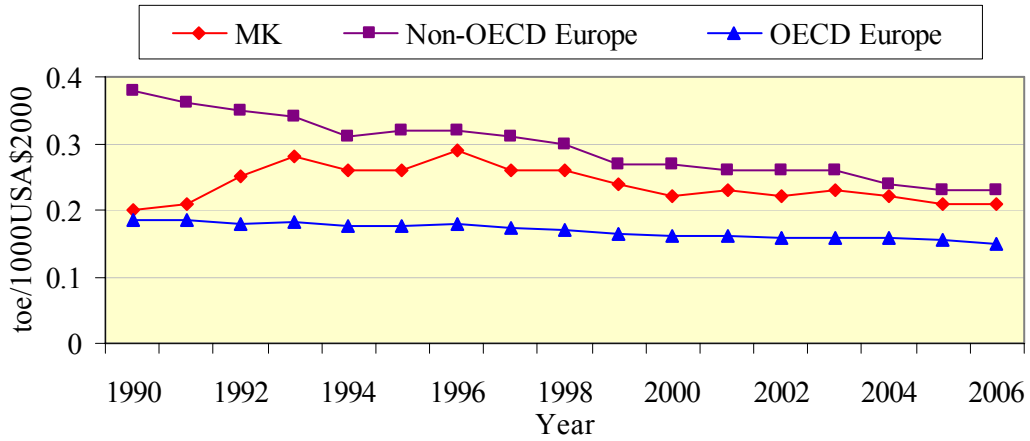

Figure 4.1.4. Primary energy consumption per unit of GDP, according to purchasing power parity[40]

[39] © OECD/IEA, [2008], IEA Online Database: Energy Balances of Non-OECD and OECD Countries and Energy Statistics of Non-OECD and OECD Countries

4.2. PRIMARY ENERGY CONSUMPTION BY FUELS

The share of the different fuels in the total primary energy consumption is provided in Figure 4.2.1 and in Table 4.2.1.

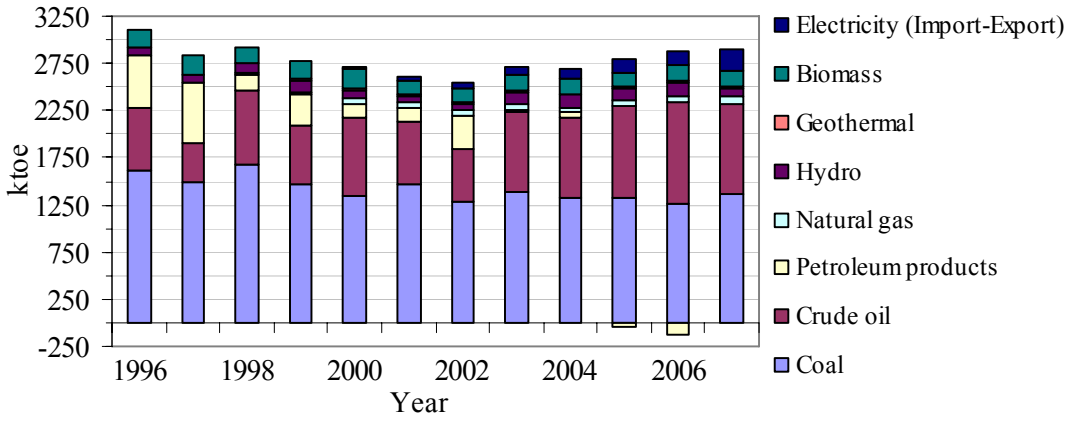

Figure 4.2.1. Primary energy consumption[41]

It is notable that coal (with a share of 45.5% in 2006), primarily lignite and crude oil and petroleum products (35%) have a prominent place in the primary energy consumption. They are followed by biomass with 6%, the imported electricity with 5.6%, hydropower with 5.1%, natural gas with 2.4% and geothermal energy with 0.4%.

Table 4.2.1. Primary energy consumption by fuels in ktoe[42]

	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007[43]	P1%	P2%
Coal	1606	1496	1681	1472	1344	1478	1291	1387	1330	1332	1254	1358	-1.5	-15.4
Crude oil	670	408	774	609	820	655	548	845	848	967	1089	964	3.4	43.9
Petroleum products	566	646	178	336	153	140	349	28	49	-53	-124	0		
Natural gas	0	0	17	33	54	72	74	66	58	63	67	86		
Hydro	73	77	93	119	101	54	65	118	127	128	142	83	1.2	13.7
Geothermal	12	12	19	15	16	23	13	13	12	10	10	12	0.0	0.0
Biomass	187	187	152	180	212	149	147	171	171	154	166	169	-0.9	-9.6
Electricity (import-export)	-2	6	0	-9	10	37	68	82	101	138	154	224		
TOTAL	**3111**	**2833**	**2915**	**2756**	**2709**	**2608**	**2555**	**2711**	**2698**	**2739**	**2759**	**2891**	-0.7	-7.1

4.2.1. Coal

Coal is the basic fuel in the total primary energy consumption. Domestic lignite takes the biggest share since it is used to generate electricity.

The consumption of lignite used for electricity production, from the surface mines Suvodol and Oslomej is shown on Figure 4.2.1.1. There are certain variations depending on the hydrological conditions during the year and the availability of the mines and thermal power plants.

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[40] © OECD/IEA, [2008], IEA Online Database: Energy Balances of Non-OECD and OECD Countries and Energy Statistics of Non-OECD and OECD Countries

[41] © OECD/IEA, [2008], IEA Online Database: Energy Balances of Non-OECD and OECD Countries and Energy Statistics of Non-OECD and OECD Countries

[42] © OECD/IEA, [2008], IEA Online Database: Energy Balances of Non-OECD and OECD Countries and Energy Statistics of Non-OECD and OECD Countries

[43] The values for the year 2007 are taken from the Energy Balance of Republic of Macedonia, prepared by the Ministry of Economy

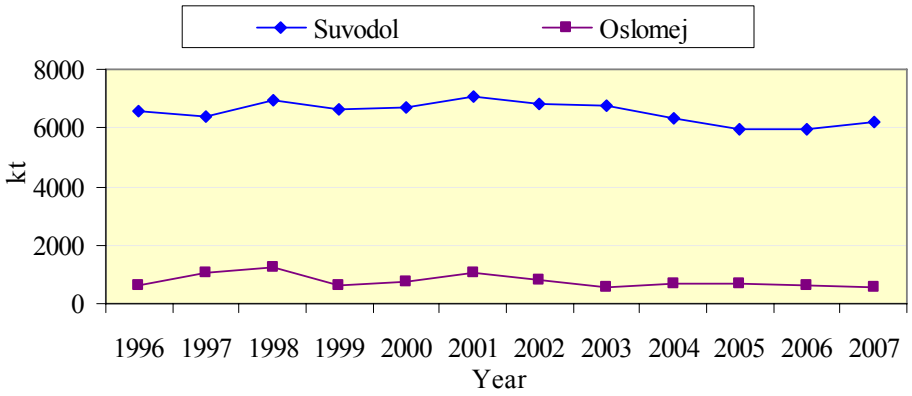

Figure 4.2.1.1. Consumption of domestically produced lignite[44]

The annual exploitation of lignite from the mine BRIK Berovo ranges between 35 and 70 thousand tons, and the exploitation from the Drimkol mine ranges between 40 and 70 thousand tons, depending on the demand.

The primary consumption of the other types of coal is imported. There are notable variations in the consumption of these coals (130 - 200 ktoe per year) primarily because of the variations in the production cycles of the industrial capacities which are the main consumers of these coal types.

4.2.2. Oil and petroleum products

The participation of oil and petroleum products in the primary energy consumption comprises, in fact, the imported crude oil and the imported petroleum products. After 2004 there is a significant increase of the consumption and the import of crude oil in comparison to the petroleum products.

4.2.3. Biomass

After lignite, biomass is the second most significant fuel from the domestic energy sources, in the energy balance of the Republic of Macedonia. It participates with 166 ktoe (1930 kWh; 6950 TJ), which is 11.5 % of the total produced energy in the Republic of Macedonia (in 2006)[45], or 6% of the total consumed primary energy. In the total biomass used for energy purposes, wood and wood coal participated with 80%. The unidentified consumption of fire wood is assessed at 25% - 35% of the registered firewood consumption.

4.2.4. Electricity

According to the methodology of Eurostat, the imported electricity is considered primary energy. As shown in table 4.2.1 the electricity imports grows starting from the year 2000. Due to increased electricity demand and the unfavorable hydrological conditions, in 2007 the import reached levels of about 2600 GWh (224.ktoe).

[44] Ministry of Economy, energy balance of the Republic of Macedonia
[45] © OECD/IEA, [2008], IEA Online Database: Energy Balances of Non-OECD and OECD Countries and Energy Statistics of Non-OECD and OECD Countries

4.2.5. Hydropower

In the energy balance for 2006, the hydropower participated with 5% of the total primary energy consumption. However, the consumption of hydropower in Macedonia varies strongly (600 to 1650 GWh) depending on the meteorological conditions, and, in the analyzed year 2006 it reached an extremely high value. The years of 2007 and 2008 were under average.

4.2.6. Natural gas

In spite of the great advantages of natural gas, this fuel was not used to any great extent in the last ten years to satisfy the energy demand of the country. In 2007, the natural gas consumption was 107 million Nm^3 (86 ktoe). For 2008 the consumption was assessed to be about 120 million Nm^3 (97 ktoe). In the total gas consumption for 2008, "Toplifikacija" AD and "Skopje Sever" participated with more than 50 million Nm^3 (40 ktoe), about 20 million Nm^3 (16 ktoe) is the share of AD ELEM's branch office "Energetika" which also produces and distributes heat, and the remaining 50 million Nm^3 (40 ktoe) account for the industrial users dominated by MAKSTIL with about 30 million Nm^3 (24 ktoe) per year.

4.2.7. Geothermal energy

The geothermal energy consumption, according to the available statistical data, is very variable, but globally, in the 1996-2001 period it grew from 502 to 963 TJ (12 ktoe to 23 ktoe) and then it has a downward trend to 419 TJ (10 ktoe) in 2006.

4.2.8. Solar energy

In the analyzed period, solar energy has a modest share of the energy balance. In 2006 Macedonia consumed 7.4 GWh (0.6 ktoe)[46] of heat, which represents 0.02 % of the total primary energy consumption.

4.3. FINAL ENERGY CONSUMPTION BY FUELS

The final energy consumption, in fact represents the part of the primary input energy which, after being transformed using appropriate energy transformation technologies, is used as final effective energy in the different sectors. The final energy consumption by sectors is shown in Figure 4.3.1 and Table 4.3.1.

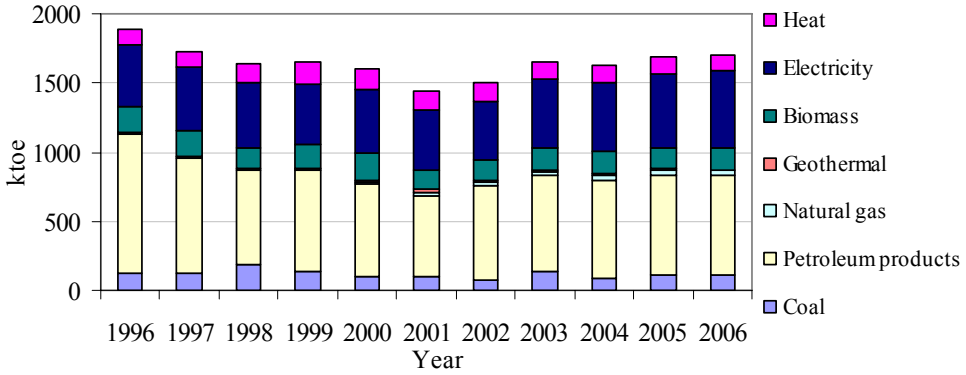

Figure 4.3.1. Final energy consumption

[46] Weiss W, Bergmann I, Faninger G.: Solar Heat Worldwide - Markets and Contribution to the Energy Markets and Supply 2006, Edition 2008. AEE INTEG, IEA Solar Heating and Cooling Programme, May 2008. p. 7- 13 , http://www.iea-shc.org/publications/statistics/IEA-SHC_Solar_Heat_Worldwide-2008.pdf

Table 4.3.1. Final energy consumption by fuels in ktoe[47]

	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	P1%	P2%
Coal	124	120	186	137	104	95	69	138	90	109	117	-0.6	-5.6
Petroleum products	1006	837	678	727	670	587	686	689	707	726	713	-3.4	-29.1
Natural gas	0	0	0	4	7	26	32	30	32	33	34	35.8	
Geothermal	11	11	17	14	15	21	12	12	11	9	9	-2.0	-18.2
Biomass	187	187	149	172	204	143	141	165	166	151	163	-1.4	-12.8
Electricity	446	459	470	440	448	432	428	490	496	536	554	2.2	24.2
Heat	112	112	145	157	153	132	136	128	122	127	118	0.5	5.4
TOTAL	**1885**	**1727**	**1645**	**1651**	**1601**	**1436**	**1504**	**1653**	**1624**	**1691**	**1708**	-1.0	-9.4

Analogously as in the case of primary energy consumption, there is a notable growth of the final energy consumption as well starting from the year 2001 and the consumption in 2006 is at the level of the average consumption for the period 1990-2006. The share of the different fuels in the final energy consumption for 2006 is provided in Figure 4.3.2.

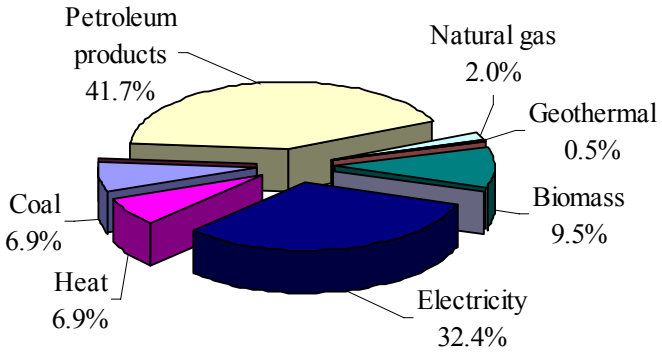

Figure 4.3.2. Share of the different fuels in the final energy consumption for 2006

The biggest share in the final energy consumption is that of petroleum products with 42% (in OECD Europe countries this share is 46%) and electricity with 32% (OECD Europe, 19%). Next in line are biomass with 10% (OECD Europe, 5%), heat and coals with 7% each (OECD Europe, 4% each), natural gas with 2% (OECD Europe, 21%) and geothermal energy with 1% (OECD Europe, 0.2%). In 2006 solar energy had a 0.04% share of the total final energy consumption (OECD Europe, solar and wind together 0.1%), but this is not registered in the official statistical data.

We can conclude that, compared to the developed European countries, the natural gas has a very low share in Macedonia's final energy consumption while the electricity consumption is very high. With a consumption of 1.80 kWh/US$2000 in 2006 Macedonia had nearly 5.5 times greater specific electricity consumption than that of the developed European countries.

4.3.1. Electricity

Figure 4.3.1.1 provides information about the electricity consumption in Macedonia in the period 1996-2007[48].

[47] © OECD/IEA, [2008], IEA Online Database: Energy Balances of Non-OECD and OECD Countries and Energy Statistics of Non-OECD and OECD Countries

[48] Data received from AD ELEM, AD MEPSO and EVN Macedonia AD

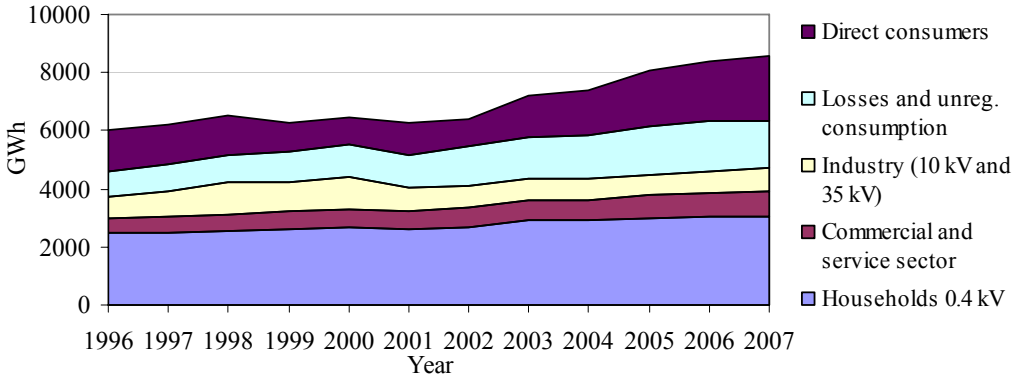

Figure 4.3.1.1. Electricity consumption

It can be noted that the demand for electricity continuously grows, and, in the last five years, the total consumption increased at an annual rate of 4.46%. This growth is caused by the restart of the large consumers (FENI, Silmak and the steel industry), where their annual growth is about 11.5%. The distributive consumption has had a constant increase, in the past ten year period, of about 2.5%.

Figure 4.3.1.2 shows the relative share of certain categories of consumers for 2007. It is notable that the residential sector participates with 36%, large consumers participate with 26%, the share of the small industry is 9%, and the share of losses is about 19%.

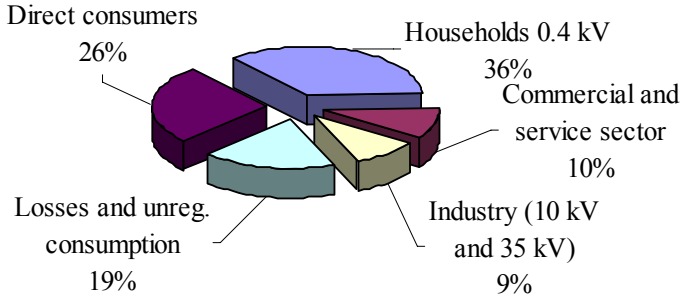

Figure 4.3.1.2. Percentage share of the different categories of consumers for 2007

Figure 4.3.1.3 provides information about the electricity supply in Macedonia for the period 1996-2007.

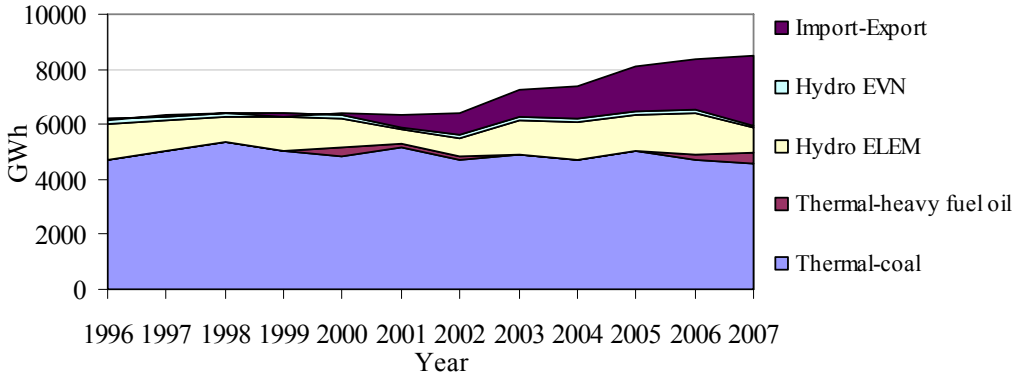

Figure 4.3.1.3. Balance of the electricity supply

In the period from 1996 to 2007 the coal fired thermal power plants and the hydropower plants generated on average 6100 GWh (from 5469 GWh in 2002 to 6,482 GWh in 2005). The share on the hydropower plants in that quantity was 19.8% on average. This share, depending on the annual hydrologic conditions, varies from 11% (2001) to 26% (2006). Negotino was turned on only sometimes due to the high price of heavy fuel oil. Since 2000, the difference between the production and the growing consumption was filled from imports.

In 2007, the coal fired thermal power plants (Bitola and Oslomej) participated with 53%, and because of the dry hydrology, the share of the hydropower was 12%, TPP Negotino share was 5% and the share of the imports was 30%.

4.3.2. Heat

The heat consumption of 112 ktoe (4689 TJ,1303 GWh) in 1996 grew to 157 ktoe (6573 TJ, 1826 GWh) in 1999, and since then it has declined to 118 ktoe (4940 TJ, 1372 GWh) in 2006.

In 2006 the heat was generated (Table 4.3.2.1) in heating plants (55%), individual boilers that generate heat for own needs (37%) and combined heat and power plants for own needs (8%). The petroleum products (71%), natural gas (19%), coal (8%) and biomass (2%) are fuels used for production of heat. The image is slightly changed in 2007 and 2008 when Toplifikacija AD Skopje increased the natural gas consumption at the expense of heavy fuel oil.

Table 4.3.2.1. Heat production in 2006 (GWh)

	Petroleum products	Coal	Natural gas	Biomass	Total	Generated heat
CHP	116	70	12	0	198	127
Heating plants	756	0	198	0	954	870
Boilers	512	93	163	35	802	591
Total	1384	163	372	35	1954	1588
Own consumption						129
Distribution losses						82
Final heat						1377

4.3.3. Petroleum products

The final consumption of petroleum products varied during the period 1996-2008 (Figure 4.3.3.1) however generally it has declined from nearly 1200 ktoe in 1996 to nearly 800 ktoe in 2008 (the consumption according to the official statistical data given in Table 4.3.1 is 100 to 200 ktoe lower). The reasons for this are different.

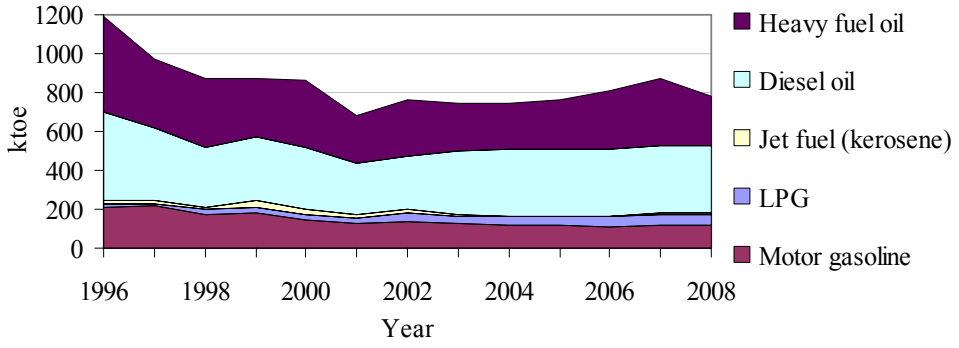

Figure 4.3.3.1. Final petroleum products consumption[49]

[49] Import export declaration, estimate for 2008

Overall, the heavy fuel oil consumption decreases because this fuel is being replaced with natural gas in some central heating plants and industrial capacities. Nevertheless, in some years there are growing peaks, depending on the demand of the TPP Negotino. The diesel fuel, after the drop of consumption during the period 1996-2001, shows constant consumption with a slight upward trend. It can be noted that there is a significant decline of engine petrol consumption on the account of the liquid petrol gas (LPG) consumption. The increasing trend of the liquid petrol gas consumption can be attributed to the increased use of this product as a driving fuel in transportation.

The dominant fuels are diesel and heavy fuel oil with respective shares in 2006 of 42.4% and 37.1%, followed by engine petrol with 13.3%, liquid petrol gas with 6.7% and kerosene with 0.5%.

4.3.4. Natural gas

Natural gas, as a form of final energy, is used only in industry. There are activities underway to introduce natural gas in the residential sector and in the other sectors. Natural gas entered the industry in 1998 and several industrial capacities were connected to natural gas until 2002. From 2002 to 2006 the natural gas consumption in the form of final energy stagnates, and begins to increase after 2006 because of the production increase of several industrial facilities, primarily MAKSTIL. The consumption of natural gas as final energy in 2008 is assessed to 50×10^6 Nm^3 (40 ktoe).

4.3.5. Biomass

Out of the total consumption of biomass as primary energy, only 2%-4% are used to produce heat in central heating plants and the rest is used in the form of final energy. With consumption of 163 ktoe (1900 GWh, 6800 TJ) and a share of almost 10% in the total final energy consumption in 2006, biomass ranks third after petroleum products and electricity.

4.3.6. Coal

Coal participated with 7% in the final energy consumption in 2006 (117 ktoe). The coal consumption varies depending on the industrial production, primarily the iron and steel metallurgy, non-ferrous metallurgy and the cement industry. There is a mild grow of the coal consumption in the recent years.

4.3.7. Geothermal energy

Geothermal energy in Macedonia is used solely in the form of final energy. Therefore, the geothermal energy consumption by sectors is different than the geothermal energy as primary energy (Chapter 4.2.7) only by the losses in transmission of about 10%. The share of geothermal energy in the final energy consumption in 2006 was about 0.5%. Most of the geothermal energy is used in greenhouses, and only a small part (10%-20%) is used for heating in the commercial sector and the service sector.

4.3.8. Solar energy

In 2006, the share of solar energy in the final energy consumption was 7.4 GWh (0.6 ktoe), or 0.04%.

4.4. FINAL ENERGY CONSUMPTION BY SECTORS

In addition to dividing the final energy consumption by fuels, the analysis also divides this type of consumption by sectors in order to facilitate the analysis of each sector, i.e. to see the energy demand in each sector separately. Table 4.4.1 provides an overview of the final energy consumption by sectors, and Figure 4.4.1 provides a graphical overview.

Table 4.4.1. Final energy consumption by sectors (ktoe)

		ktoe												
		1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	P1%	P2%
Industry	Electricity	177	180	182	135	134	131	115	152	157	184	191	93.4	7.9
	Heat	67	67	93	105	102	79	79	62	61	63	57		-14.9
	Petroleum products	258	184	155	114	186	131	148	132	134	163	183		-29.1
	Natural gas	0	0	0	4	7	26	32	30	32	32	33	16.4	
	Coal	109	106	181	124	99	91	63	131	78	102	110	99.2	0.9
	Biomass	0	0	2	2	2	1	1	1	2	5	3	70.1	50.0
	Total Industry	**611**	**537**	**613**	**484**	**530**	**459**	**438**	**508**	**464**	**549**	**577**		-5.6
Residential	Electricity	214	216	220	226	228	224	231	249	250	257	262	83.3	22.4
	Heat	28	28	29	37	33	38	40	44	40	43	42	69.4	50.0
	Petroleum products.	39	30	29	32	33	34	35	38	39	40	41	95.6	5.1
	Coal	8	8	5	4	4	3	3	3	3	3	3		-62.5
	Biomass	187	187	146	153	182	142	140	156	155	140	150		-19.8
	Total Residential	**476**	**469**	**429**	**452**	**480**	**441**	**449**	**490**	**487**	**483**	**498**	96.0	4.6
Commercial and service	Electricity	51	60	62	75	81	73	78	85	85	90	96	56.6	88.2
	Heat	17	17	23	15	18	15	17	21	22	21	20	86.4	17.6
	Petroleum products	0	0	62	131	40	29	92	132	99	117	93	70.1	50.0
	Natural gas	0	0	0	0	0	0	0	0	0	1	1	100	0.0
	Coal	6	6	0	9	1	1	3	4	9	4	4		-33.3
	Biomass	0	0	0	0	0	0	0	7	8	5	8	91.5	14.3
	Geothermal	1	1	2	2	3	0	1	2	2	1	1	100	0.0
	Total Com. and Ser.	**75**	**84**	**149**	**232**	**143**	**118**	**191**	**251**	**225**	**239**	**223**	37.5	
Transport	Electricity	2	1	2	2	2	2	2	2	2	2	2	10	0.0
	Petroleum products	580	521	354	397	354	337	354	339	344	346	347		-40.2
	Total Transport	**582**	**522**	**356**	**399**	**356**	**339**	**356**	**341**	**346**	**348**	**349**		-40.0
Agriculture and Forestry	Electricity	3	3	3	3	2	2	2	2	2	2	2		-33.3
	Petroleum products	91	64	45	32	41	33	19	15	48	24	19		-79.1
	Biomass	0	0	0	0	0	0	0	1	1	2	1	100	0.0
	Geothermal	9	10	15	12	12	21	11	10	8	8	8		-11.1
	Total Agr. and For.	**103**	**77**	**63**	**47**	**55**	**56**	**32**	**28**	**59**	**36**	**30**		-70.9
Non-energy use	Petroleum products	38	39	33	20	16	24	38	33	43	35	29		-23.7
	Biomass	0	0	1	17	20	0	0	0	0	0	0		
	Total Non-energy use	**38**	**39**	**34**	**37**	**36**	**24**	**38**	**33**	**43**	**35**	**29**		-23.7
	TOTAL	**1885**	**1728**	**1644**	**1651**	**1600**	**1437**	**1504**	**1651**	**1624**	**1690**	**1706**	109	-9.5

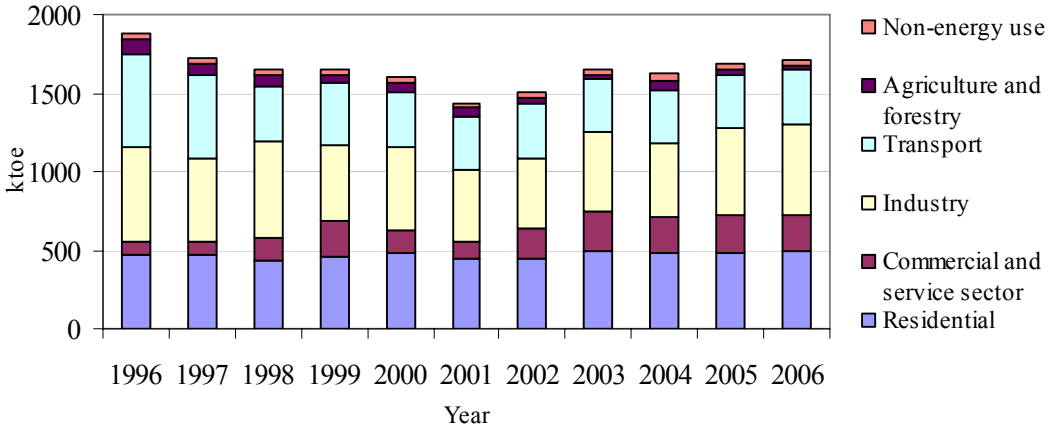

Figure 4.4.1. Final energy consumption by sectors[50]

The biggest growth in the final energy consumption, in the last 4 years was noted in the industry, and the growth rate was 7.15% which can be attributed to the reactivation of the electric and metallurgy capacities (FENI, SILMAK and Zhelezara). This sector is followed by the commercial and the service sector with an annual rate of almost 4%, followed by the residential sector with 2.64%.

The energy consumption in Macedonia is concentrated in four sectors (Figure 4.4.2): industry (33.8%), the residential sector (29.2%), transportation (20.5%), and commercial and service (13.1%). The agriculture and forestry and non-energy use have modest consumption of 1.8% and 1.7%, respectively.

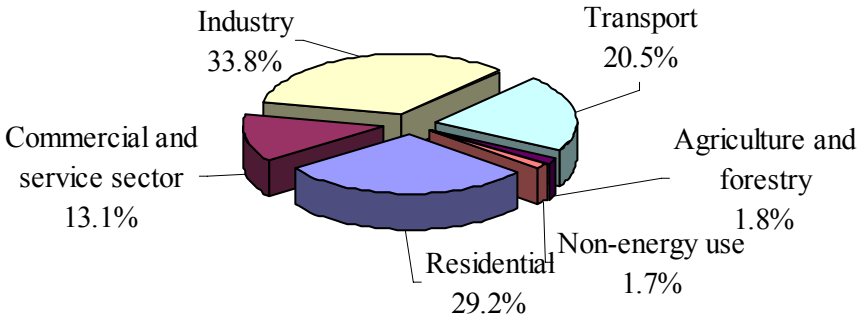

Figure 4.4.2. Final energy consumption by sector in 2006

4.4.1. Industry sector

Macedonia has a relatively high energy consumption in the industry sector even when the analysis is performed using the economic power of the country (Figure 4.4.1.1).

The industry sector used mostly electricity and petroleum products with 33% and 32% respectively in 2006, followed by coal with 19%, heat with 10%, natural gas with almost 6% and biomass with less than 1%.

[50] © OECD/IEA, [2008], IEA Online Database: Energy Balances of Non-OECD and OECD Countries and Energy Statistics of Non-OECD and OECD Countries

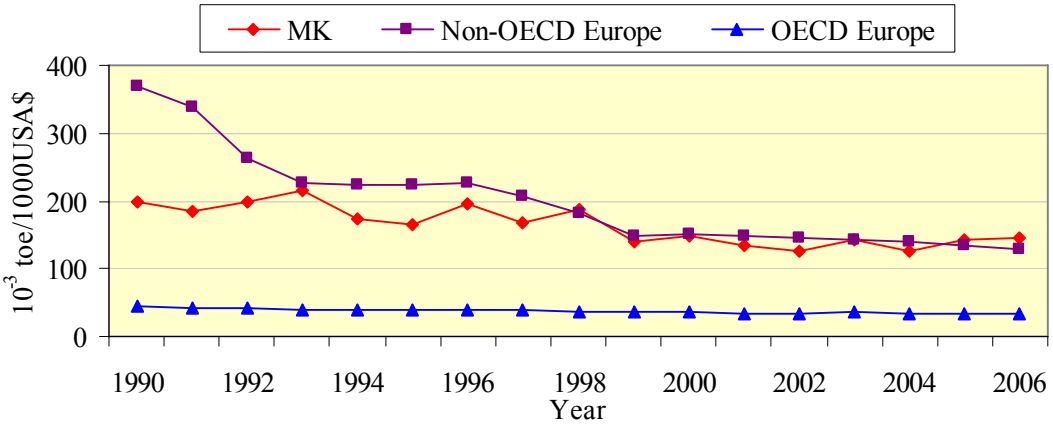

Figure 4.4.1.1. Energy consumption in the industry sector per unit of GDP[51]

With a relative share of 61% in the energy consumption in the industry (2006), the steel and ferroalloy industry is by far the most intensive consumer of practically all types of energy. It is followed by the non-metal industry (21%) and food and cigarettes industry (6%).

The electricity consumption is especially significant and fairly changeable. The variations in the electricity consumption in the Republic of Macedonia follow the oscillations in the consumption of steel and ferroalloy industry. In 2006 this industry had a share of more than 70% (1534 GWh, 132 ktoe) of the electricity consumption in the industry.

4.4.2. Residential sector

The household energy consumption in Macedonia, expressed per capita is very low. This type of consumption usually remains relatively constant for very long periods of time (Figure 4.4.2.1).

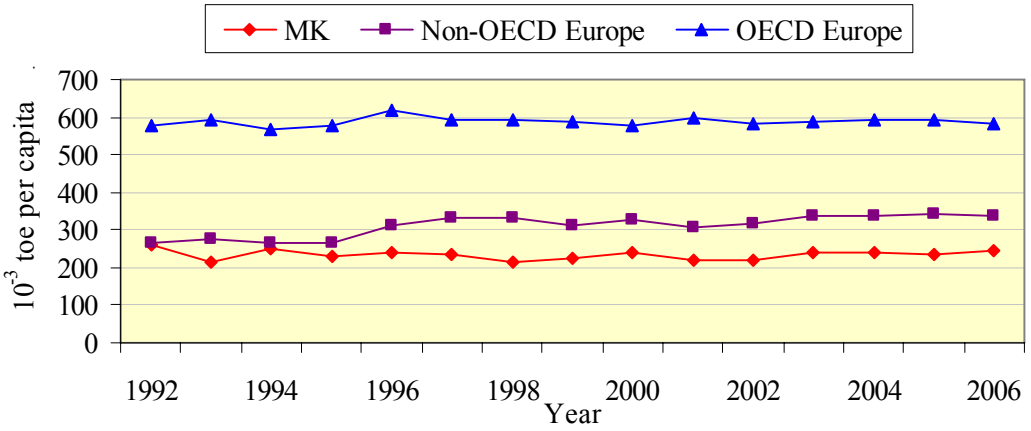

Figure 4.4.2.1. Residential sector energy consumption per capita[52]

The developed European countries have 2.6 times greater household consumption per capita than Macedonia, and the less developed European countries have a 50%

[51] © OECD/IEA, [2008], IEA Online Database: Energy Balances of Non-OECD and OECD Countries and Energy Statistics of Non-OECD and OECD Countries

[52] © OECD/IEA, [2008], IEA Online Database: Energy Balances of Non-OECD and OECD Countries and Energy Statistics of Non-OECD and OECD Countries

higher consumption than Macedonia. The actual energy consumption in Macedonia is 10% - 15% higher than official estimations, if the unregistered consumption of trees, estimated at 25%-35% of the registered consumption, and the unregistered electricity consumption, estimated at 8% of the registered electricity consumption, are introduced into the calculation.

The household energy consumption in Macedonia is also very high when expressed per unit of GDP. In 2006 the household energy consumption per unit of GDP in Macedonia was 4 times higher than the average in the developed European countries. This implies that, in spite of the relatively low consumption per capita, it is necessary to devote more attention to the measures for energy efficiency in the residential sector, i.e. measures for reducing the household energy consumption relative to the household's economic power.

The consumption is dominated by the electricity (53% in 2006) and biomass (30%). Their share is even higher when the unregistered use of biomass and electricity is included. The share of heat and petroleum products is 8% each and the coal has a modest share of 1%.

The relative share of electricity in the residential sector in Macedonia is more than twice the share of electricity in the residential sector in other European countries.

The relative share of biomass is at same level as in the European countries outside OECD and three times greater than in the OECD countries

The household heat consumption is twice the share in the European OECD countries (4%) and lower than in the European non-OECD countries (13.7%). The household heat consumption in all countries has been falling for the past ten years both in absolute and in relative quantities, whereas in Macedonia this consumption is at the same level of consumption as in 1994.

One characteristic of the European countries, particularly the developed European countries, is the large share of household natural gas consumption (close to 40%). The share of household natural gas consumption in the developed countries has continuously increased. The share of household petroleum products consumption in the developed European countries is also notable although this type of consumption decreases on the account of natural gas. The share of both natural gas and petroleum products consumption in the residential sector in the developed European countries is close to 60%. With a share of 8% in 2006, Macedonia has more than two times smaller share of petroleum products consumption in comparison to the developed European countries and Macedonian households still do not use natural gas. In that context intensive measures have to be taken to introduce natural gas in the residential sector and to increase the share of petroleum products (LPG, heating oil) on the account of electricity.

With a share of 1%, the use of coals in the residential sector in Macedonia is one fourth of the use of coals in the residential sector of the developed European countries.

4.4.3. Commercial and service sector

The energy consumption in the commercial and the service sectors, according to the data from the International Energy Agency (IEA) which are based on the data from the State Statistical Office of the Republic of Macedonia, is very variable during the analyzed period.

The energy consumption in this sector per capita is similar to that in the European non-OECD countries and 2.5 times smaller than that of the developed European countries (Figure 4.4.3.1).

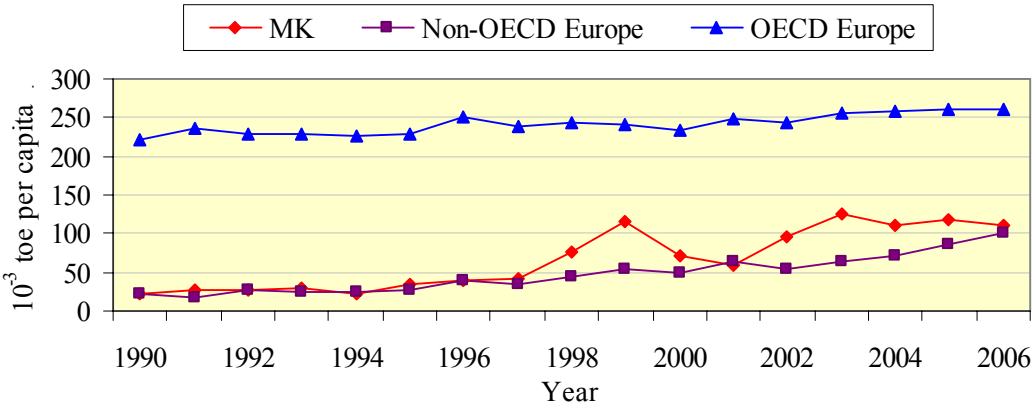

Figure 4.4.3.1. Energy consumption in the commercial and service sector[53]

However, according to the economic power, Macedonia has very high energy consumption in this sector. More than 4 times higher than in the European OECD countries and almost twice as high as in the European non-OECD countries. The decline of the consumption registered in the last three years in encouraging.

The energy consumption in this sector mainly comprises electricity with a 43% share in the consumption, and petroleum products (heating oil, the so called D2 fuel, heavy fuel oil and LPG) with almost 42% of the total energy consumption in the sector in 2006. The electricity consumption in this sector has been growing continuously during the analyzed period. The consumption of heat is relatively constant in absolute quantities and remained at 9% in 2006. The share of other fuels is small, biomass participated with 3.6%, coal with 1.8% and geothermal energy and natural gas with 0.4% each.

In the developed European countries the electricity consumption also grew continuously and reached 48% in 2006. There, the combined share of natural gas and petroleum products in the energy consumption is 46%, but their relative shares changes in favor of natural gas.

4.4.4. Transport

With a share of nearly 21%, the transportation sector is a significant consumer of energy, following the industry and the residential sector.

Compared to the member states of EU-27, the energy consumption per capita in the transportation sector is significantly smaller (Figure 4.4.4.1). The average for EU-27 is more than 710 ktoe per one thousand inhabitants, and in Macedonia this value is 170 ktoe per one thousand inhabitants. Furthermore, the data suggest that, while EU-27 countries demonstrate an upward trend of the energy consumption intensity, the energy consumption in the transportation sector in Macedonia per capita is relatively stable.

[53] © OECD/IEA, [2008], IEA Online Database: Energy Balances of Non-OECD and OECD Countries and Energy Statistics of Non-OECD and OECD Countries

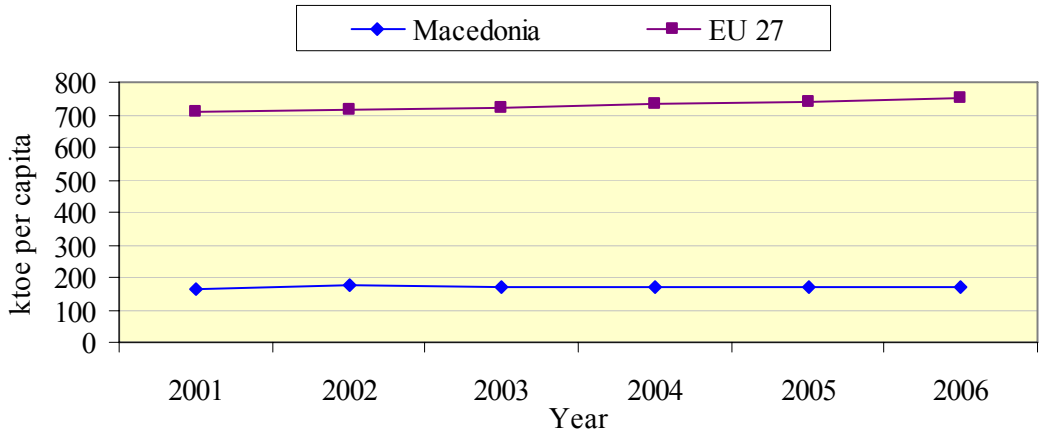

Figure 4.4.4.1. Intensity of the energy consumption in the transportation sector in the Republic of Macedonia and in EU-27[54]

Regarding the type of fuel used in the transportation sector, the fuels with the biggest share (99%) are petroleum products (petrol, diesel, kerosene, butane etc.). Electricity consumption of about 2 ktoe (24 GWh) annually (1%) represents the share consumed by the railways for powering their electric engine locomotives.

In 2006, 98% of the total consumption in the transport sector was attributed to the road traffic, the railways and the air traffic have shares of 1% each.

With respect to the type of petroleum products consumed in the transportation sector, in the period from 1990 to 2006 it is notable that the share of diesel has increased from 33% to 60% and the share of liquid petrol gas has been increasing (3.5% in 2006) while the petrol's share has declined

According to the number of vehicles, the biggest group is the vehicles using petrol, although there is a clear increasing trend of the number of vehicles using diesel fuel and a combination of petrol and LPG. In 2006, about 72% of the vehicles used petrol, 24% used diesel fuels and about 4% used a combination of petrol and LPG. The disproportion of the different types of fuel consumed in the transportation sector relative to the number of registered vehicles by type of fuels can be attributed to the fact that diesel fueled vehicles are being used more intensively, (this primarily applies to commercial vehicles – busses, cargo vehicles, tow vehicles) and have higher unit fuel consumption.

4.4.5. Agriculture and forestry

Agriculture and forestry are not a significant energy burden. Their share is less than 2% of the total final energy consumption in Macedonia. There is a notable reduction of the energy consumption in this sector in the last 10 years, from 104 ktoe in 1996 to 31 ktoe (360 GWh, 1300 GJ) in 2006.

The consumption of energy in this sector in 2006 was dominated by petroleum products (for agricultural machinery and heating of greenhouses) with 63%, followed by geothermal energy (for heating of greenhouses) with 27 %, electricity with 7 % and biomass with 3 %. The fuel distribution in the European countries is similar, but the use of geothermal energy is negligent, and instead, the share of electricity is higher and natural gas is used.

[54] Prepared based on data by: IEA Energy Statistics, Electronic Version 2008 и EUROSTAT - Energy - yearly statistics 2006 EUROPEAN COMISSION - 2008 edition

The energy consumption per capita in this sector is at the level of the non OECD European countries and three times smaller than the consumption in this sector in the developed European countries. However, the consumption per unit of GDP is somewhat higher than the consumption in the developed European countries. It is characteristic that the consumption in this sector decreases according to both indicators.

4.4.6. Non-energy purposes

The energy consumption for non-energy use in Macedonia is very small. In 2006 it was 29 ktoe (337 GWh, 1210 TJ) or 1.7% of the total final energy consumption in Macedonia. Macedonia uses only petroleum products for non-energy use,.

In comparison with the other European countries, Macedonia consumes very little energy for non-energy use per capita. In terms of GDP, this consumption is at the level of the developed European countries.

5. FINAL ENERGY NEEDS IN THE PERIOD 2008 – 2020

In order to forecast the energy consumption in Macedonia in the period until 2020, the chapter 4 analyses the energy consumption in the period between 1996 and 2007. In certain cases we analyzed the energy consumption in longer period of time, since 1990, in order to get more complete series for forecasting.

The analyzed period is characterized with great turbulences in the region such as: the military actions in the former Yugoslav republics, the embargo to Serbia, the NATO intervention in Kosovo, the refugee crisis. That culminated with the military actions in Macedonia in 2001. All these events inevitably influenced the Macedonian economy and on the energy sector in Macedonia. The privatization process brought further negative trends in the industrial production. In the transition period many companies ceased to work or minimized their production. Some industrial capacities reduced their production to 10% of their installed capacity. Few of the industries had stabile work in the period between 1989 and 2002, such as the cement, beer, food industry etc.

Except that the official statistic data on energy consumption in the analyzed period are not consistent and sufficiently accurate.

The global economic crisis started during the preparation of this Strategy and it certainly will influence the energy sector in Macedonia. In such circumstances it is not possible to forecast the development of the Macedonian energy sector only by simple extrapolation of the trends in the analyzed period. Therefore, we made several additional analyses including a comparative analysis and its results are used for the preparation of this strategy.

Having in mind the high energy consumption per unit of GDP and Macedonia's high energy imports dependency on one hand and the low energy consumption per capita on the other hand, there is an inevitable need to improve energy efficiency through energy savings to the greatest possible extent that will not jeopardize the economic development and the standard of living of the population.

The Directive 2006/23/EC of the European Parliament and of the Council for End User Energy Efficiency and Energy Services requires the member states to prepare three National Energy Efficiency Action Plans (NEEAP) for the period 2008-2016 and to submit them to the European Commission. The national objective of the member states is to achieve energy savings in the ninth year of the implementation of this Directive (2016) in the amount equal to 9% of the average final energy consumption value in the period 2001-2005. This objective does not encompass the consumers covered under the Directive 2003/87/EC which establishes the trading scheme with greenhouse emission licenses, as well as the consumers whose consumption is classified under air and domestic water traffic.

NEEAP of the Republic of Macedonia (first draft version)[55] refers the period 2009-2016 and sets forth an indicative target for energy savings in 2016 in the amount of 147 ktoe which is 9% of the average final energy consumption value during the five year period 2002-2006 (1636 ktoe). This means that the cumulative effect of the implemented energy efficiency measures in the period 2009-2016 are annual savings of 147 ktoe in 2016.

For the purpose of achieving the indicative target set forth in the NEEAP of the Republic of Macedonia a packet of measures will be implemented in the following four sectors.

[55] National Energy Efficiency Action Plan, MACEF, 2009 (Draft version)

Residential Sector

- interventions in the central heating system in Skopje;
- social housing project;
- building codes (including measures for more efficient electric appliances, energy performance standards and labeling);
- highly efficient wood stoves;
- information centers, information campaigns;
- hot water systems, air conditioner labeling and control of the energy performance standards;
- financial support for investments in the area of energy efficiency;

The estimated savings in 2016 is 46.8 ktoe.

Commercial and Service Sector

- building codes;
- inspections of boilers and air conditioning systems;
- project for renovating 100 schools;
- information centers, information campaigns and networking dedicated to energy efficiency;
- energy management and audits;
- street illumination project in Skopje; similar projects in other municipalities;
- more efficient electric appliances; energy performance standards and labeling;
- meters;

The estimated savings in 2016 is 23.1 ktoe.

Industry (all consumers that are not covered under the Emission Trading Directive)

- improvement of process performances,
- energy audits,
- facilities for combined heat and electricity generation ("Kogel");
- energy performance of non-residential buildings;
- improved illumination;
- improved heating systems;
- fuel replacement;
- projects that apply the clean development mechanism,
- utilization of waste heat,
- intelligent devices,
- compressed air supply and
- good maintenance;

The estimated savings in 2016 is 56.9 ktoe.

Traffic

- renewal of the vehicle fleet;

- promotion of sustainable urban transportation systems (including tramway in Skopje, renewal of the vehicle fleet of public buses, establishment of an integrated traffic management center, greater utilization of bicycles, improved parking strategies);
- quality standards and fuel economy;
- days without cars;
- promotion and increased use of railway traffic;

The estimated savings in 2016 is 34.5 ktoe.

The total estimated savings in 2016 in all these measures are implemented in 161.3 ktoe which is higher than the indicative target. The NEEAP of the Republic of Macedonia also envisages a control indicative target for 2012 in the amount of 65.4 ktoe.

The implementation of the NEEAP is the initial stage of implementation of the overall national energy efficiency policy. The key point during this period will be to eliminate the shortfalls in legislation and institutional organization, primarily through the following:

- complete transposition and implementation of the directive for energy performance of buildings into the Macedonian legislation;
- building of institutional capacities by forming an energy efficiency sector within the energy agency or creating an energy efficiency agency;
- establishment of Energy Efficiency Fund;

The Strategy envisages the implementation of savings measures stipulated in NEEAP to continue after 2016. The indicative energy saving target in the amount of 147 ktoe in 2016 is extrapolated to 230 ktoe in 2020.

The strategy analyses two scenarios.

The forecasts for energy consumption have been made for each sector and for each fuel individually within the framework of the sector, on the basis of the consumption of a given fuel within the analyzed sector in the past period, a comparative analysis with the consumptions in the countries of the region and the developed European countries, the expected growth of the gross domestic product, the expected population growth, the plans of the larger producers and users of energy, the initiated activities within the sector on national and regional level as well as other indicators specific to a given sector. The expected consumption in the sectors as well as the total consumption in Macedonia has been obtained on the basis of the expected consumption for individual fuels.

The baseline scenario takes into account the already implemented measures for energy efficiency, as well as the obligation to raise the electricity price to the market price until 2015 as well as realization of the measures stipulated in NEEAP for energy savings in the amount of 33% of the target for 2020.

The second scenario envisages additional energy efficiency measures, for each of the sectors. This scenario envisages implementation of the targets stipulated in the NEEAP with the realization of all planned measures until 2016 and continuation with new measures for energy savings in the amount of 230 ktoe in 2020.

5.1. FINAL ENERGY NEEDS IN THE PERIOD 2008 – 2020 BY SECTORS

5.1.1. Industry sector

Bases for planning of the energy demand of the industry

Planning of the energy demand of the industry in the period until 2020 is based primarily on the projections of the economic growth and on the growth of the industrial production. In addition, we must also consider the weaknesses that need to be removed as well as the opportunities that need to be used. These include the following in particular:

- Increase of the efficient use of energy,
- Reduction of the dependence on fossil fuels and minerals,
- Reduction of the use of electricity in the thermal processes.

Despite all efforts to change the structure of the industry in Macedonia toward industries which need less energy and forcing of small and medium sized enterprises, Macedonia in the upcoming period will also be dominated by industries with intensive energy consumption. These industries in the upcoming period will continue to make most of the energy consumption. However, due to the recession in the world economy and orientation of the biggest capacities toward to world market, it is already evident that part of the envisaged activities will occur at slower pace, and some of the capacities will cease to work for some time. Companies' plans, in most cases were in line with these trends, but in 2007 the consumption was larger which was in line with the rate of growth of the industrial production.

Based on the analysis of the energy consumption in the previous period and based on the comparative analysis (provided in chapter 4) and the analysis of the situation and perspectives of the industry sector, we prepared two scenarios of the annual rate of growth of the energy consumption in the industry: baseline scenario and Scenario with strengthened energy efficiency measures.

The baseline scenario has average annual rate of growth of the energy consumption of 3% which approximately corresponds to the growth rate in the last four years in the industry, excluding steel and ferroalloys. Considering the problems it faces, the steel and ferroalloys industry cannot develop as planned without additional energy efficiency measures. Therefore, we do not expect more rapid growth of the energy consumption in the entire industrial sector than the planned 3%.

The system of integrated prevention and control of the pollution which is implemented through so called integrated licenses is based on application of the best available techniques (BAT). One of the key elements of BAT is the efficient use of energy. Larger industrial installations have already submitted their applications for License for Harmonization with Operative Plan which precedes the integrated license of the existing installations. The operative plan, among the other, should include measures to improve the installations' energy efficiency.

The strategy of cleaner production is not unknown in Macedonia. Starting from 2000, with small interruption between 2004 and 2007, when the National Center for Cleaner Production was established, around 50 small projects were prepared and around 10 of them were implemented. Part of them relate to efficient energy use.

Furthermore, all industries and especially the steel and ferroalloys industry will have to include additional energy efficiency measures in order to maintain the competitive position on the world market with moderate steel and ferroalloy prices.

The above elements may significantly reduce the energy consumption per unit product, but its growth will be in correlation with the industrial production growth.

According to the above analyses, the **scenario with strengthened energy efficiency measures** envisages annual energy consumption growth of 2.5%.

The year of 2006 is a baseline year for planning purposes.

Demand for electricity for the industry

The crisis which stroked the world economy at the end of 2008 most probably will last for several years. By all means, it will have consequences on the Macedonian industry. Some of the electro-thermal companies are already reducing their production, and others are preparing to do that. Some of the capacities will recover shortly, but one part, due to consequences of the conservation, migration of the qualified staff, loss of markets etc. will do that with slower pace.

The portion of the electricity consumption in large metallurgy companies will be reduced as a result of the improvement of the efficiency of use. However, that savings will be partly compensated with the increase of the electricity demand of the systems for environmental protection required by the law.

Figure 5.1.1.1 and Figure 5.1.1.2 and the Tables 5.1.1.1 and 5.1.1.2 show the envisaged demand for electricity of the Macedonian industry according to the baseline scenario and to the Scenario with strengthened energy efficiency measures.

The analyses show that according to the baseline scenario, the use of electricity in the industry, in the 2006 – 2020 period will increase by 58.7% (Table 5.1.1.1, P2) with annual average rate of 3.35% (Table 5.1.1.1, P1). It is specific that the growth of ferrous metallurgy is greater, it is almost identical in the non-ferrous metallurgy, while in the other industries it is significantly lower than average. This trend can also be seen in the Scenario with strengthened energy efficiency measures, but in this case, the total growth of the electricity consumption is expected to be 50.8% (Table 5.1.1.2, P2) with average annual rate of 2.98% (Table 5.1.1.2, P1).

In these parameters it is especially important to take into account the influence of the expected recession during 2009, which is expected to cause significant decrease of the industrial production, and consequently reduction of the energy consumption in the production sector. After the crisis period, in 2013-2020 it is expected to have statistically leveled annual growth of the electricity demand in this sector of 4.1% and 3.7% for the baseline scenario and the scenario with strengthened energy efficiency measures respectively (Figure 5.1.1.1 and Figure 5.1.1.2).

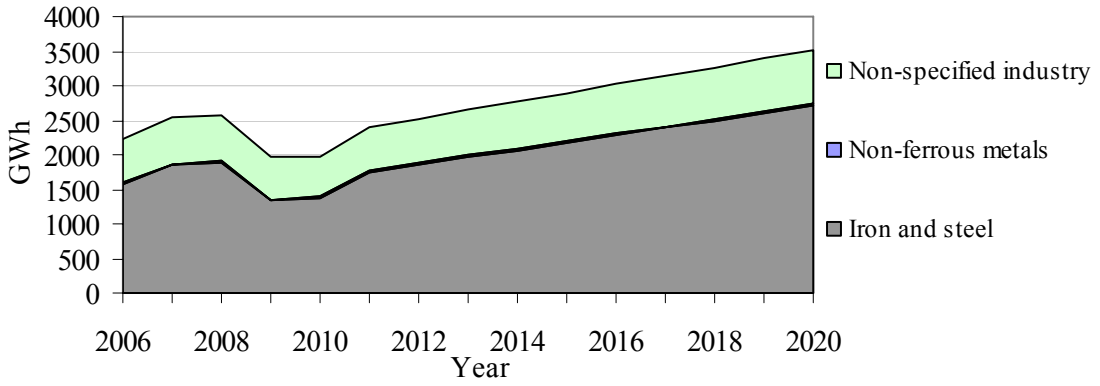

Figure 5.1.1.1. Electricity consumption in the industry until 2020 according to the baseline scenario

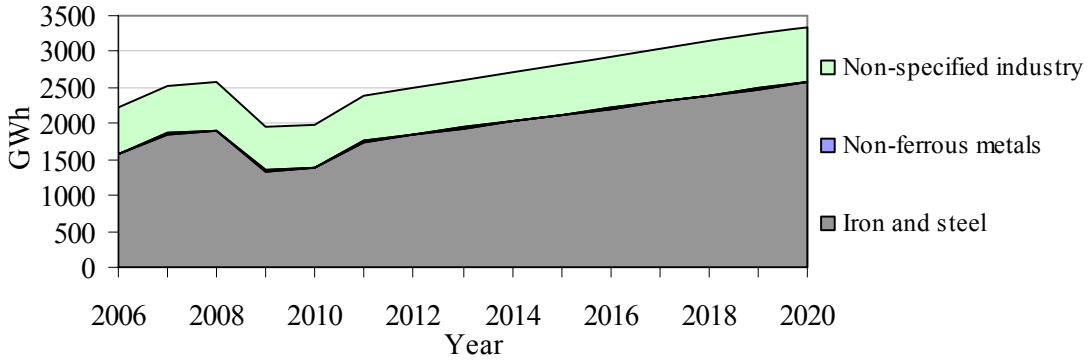

Figure 5.1.1.2. Electricity consumption in the industry until 2020 according to the Scenario with strengthened energy efficiency measures

Table 5.1.1.1. Electricity consumption in the industry until 2020 according to the baseline scenario

	GWh															%	
	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	P1	P2
Iron and steel	1574	1855	1891	1343	1377	1750	1865	1973	2070	2179	2288	2397	2494	2602	2711	3.96	72.2
Non-ferous metals	13	15	15	13	12	14	14	15	15	16	16	17	17	17	18	2.26	36.8
Non-specif. industry	634	660	663	606	588	626	645	664	682	701	720	739	757	776	795	1.63	25.4
TOTAL	**2221**	**2530**	**2569**	**1962**	**1977**	**2390**	**2524**	**2652**	**2768**	**2896**	**3024**	**3152**	**3268**	**3396**	**3524**	**3.35**	**58.7**

Table 5.1.1.2. Electricity consumption in the industry until 2020 according to the Scenario with strengthened energy efficiency measures

	GWh															%	
	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	P1	P2
Iron and steel	1574	1855	1891	1343	1377	1750	1841	1931	2022	2112	2203	2294	2384	2475	2565	3.55	63.0
Non-ferous metals	13	15	15	13	12	14	14	15	15	15	16	16	16	17	17	2.00	31.9
Non-specif. industry	634	660	663	606	588	626	642	657	673	689	704	720	736	751	767	1.37	21.0
TOTAL	**2221**	**2530**	**2569**	**1962**	**1977**	**2390**	**2497**	**2603**	**2710**	**2816**	**2923**	**3030**	**3136**	**3243**	**3349**	**2.98**	**50.8**

Heat for technological processes

Since the biggest heat consumption in the metallurgy is the steel industry which is expected to be relatively less influenced by the economic crisis, and the remaining industry is significant consumer of heat, we do not expect great falls in the next few years, but the growth in the recovery period will probably be smaller, mainly due to orientation to renewable energy sources which are especially suitable for heat.

Petroleum products

Although they participate with small quantity, the petrol and diesel fuels amortize the large oscillations which occur as a result of the use of heavy fuel oil in the industry. There is an impression that in long term, the consumption of liquid fuels will not be changed radically although there is growth in the last few years.

In the meanwhile the application of liquid petrol gas will grow, but it cannot be a significant factor.

Natural gas in the industry

The industry is strongly interested in larger participation of the natural gas in meeting of the energy demand both due to the price as well as due to many other advantages such as: simplification of the technological processes, elimination of warehousing, reduction of the air emission etc. This latter item is connected to the global reduction of the carbon dioxide emissions and the Kyoto Protocol, i.e. the possibilities of the Clean Development Mechanism (CDM).

Since the largest consumer of natural gas in the industry is the production of steel, the second scenario was prepared without significant reduction of the demand in the first years.

It is expected that the installation of the gas substations to enable use of gas in the installations in the vicinity such as the nonmetal industry and textile and leather industry.

Coal and coal products

Since the change of the structure of the Macedonian industry will change slowly, the consumption of solid fuels which is concentrated at the metallurgical complexes will follow the trend of growth of the production in that industry with a rate exceeding the production growth.

Substitution of solid fuels with gas is not completely possible in the metallurgical processes, but it will occur gradually if there are conditions for that.

Renewable energy sources

Except for the wooden chips which are used in the ferronickel production, the renewable energy sources practically do not have any share in the energy consumption of the Macedonian industry. Despite the fact that they cannot pretend to substitute significant part of the fossil fuels, the renewable energy sources (sun, wind and biomass) should be among the priority options.

Forecast of the energy consumption in the steel and ferroalloys industry

It is assumed that the crisis will be overcome in 2010 and in the following year serious increase of the activities in this industry will start (Figure 5.1.1.3 and Figure 5.1.1.4). The lowest level of around 3570 GWh (307 ktoe) is expected in 2010 and the further growth is estimated within the range of 3.1 and 3.7%.

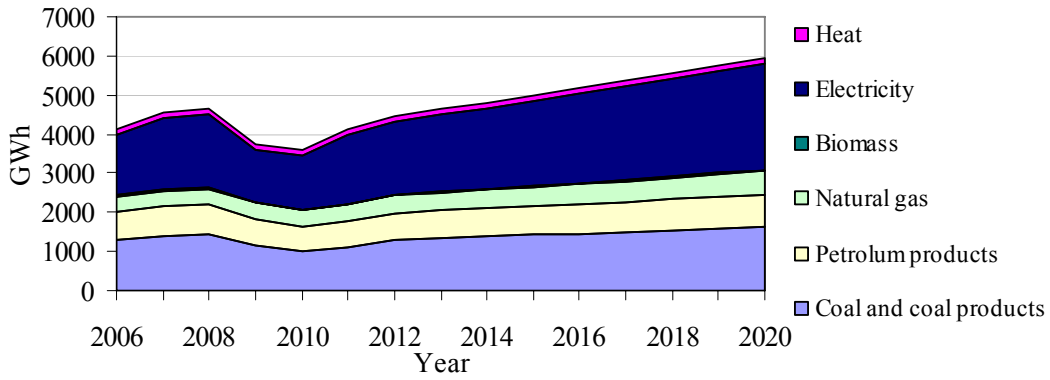

Figure 5.1.1.3. Energy consumption in the steel and ferroalloys industry until 2020 according to the baseline scenario

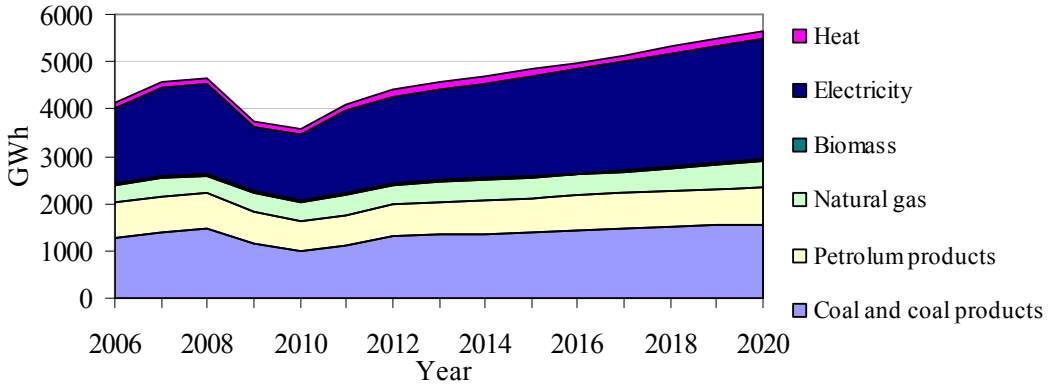

Figure 5.1.1.4. Energy consumption in the steel and ferroalloys industry until 2020 according to the Scenario with strengthened energy efficiency measures

Forecast of the energy consumption in the non-ferrous metallurgy

The non ferrous metallurgy remains with no special influence on the total energy demand in the upcoming period (Figure 5.1.1.5 and Figure 5.1.1.6). However any new capacity will mean serious disruption of the hypotheses since, now, in Macedonia there are no capacities in the primary non-ferrous metals production.

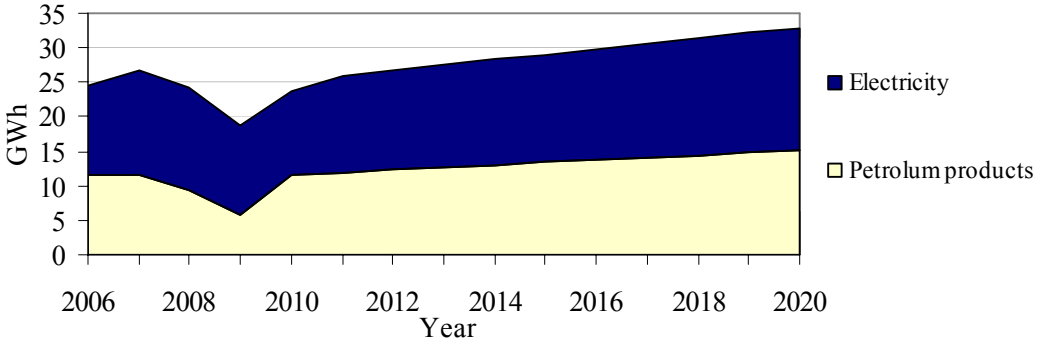

Figure 5.1.1.5. Energy consumption in non-ferrous metallurgy until 2020 according to the baseline scenario

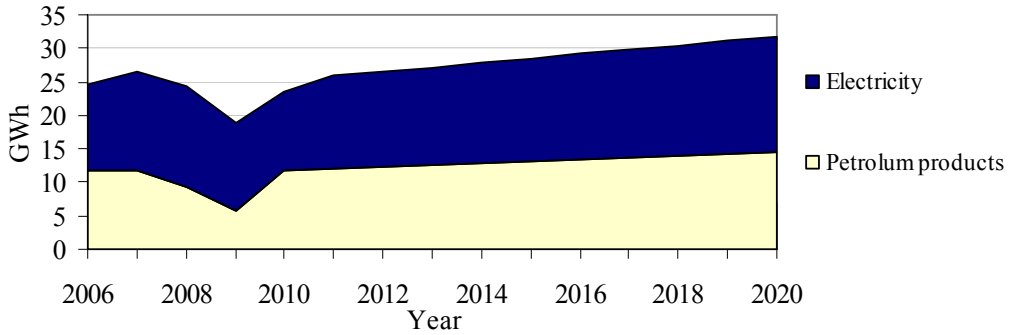

Figure 5.1.1.6. Energy consumption in the non-ferrous metallurgy until 2020 according to the Scenario with strengthened energy efficiency measures

Forecast of the energy consumption in the other industry

The Macedonian industry excluding the metallurgy has a relatively large consumption of electricity (Figure 5.1.1.7 and Figure 5.1.1.8).

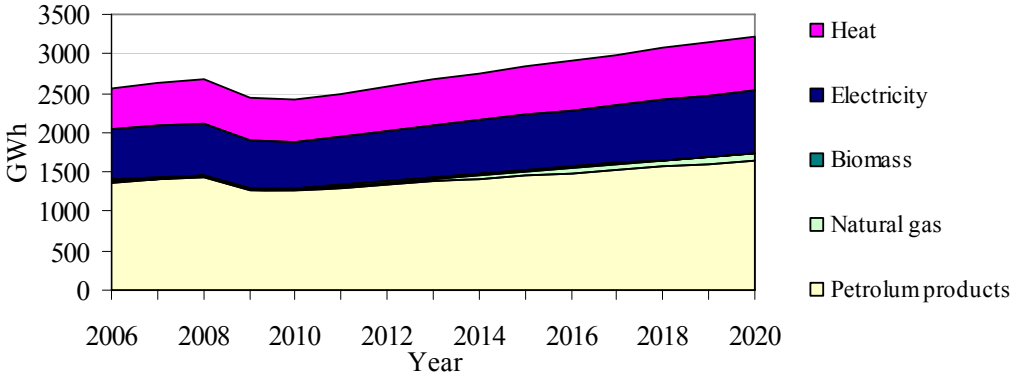

Figure 5.1.1.7. Energy consumption in the other industry until 2020 according to the baseline scenario

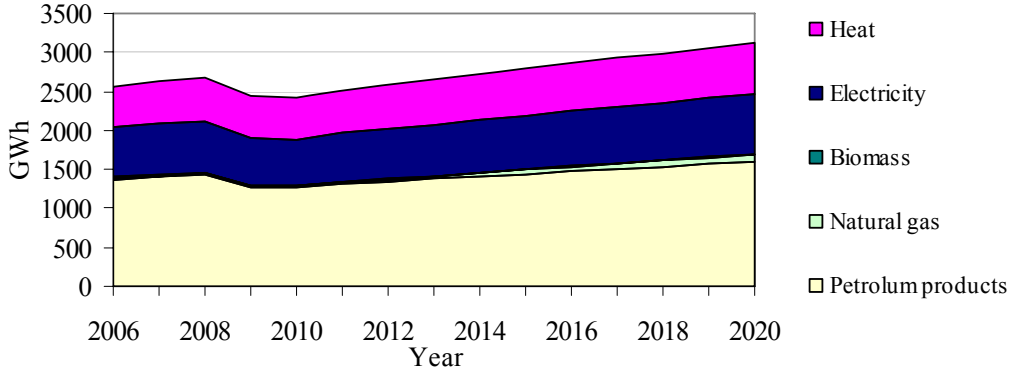

Figure 5.1.1.8. Energy consumption in the other industry until 2020 according to the Scenario with strengthened energy efficiency measures

There is especially intensive consumption in the nonmetals, mining and food and cigarettes industries. Without construction of solid network for transport and distribution of natural gas, this trend will remain. The electricity consumption is expected to decrease only as a result of a temporary backlog in mining.

Total energy consumption of the industry

Baseline scenario

The energy consumption according to subsectors and fuels is given in Table 5.1.1.3 and shown in Figure 5.1.1.9 and Figure 5.1.1.10.

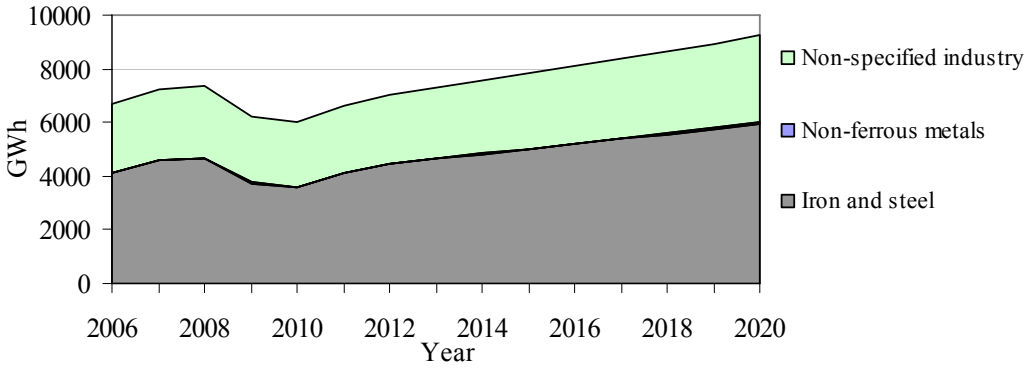

Figure 5.1.1.9. Energy consumption in the industry until 2020 by subsectors according to the baseline scenario

Table 5.1.1.3. Total energy demand in the industrial sector according to baseline scenario (GWh)

		GWh															%	
		2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	P1	P2
Industry for steel and ferroalloys (ISF)	Electricity	1574	1855	1891	1343	1377	1750	1865	1973	2070	2179	2288	2397	2494	2602	2711	3.96	72.24
	Heat	123	128	132	128	125	131	134	138	142	146	150	154	158	162	166	2.17	35.05
	Coal and coal products	1279	1396	1454	1163	989	1105	1303	1342	1381	1420	1459	1498	1537	1576	1615	1.68	26.25
	Petroleum products	744	768	756	675	640	659	678	697	716	736	755	774	793	812	832	0.79	11.72
	Natural gas	372	383	394	406	417	429	446	457	470	486	503	532	560	589	617	3.68	65.90
	Biomass	31	33	29	27	27	28	28	28	28	28	28	28	28	28	28	-0.74	-9.91
	TOTAL (ISF)	**4123**	**4563**	**4656**	**3741**	**3574**	**4102**	**4454**	**4636**	**4807**	**4995**	**5183**	**5382**	**5570**	**5769**	**5969**	**2.68**	**44.75**
Ind. for non - ferrous metals (INFM)	Electricity	13	15	15	13	12	14	14	15	15	16	16	17	17	17	18	2.26	36.77
	Petroleum products	12	12	9	6	12	12	12	13	13	13	14	14	14	15	15	1.89	30.00
	TOTAL (INFM)	**25**	**27**	**24**	**19**	**24**	**26**	**27**	**28**	**28**	**29**	**30**	**31**	**31**	**32**	**33**	**2.09**	**33.57**
Non - specified industry (NSI)	Electricity	634	660	663	606	588	626	645	664	682	701	720	739	757	776	795	1.63	25.40
	Heat	535	549	555	539	537	544	560	576	592	608	624	641	657	673	689	1.83	28.87
	Petroleum products	1372	1399	1426	1275	1262	1300	1338	1375	1413	1451	1489	1527	1565	1603	1640	1.28	19.53
	Natural gas	21	22	22	23	23	24	31	43	54	60	67	73	79	86	92	11.16	339.56
	Biomass	7	7	7	6	6	6	8	8	10	10	10	10	11	11	12	3.98	72.71
	TOTAL (NSI)	**2569**	**2637**	**2673**	**2449**	**2417**	**2500**	**2580**	**2666**	**2751**	**2831**	**2910**	**2989**	**3069**	**3148**	**3228**	**1.65**	**25.67**
Total Industry	Electricity	2221	2530	2569	1962	1977	2390	2524	2652	2768	2896	3024	3152	3268	3396	3524	3.4	58.7
	Heat	658	677	687	667	662	674	694	714	734	755	775	795	815	835	855	1.9	30.0
	Coal	1279	1396	1454	1163	989	1105	1303	1342	1381	1420	1459	1498	1537	1576	1615	1.7	26.3
	Petroleum products	2128	2178	2191	1955	1913	1971	2028	2085	2143	2200	2257	2315	2372	2430	2487	1.1	16.9
	Natural gas	393	405	417	428	440	454	477	500	523	547	570	605	640	675	709	4.3	80.5
	Biomass	38	41	36	33	33	34	35	36	37	38	38	38	38	39	39	0.3	4.8
	TOTAL (Industry)	**6717**	**7226**	**7354**	**6209**	**6015**	**6627**	**7061**	**7329**	**7586**	**7855**	**8123**	**8402**	**8670**	**8950**	**9230**	**2.30**	**37.42**

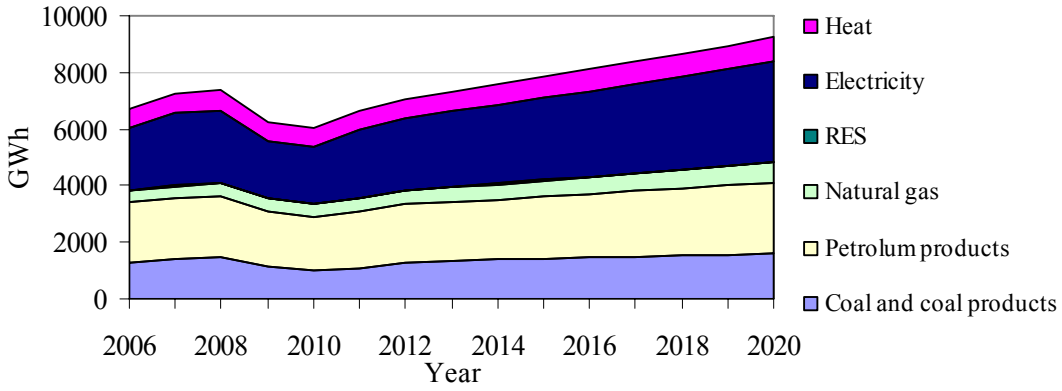

Figure 5.1.1.10. Energy consumption in the industry until 2020, according to fuels, according to the baseline scenario

According to the baseline scenario the use of energy in the 2006-2020 period will grow by 37.42% and in 2020 it will be 9230 GWh (794 ktoe). The average annual growth rate of energy consumption will be 2.3%. It is characteristic that the growth rate in steel and ferroalloys industry is greater (2.68%), in the nonferrous metallurgy it is almost identical (2.09%), while in the other industries it is lower than average (1.65%). The calculations take into account the influence of the expected recession during 2009, which is expected to cause significant drop of the industrial production and consequently drop in the energy consumption in the production sector. After the crisis period, after 2012, it is expected to have a relatively equal annual growth of the demand for energy in this sector with average rate of 3.1 – 3.8%.

The share of fuels in the industry in 2020 is given in Figure 5.1.1.11. According to the baseline scenario, in 2020 the electricity and petroleum products will have largest share – 38% and 27%, respectively, followed by the coal – 17.5%, natural gas – nearly 8% and heat – around 9%. The renewable energy sources will have share of less than 1%.

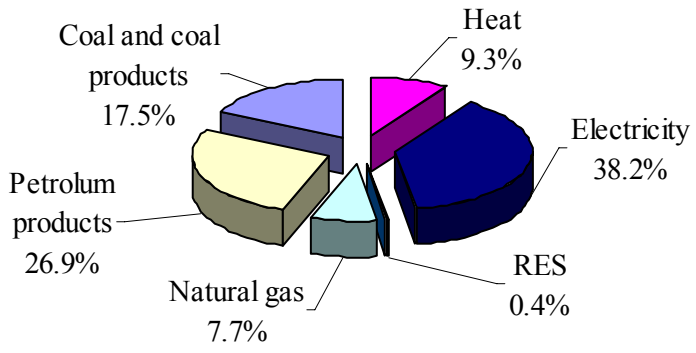

Figure 5.1.1.11. Percentage share of fuels in the industry in 2020 according to the baseline scenario

Scenario with strengthened energy efficiency measures

Energy consumption according to this scenario is given in Table 5.1.1.4 and Figure 5.1.1.12 and Figure 5.1.1.13.

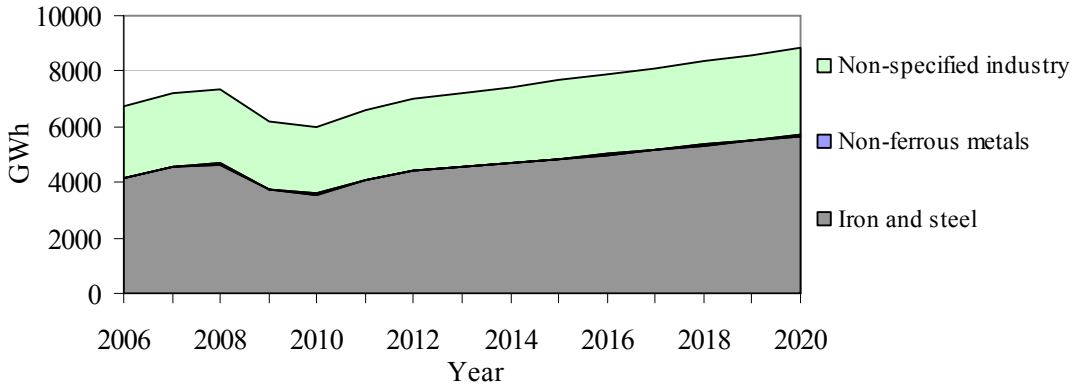

Figure 5.1.1.12. Energy consumption in the industry until 2020 according to the Scenario with strengthened energy efficiency measures

The consumption of fuels according to the Scenario with strengthened energy efficiency measures is shown in Figure 5.1.1.13.

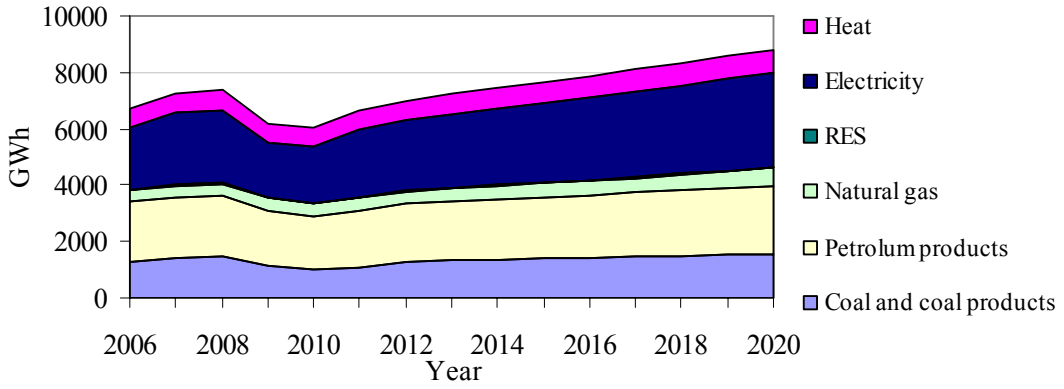

Figure 5.1.1.13. Energy consumption in the industry until 2020, according to fuels, according to the Scenario with strengthened energy efficiency measures

According to the Scenario with strengthened energy efficiency measures, the use of energy in the industry, in the 2006-2020 period will grow by 31.2% and in 2020 it will be 8814 GWh (758 ktoe) which is by 416 GWh (36 ktoe) less than the consumption envisaged in the baseline scenario. The average annual growth rate of energy consumption in the analyzed period is 1.96%. The average annual growth in ferrous metallurgy is (2.28%), in the non-ferrous metallurgy (1.82%) and in other industries (1.42%). The calculations take into account the influence of the expected recession in 2009. After the crisis period, from 2013 to 2020 it is expected to have relatively equal annual growth of the demand for energy in this sector with average rate of 2.8% – 3.1%.

The share of fuels in the industry in 2020, according to this scenario is shown in Figure 5.1.1.14.

Table 5.1.1.4. Total energy demand in the industrial sector according to Scenario with strengthened energy efficiency measures (GWh)

		GWh															%	
		2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	P1	P2
Industry for steel and ferroalloys (ISF)	Electricity	1574	1855	1891	1343	1377	1750	1841	1931	2022	2112	2203	2294	2384	2475	2565	3.55	62.99
	Heat	123	128	132	128	125	131	134	137	140	144	147	150	153	157	160	1.91	30.26
	Coal and coal products	1279	1396	1454	1163	989	1105	1303	1335	1368	1400	1433	1465	1498	1531	1563	1.44	22.18
	Petroleum products	744	768	756	675	640	656	672	688	704	720	736	752	768	784	800	0.51	7.42
	Natural gas	372	381	391	400	409	419	429	435	429	432	438	453	481	510	539	2.68	44.81
	Biomass	31	33	29	27	27	27	27	27	27	27	27	27	27	27	27	-0.89	-11.71
	TOTAL (ISF)	**4123**	**4561**	**4653**	**3736**	**3567**	**4087**	**4405**	**4553**	**4690**	**4835**	**4983**	**5140**	**5312**	**5483**	**5654**	**2.28**	**37.12**
Ind. for non - ferrous metals (INFM)	Electricity	13	15	15	13	12	14	14	15	15	15	16	16	16	17	17	2.00	31.92
	Petroleum products	12	12	9	6	12	12	12	13	13	13	13	14	14	14	15	1.61	25.00
	TOTAL (INFM)	**25**	**27**	**24**	**19**	**24**	**26**	**27**	**27**	**28**	**28**	**29**	**30**	**30**	**31**	**32**	**1.82**	**28.65**
Non - specified industry (NSI)	Electricity	634	660	663	606	588	626	642	657	673	689	704	720	736	751	767	1.37	20.95
	Heat	535	549	555	539	537	544	557	571	584	598	611	624	638	651	665	1.57	24.35
	Petroleum products	1372	1399	1426	1275	1262	1316	1347	1378	1409	1440	1471	1503	1534	1566	1597	1.09	16.36
	Natural gas	21	21	22	23	23	24	24	30	48	56	62	71	77	83	89	10.90	325.56
	Biomass	7	7	7	6	6	7	7	8	9	9	10	10	10	10	11	3.44	60.49
	TOTAL (NSI)	**2569**	**2637**	**2673**	**2448**	**2417**	**2516**	**2577**	**2644**	**2722**	**2792**	**2859**	**2928**	**2995**	**3061**	**3128**	**1.42**	**21.79**
Total Industry	Electricity	2221	2530	2569	1962	1977	2390	2497	2603	2710	2816	2923	3030	3136	3243	3349	3.0	50.8
	Heat	657	677	687	667	662	674	691	708	724	741	758	775	791	808	825	1.6	25.5
	Coal	1279	1396	1454	1163	989	1105	1303	1335	1368	1400	1433	1465	1498	1531	1563	1.4	22.2
	Petroleum products	2128	2178	2191	1955	1913	1984	2031	2078	2125	2173	2220	2268	2316	2363	2411	0.9	13.3
	Natural gas	393	403	413	423	432	442	454	465	477	488	500	523	558	593	628	3.4	59.8
	Biomass	38	41	36	33	34	34	34	35	36	37	37	37	37	38	38	0.1	1.1
TOTAL (Industry)		**6717**	**7224**	**7350**	**6203**	**6007**	**6629**	**7009**	**7224**	**7440**	**7655**	**7871**	**8098**	**8337**	**8575**	**8814**	**1.96**	**31.23**

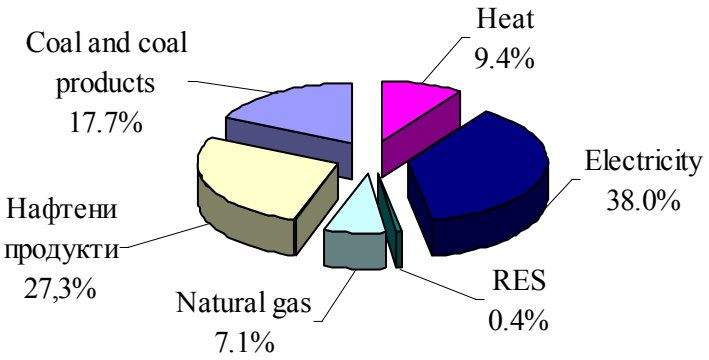

Figure 5.1.1.14. Percentage share of fuels in the industry in 2020 according to the Scenario with strengthened energy efficiency measures

As we can see in Figure 5.1.1.24 in 2020 the electricity will have the largest share with 38%, followed by the petroleum products with 27%, coal with nearly 18%, natural gas with 7% and heat with slightly more than 9%. The renewable energy sources will have share of less than 1%.

These figures are close to the relative share of fuels in the developed European countries in 2006, but they have larger share of the natural gas and smaller share of the heat. They have share of electricity of 32.4%, petroleum products and natural gas together with 43%, coal and biomass together with 18%, heat with 5%, solar energy and geothermal energy together with less than 0.1%.

5.1.2. Residential sector

With a share of 29% of the total final energy in 2006 (Figure 4.4.2) the residential sector is immediately next to the industry which is the largest consumer of final energy (34%) in Macedonia.

In order to determine the energy consumption level of the residential sector until 2020 we took 2006 as a baseline year. Certain statistical data necessary for analyses for assessment of the consumption trend are based on the last census of 2002.

The energy consumption in the Macedonian residential sector, according to the official statistical data for the period of 1996 to 2006, grew by 0.47% annually[56]. However, if we take into account the unrecorded consumption of firewood and unrecorded consumption of electricity, the growth of the household energy consumption is assessed at nearly 2% annually. In the analyzed 10 year period we can see the following trends of annual growth of energy consumption of the residential sector: biomass 0.8%, electricity 2.8%, petroleum products 0.5%, heat from central heating systems 4.2% and coal -9.3%[57].

If we take into account the unregistered consumption of biomass and electricity as well as the use of solar energy in amount of 7.4 GWh in 2006, which is also unregistered in IEA data, the percentage share of the fuels is changed compared to the situation given in Figure 4.4.2.4. The electricity consumption has a share of slightly less than 53% (Figure 5.1.2.1), followed by the biomass with around 33%, heat and petroleum products with nearly 7% each, coal with 0.5% and solar energy with 0.1%.

[56] © OECD/IEA, [2008], IEA Online Database: Energy Balances of Non-OECD and OECD Countries and Energy Statistics of Non-OECD and OECD Countries

[57] IEA Data are corrected for unrecorded consumption of biomass and electricity

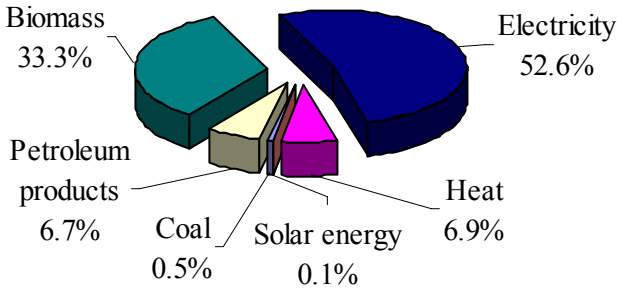

Figure 5.1.2.1. Share of fuels in the residential sector in 2006 including the unrecorded consumption

In order to assess the necessary energy in the upcoming period we analyzed the energy consumption in the residential sector by to purposes. Average family consumes 57% of the energy for heating, 25% for the home appliances (stove, refrigerator, vacuum cleaner, washing machines, air conditioning, ventilators, TV-set, computer etc.) as well as for street lighting, 11% for sanitary water and 7% for illumination. As highest, we analyzed the consumption of energy for heating in the residential sector. In order to get heating energy, the residential sector use primarily biomass with share of 76% of the energy consumed for heating, followed by electricity with share of 16.8%, heat with share of 5.4% and others with a share of 1.8%[58]. The electricity consumption for heating of the residential sector is around 18% of the total electricity consumption in the residential sector.

The analyses considers that the net salary in the last seven years, on average, grows by 4.95% annually and the cost of living grow by 3.41%. According to the statistical data for the last 6 years one average household, after covering the costs of average shopping basket, has only 15%-25% of the average salary to cover all the other costs. In absolute amount it is around 3000 Denars.

The annual growth of construction of new homes in the same period is 5.25%.

The average annual rate of growth of the population in the period between 1994 and 2002 is 0.48%. However in the recent years, the population growth rate is decreasing. According to the United Nations demographic research[59] the Macedonian population will decrease from 2.036 million in 2006 to 2.025 million in 2020 and 1.966 million in 2030.

The analyses take into account the following factors that influence the energy consumption of the residential sector:

- energy price,
- living standard,
- number of constructed homes,
- population and number of families,
- purchase value of the home appliances with higher efficiency,
- measures (laws and bylaws, training, propaganda) for improvement of the energy efficiency, especially of the home appliances and homes,
- automatic control of the energy consumption.

[58] Ramboll/EBRD, 2006

[59] Population Division of the Department of Economic and Social Affairs of the United Nations Secretariat, World Population Prospects: The 2006 Revision and World Urbanization Prospects: The 2005 Revision, http://esa.un.org/unpp

Taking into account the above elements we prepared two scenarios for energy consumption in the residential sector until 2020:

- baseline scenario which follows the growth of the energy consumption of the residential sector in the previous period reduces for already implemented energy efficiency measures and expected pace of harmonization of the electricity prices with the market value, and
- scenario with strengthened energy efficiency measures in the residential sector.

Baseline scenario

According to the baseline scenario the total energy consumption of the residential sector and the consumption of certain fuels in the period until 2020 will be according to the dynamics given in Table 5.1.2.1 and Figure 5.1.2.2. In the baseline year 2006 we also included the unidentified consumption of firewood and electricity because it will continue to exist as consumption but it will transit into recorded consumption. The forecasts of the baseline scenario are made based on the previous consumption, the above elements and analyses and according to the comparative analysis of the consumption of the Macedonian residential sector given in section 4.4.2.

Table 5.1.2.1. Forecast of the energy consumption of the residential sector – baseline scenario (GWh)[60]

	GWh															%	
	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	P1	P2
Coal	35	35	36	36	37	38	39	40	41	42	43	44	45	47	49	2.43	40.00
Petroleum prod.	477	481	485	489	493	497	501	505	510	515	520	525	530	535	540	0.89	13.21
Biomass	2354	2371	2388	2405	2422	2439	2456	2473	2490	2507	2524	2541	2559	2577	2595	0.70	10.24
Electricity	3721	3792	3863	3934	4006	4078	4150	4222	4294	4366	4438	4510	4582	4654	4726	1.72	27.01
Heat	485	487	482	482	484	487	489	492	496	500	504	508	512	516	520	0.50	7.22
Natural gas	0	0	0	4	16	28	40	64	90	120	160	205	254	304	354	0	0
Solar	7	8	9	10	11	13	16	19	23	27	32	37	43	49	55	15.86	
TOTAL	**7079**	**7174**	**7263**	**7360**	**7469**	**7580**	**7691**	**7815**	**7944**	**8077**	**8221**	**8370**	**8525**	**8682**	**8839**	**1.60**	**24.86**

The total energy consumption of the residential sector according to the baseline scenario will grow by rate of 1.6% or the total growth for the 2006-2020 period will be 25% and in 2020 it will be 8839 GWh (760 ktoe).The electricity consumption will grow with a rate of 1.72% or the total growth for the 2006-2020 period will be 27% and in 2020 it will be 4726 GWh (406 ktoe).

The consumption of biomass grows with a rate of 0.7% and in 2020 it will be 10% larger than the consumption in 2006 and will be 2595 GWh (223 ktoe).

According to this scenario the consumption of petroleum products will have moderate growth rate of 0.9% and with 540 GWh (46 ktoe) in 2020 it will be 13% higher than the petroleum products consumption in 2006.

[60] The consumption of energy for 2006 also takes into account the unregistered consumption of biomass and electricity as well as solar energy which is also not registered in the IEA data.

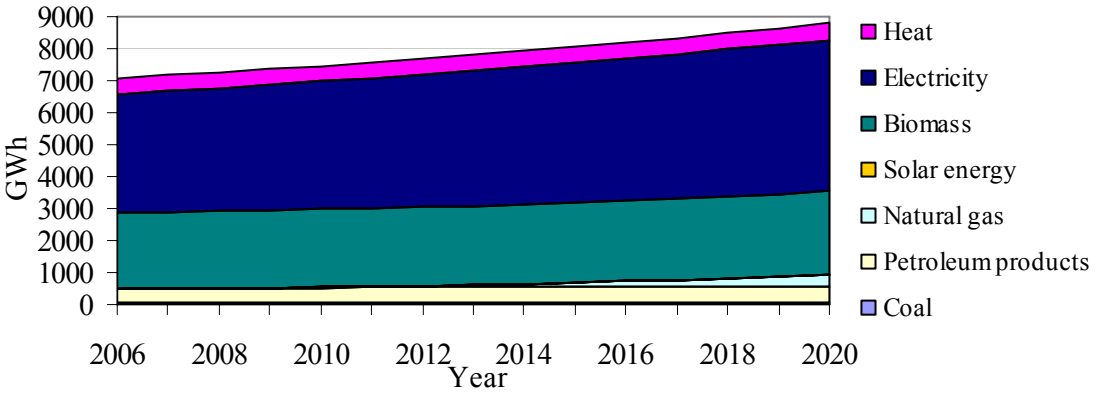

Figure 5.1.2.2. Energy consumption of the residential sector according to baseline scenario

In the analyzed period we expect mild growth of the consumption of heat in the residential sector. In Skopje, around 90% of the consumers that are feasible for Toplifikacija are already covered. In the other towns in Macedonia, construction of central heating systems is envisaged only in areas with high specific consumption (more than 25 MW/km^2). In the period until 2020 the consumption growth is envisaged to be a total 7% or an annual rate of 0.5% up to 520 GWh (45 ktoe) in 2020.

Until 2020, in this sector, we expect growth of the coal consumption of 40% with an annual rate of 2.4% as a result of the introduction of briquettes with better quality which are environmentally acceptable. In 2020 the coal consumption will be 49 GWh (4.2 ktoe).

The use of natural gas in the residential sector in 2020 will reach the value of 354 GWh (38×10^6 Nm^3, 30 ktoe). In this case we envisaged use of natural gas in 25000 households in 2020. During the assessment of the necessary gas quantities, based on the technical experience and the climate characteristics and expected users who use the natural gas basically for heating, cooking and preparation of sanitary water, we consider average annual consumption of household of 1500 Nm^3 (14 MWh).

The solar energy and heat pumps in 2020 in this sector will be used in a total amount of 55 GWh (192 TJ, 4.7 ktoe). The envisaged growth of use of the solar energy means installation of 60000 devices until 2020.

According to the baseline scenario, the relative share of the electricity in the energy consumption of the residential sector in Macedonia will continue to dominate in 2020 (Figure 5.1.2.3), and with 53.5% will be around 1% higher than the share in 2006 (Figure 5.1.2.1).

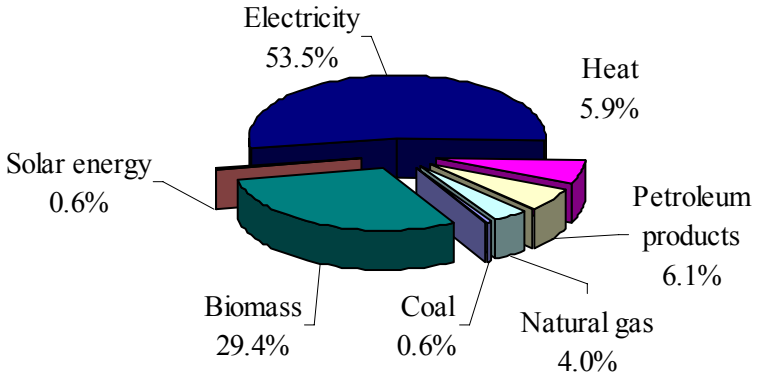

Figure 5.1.2.3 Share of fuels in the residential sector in 2020 – baseline scenario

The share of biomass will be reduced from 33% in 2006 to 29% in 2020. The petroleum products in 2020 will have share of 6.1% which is a decrease of 0.6%. The share of the heat in the reviewed period will be reduced from 6.9% to 5.9%. The coal will have approximately the same share while the share of the solar energy will increase from 0.1% to 0.6% and the natural gas shall be introduced with 4%.

Scenario with strengthened energy efficiency measures

The second scenario envisages stronger realization of the above mentioned energy efficiency measures in the residential sector and energy savings measures in accordance with NEEAP.

The scenario envisages wide application of solar systems and natural gas which means stronger measures for stimulation of the introduction of solar energy in the residential sector and of the natural gas in several cities in Macedonia. It is envisaged that Skopje and Kumanovo will have rapid development of the distribution network. We envisage connection of Tetovo and Gostivar to the gas pipeline and certain expansion of the secondary network in 2020. The construction of the pipeline to Veles and Shtip is also envisaged.

We envisage incentives for installation of geothermal heat pumps as potential systems for heating of individual housing structures due to small consumption of energy.

The consumption of energy in the new construction structures, according to the Rulebook on Energy Efficiency of Construction Structures will be halved compared to today's values.

All these measures would lead to reduction of the share of the electricity in the residential sector.

This scenario also takes into account the global energy crisis which will influence the standard of living in Macedonia, together with the inevitable increase of the electricity price.

According to this scenario, the application of the energy efficiency measures and rapid introduction of the natural gas and solar energy will lead to energy consumption shown in Table 5.1.2.2 and Figure 5.1.2.4.

Table 5.1.2.2. Energy consumption of the residential sector with stronger energy efficiency measures (GWh)[61]

	GWh															%	
	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	P1	P2
Coal	35	35	36	36	37	38	38	38	38	38	38	38	38	38	37	0.40	5.71
Petroleum prod.	477	488	483	478	469	454	441	428	419	411	405	398	392	387	381	-1.59	-20.1
Biomass	2354	2373	2396	2407	2419	2442	2454	2466	2477	2489	2500	2500	2500	2500	2491	0.40	5.82
Electricity	3721	3804	3888	3901	3908	3919	3943	3977	4012	4071	4129	4187	4245	4303	4361	1.14	17.21
Heat	486	487	482	482	484	487	489	492	496	500	504	508	512	516	520	0.48	7.00
Natural gas	0	0	0	5	24	68	130	205	280	355	443	530	618	705	793		
Solar	7	8	11	14	17	20	23	26	30	36	42	50	60	70	81	19.11	
TOTAL	**7080**	**7195**	**7296**	**7323**	**7358**	**7429**	**7518**	**7632**	**7753**	**7899**	**8061**	**8211**	**8365**	**8520**	**8664**	**1.45**	**22.38**

[61] The consumption of energy for 2006 also takes into account the unregistered consumption of biomass and electricity as well as solar energy which is also not registered in the IEA data

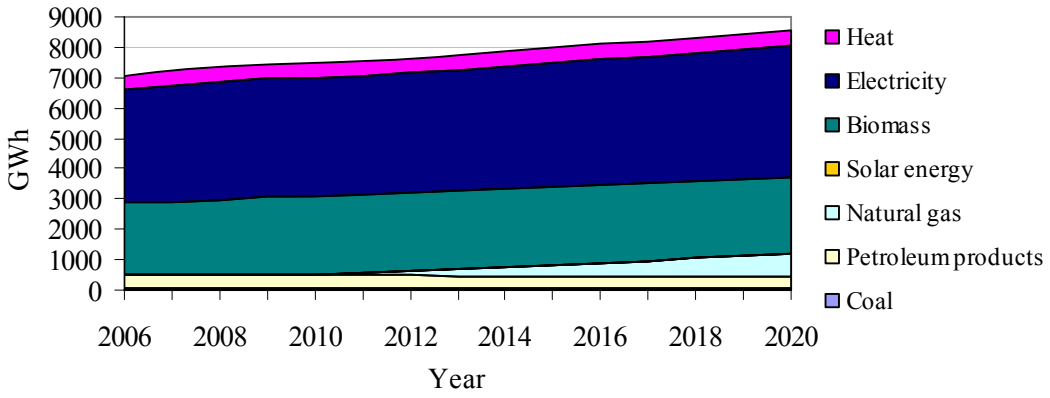

Figure 5.1.2.4. Energy consumption of the residential sector with stronger energy efficiency measures

The total energy consumption of the residential sector according to this scenario will grow with annual rate of 1.45% or in total, for the 2006-2020 period, by 22% and in 2020 it will be 8664 GWh (745 ktoe).

The electricity consumption will grow by rate of 1.14% or total for the 2006-2020 period, by 17.21% and in 2020 it will be 4361 GWh (375 ktoe).

The consumption of biomass will grow with a rate of 0.4% and in 2020 will be 5.8% larger than the consumption in 2006 and will be 2491 GWh (214 ktoe).

According to this scenario the consumption of petroleum products will decrease with a rate of -1.6% and with 381 GWh (33 ktoe) in 2020 it will be 20% lower than the petroleum products consumption in 2006.

We expect mild growth of the consumption of heat in the analyzed period of total 7% or annual rate of 0.5% up to the amount of 520 GWh (45 ktoe) in 2020.

Until 2020, in this sector, we expect growth of the coal consumption of 5.7% with an annual rate of 0.4%. In 2020 the coal consumption will be 37 GWh (3.2 ktoe).

The use of natural gas in the residential sector in 2020 will be used in 56,000 households and will reach the value of 793 GWh (85×10^6 Nm^3, 68 ktoe).

The solar energy and heat pumps in 2020 in this sector will be used in 90,000 households, in the total amount of 81 GWh (292 TJ, 7 ktoe).

According to this scenario the energy consumption in 2020 will be 175 GWh (15 ktoe) lower than in the baseline scenario.

The electricity consumption according to this scenario is lower than the consumption according to the baseline scenario by 365 GWh (31 ktoe) due to larger share of the natural gas and solar energy, improved thermal insulation of the housing structures and use of light bulbs and home appliances with better efficiency. Despite these measures, due to the growth of the living standards of the population, the consumption of electricity in the residential sector will still grow until 2020, but with average annual rate of only 1.14%.

This scenario envisages installation of solar energy devices at 90000 locations (housing structures).

It is envisaged that nearly 57,000 households will be connected to the natural gas supply system which will be used for heating, preparation of sanitary water and cooking.

According to this scenario, the share of electricity consumption in the total energy consumption of the residential sector will be reduced from 52.6% in 2006 to 50.3% in 2020 (Figure 5.1.2.1 and Figure 5.1.2.5).

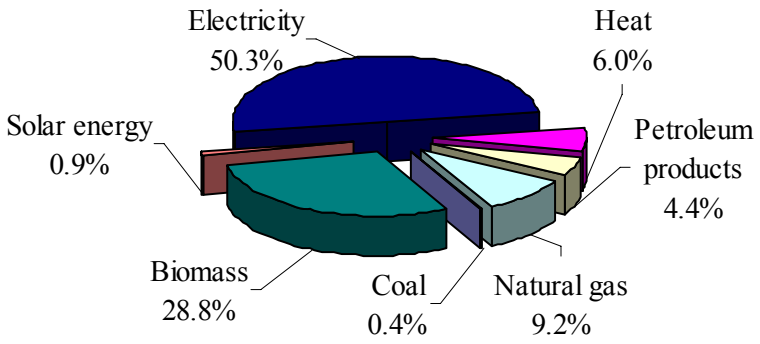

Figure 5.1.2.5. Share of fuels in the residential sector in 2020 according to the Scenario with strengthened energy efficiency measures

The share of biomass will also decrease in this period from 33.3% to 28.8%. The share of petroleum products will also decrease from 6.7% to 4.4%, as well as the share of the heat from 6.9% to 6%. The share of coal is modest, around 0.4%. In 2020, the natural gas will have share of nearly 9% in the energy consumption of the residential sector and the solar energy will have share of around 1%.

5.1.3. Commercial and service sector

The commercial and service sector has a share of 13% in the total final energy consumption in Macedonia in 2006. The energy consumption of this sector is dominated mainly by the electricity with 43% and petroleum products (heating oil i.e. D2 fuel, heavy fuel oil and LPG) with nearly 42% of the total energy consumption in this sector in 2006 (Figure 4.4.3.4). The electricity consumption of this sector has steady growth in the analyzed period. The heat consumption is fairly constant in absolute amount and in 2006 it has a share of 9%. The share of the other fuels is small, the biomass has a share of 3.6%, the coal 1.8% and the geothermal energy and the natural gas have share of 0.4% each.

The developed European countries also have largest share of electricity consumption in the sector with 48% in 2006. The natural gas and petroleum products together have a share of 46% in the energy consumption of this sector, but their relative share is changing in favor of the natural gas.

Baseline scenario

The change of the energy consumption in this sector can be hardly realized from the available statistical data which are inconsistently processed (Figure 4.4.3.1). However, we can see a certain stagnation of the energy consumption in this sector in the last several years. Certain segments of this sector, such as the public administration, education and health are not expected to experience high growth rates, but there are still many possibilities for improvement of the energy efficiency. We do not expect intensive construction of structures in these subsectors either on central or on local (municipal) level. We can expect higher growth in the hotel industry, wholesale and retail trade and financial sector, but, in this group only the hotels are significant consumers of energy.

Based on the comparative analysis, the baseline scenario determines growth rate of the energy consumption in the commercial and service sector of 2.4% per year. With this growth rate, the energy consumption until 2020 will be 39% higher. The energy consumption growth of the commercial and service sector is given in Table 5.1.3.1 and in Figure 5.1.3.1. The individual fuels that take part in the meeting of the demand have

various shares and different growth dynamics. The growth of certain fuels is in line with gradual shift of their share towards the one in the more developed European countries.

The electricity consumption will grow with a rate of 3% or total for the 2006-2020 period by 52% and in 2020 it will be 1720 GWh (148 ktoe).

The consumption of petroleum products will grow with an average rate of nearly 2% and with 1425 GWh (122 ktoe), it will be 32% higher than the petroleum products consumption in 2006.

Until 2020 we do not expect more significant change of the consumption of coal and biomass. We expect a moderate growth of the geothermal energy by 2 GWh (7.2 TJ; 0.2 ktoe) and small growth of the consumption of heat of 20 GWh (72 TJ; 1.7 ktoe), i.e. by 9% in total from 2006 to 2020.

In the analyzed period, the natural gas will have larger share in this sector up to 76 GWh (8×10^6 Nm^3, 6.53 ktoe). The solar energy and heat pumps in 2020 will be used in this sector in total amount of 5 GWh.

Table 5.1.3.1 Forecast of the energy consumption of the commercial and service sector – baseline scenario (GWh)

	GWh															%	
	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	P1	P2
Coal	47	47	47	47	47	47	47	47	47	47	47	47	47	47	47	0	0
Petroleum prod.	1082	1100	1120	1140	1160	1180	1200	1220	1245	1260	1305	1334	1365	1395	1425	1.99	31.7
Biomass	96	96	96	96	96	96	96	96	96	96	96	96	96	96	96	0	0
Electricity	1129	1170	1210	1250	1290	1330	1370	1415	1460	1505	1550	1595	1640	1680	1720	3.05	52.4
Heat	233	235	237	239	241	243	245	246	247	248	249	250	251	252	253	0.59	8.6
Natural gas	5	5	5	6	6	7	10	12	16	21	27	35	45	59	76	21.46	
Solar	2	2	2	2	2	3	3	3	3	3	4	4	4	5	5	6.76	
Geothermal	17	17	17	17	17	17	17	17	17	17	18	18	18	19	19	0.80	11.8
TOTAL	**2610**	**2672**	**2734**	**2797**	**2859**	**2923**	**2988**	**3056**	**3131**	**3197**	**3296**	**3379**	**3466**	**3553**	**3641**	**2.40**	**39.5**

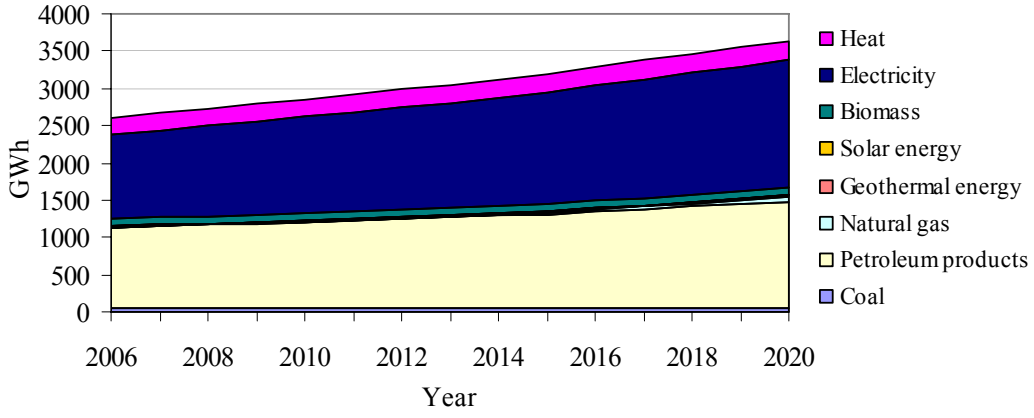

Figure 5.1.3.1 Forecast of the energy consumption of the commercial and service sector according to the baseline scenario

The share of the fuels in the commercial and service sector in Macedonia in 2020, according to the baseline scenario is presented in Figure 5.1.3.2. The electricity dominates with 47%, followed by the petroleum products with 39% and heat with 7%. The biomass (2.6%), natural gas (2.1%), coal (1.3%), geothermal energy (0.5%) and solar energy with heat pumps (0.1%) together have less than 7% share in the total energy consumption in this sector in 2020.

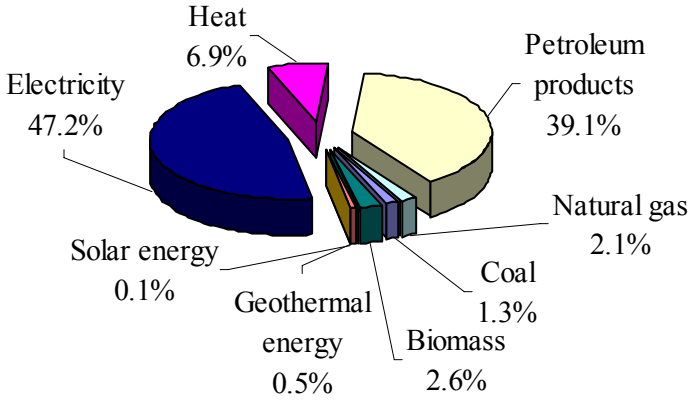

Figure 5.1.3.2. Percentage share of fuels in the commercial and service sector in 2020 – baseline scenario

Scenario with strengthened energy efficiency measures

Based on the degree of construction of the structures in the commercial sector as well as based on the expectations for investments in the upcoming period it is realistic to expect calmer growth of the energy consumption in this sector. Rising of the electricity tariffs will also influence the energy consumption mostly through more intensive energy efficiency measures (improvement of the thermal insulation of the existing structures and new structures, illumination with lower electricity consumption, development of the awareness that the energy saving is a new energy source and that the state and local budget institutions should make an example of energy savings). The private sector will react more rapidly due to purely economic reasons. The total energy savings in this sector have been planned in accordance with NEEAP.

Due to the above reasons the analyzed scenario with average annual growth rate of energy consumption of 1.9% by 2020 is feasible. In this case the share of the individual fuels is projected in direction of the more developed European countries, excluding the natural gas. We cannot expect high share of the natural gas in this sector until 2020 because lack of infrastructure and habits to use gas. The development of the energy consumption in the commercial and service sector until 2020 according to this scenario is given in Table 5.1.3.2 and Figure 5.1.3.3

Table 5.1.3.2 Energy consumption of the commercial and service sector – Scenario with strengthened energy efficiency measures (GWh)

	GWh															%	
	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	P1	P2
Coal	47	47	47	47	47	46	46	45	45	43	43	43	40	40	40	-1.15	-14.9
Petroleum prod.	1082	1082	1087	1097	1107	1122	1140	1158	1176	1194	1212	1230	1248	1268	1288	1.25	19
Biomass	96	97	97	97	97	97	97	98	98	98	99	99	99	100	100	0.29	4.2
Electricity	1129	1170	1210	1240	1270	1310	1350	1390	1430	1460	1490	1520	1548	1576	1603	2.54	42
Heat	233	235	238	236	234	232	232	233	234	235	237	239	241	243	245	0.36	5.2
Natural gas	5	5	5	5	6	8	10	15	20	25	35	50	65	80	95	23.41	
Solar	2	2	2	3	3	3	3	3	3	3	4	5	6	7	8	10.41	
Geothermal	17	17	17	17	17	17	17	17	17	17	18	18	18	19	19	0.80	11.8
TOTAL	**2611**	**2655**	**2703**	**2742**	**2781**	**2835**	**2895**	**2959**	**3023**	**3075**	**3138**	**3204**	**3265**	**3333**	**3398**	**1.90**	**30.1**

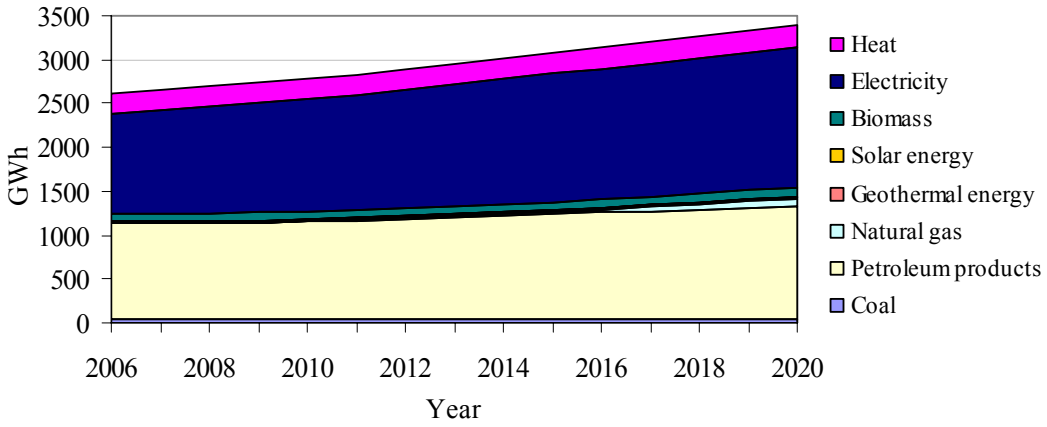

Figure 5.1.3.3. Energy consumption of the commercial and service sector – Scenario with strengthened energy efficiency measures

According to the Scenario with strengthened energy efficiency measures the electricity consumption will grow with a rate of 2.54% or total for the 2006-2020 period it will grow by 42% and in 2020 it will be 1603 GWh (138 ktoe), which is 117 GWh (10 ktoe) less than the consumption according to baseline scenario.

The consumption of petroleum products will grow with average rate of 1.3%. With 1288 GWh (111 ktoe), the petroleum products consumption will 19% higher than in 2006.

In this sector we do not expect more significant change of the biomass and geothermal energy. According to this scenario, the modest consumption of coal will drop additionally from 47 GWh (4 ktoe) in 2006 to 40 GWh (3.4 ktoe) in 2020.

A small growth of the heat consumption is envisaged, in total of 12 GWh (43 TJ; 1.03 ktoe), i.e. a total growth of 5% from 2006 to 2020.

This scenario envisaged greater share of the natural gas and solar energy in this sector. In the analyzed period, the natural gas will increase its share up to 95 GWh (10×10^6 Nm^3, 8 ktoe). The solar energy and the heat pumps in 2020 will be used in total quantity of 8 GWh (0.7 ktoe).

The share of the fuels in the commercial and service sector in Macedonia in 2020 according to the Scenario with strengthened energy efficiency measures is given in Figure 5.1.3.4. The electricity is dominating with 47%, followed by petroleum products with 38% and heat with 7%. Biomass (2.9%), natural gas (2.8%), coal (1.2%), geothermal energy (0.6%) and solar energy and heat pumps (0.2%) together make around 8% of the total consumption of energy in this sector in 2020.

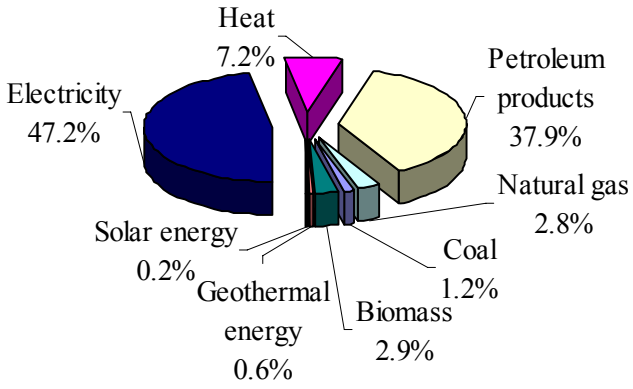

Figure 5.1.3.4. Share of fuels in the commercial and service sector in 2020 – Scenario with strengthened energy efficiency measures

5.1.4. Transport

The selection of a model for transport demand in the Republic of Macedonia, and, as a result of that the modeling of the energy consumption in the transportation sector for the period until 2030, analogously to the other sectors is influenced by the total ambient of the Macedonian state and Macedonian economy. The selection of a model for assessment of the energy consumption for traffic is influenced by the characteristics of the transportation sector in Macedonia. Road traffic dominates the passenger transport as well as the cargo transport. In the passenger transport its share in 2006 was 85%, and 81% in the cargo transport. Other types of traffic which are more significant include: air traffic in passenger transport (5.6% in 2006) and railway transport in the cargo transport (18.1% in 2006). The water traffic is present as lake traffic which has only seasonal and tourist character and, in the total scope of transportation, has only symbolic significance.

One result of the dominant role of the road traffic in the transportation is by all means the dominant consumption of energy in this type of traffic. That domination is so great, that in certain years the road traffic has spent up to 97% of the total consumed energy in the traffic, as it was already shown in section 4.4.4.

The characteristics of the energy consumption in the transportation sector in Macedonia influence the approach in the selection of a model for assessment of that consumption. The basic accent of the analysis is given to modeling of the road traffic, where a more complex model is used, while the analysis of the air and railway traffic is reduced to identification and application of the trends as bases for forecasting. The energy consumption in the lake transport is neglected due to the symbolic share of this type of traffic in the total energy consumption.

Certainly it is very important to emphasize the fact that the model presumptions include the strategic decisions for development of the transport system of the Republic of Macedonia included in the National Transport Strategy[62].

Finally, the scenarios for development based used to produce the model results, use the knowledge, prognoses and goals for development of the transport system in Europe.[63,64]

Forecast of the energy consumption of the road traffic

According to the data from the State Statistical Office, in Macedonia there are vehicles in the road traffic that use one of the following five main types of energy: petrol, diesel, fuel-oil mixture, combination of petrol and LPG, and electricity. Several types of petrol and diesel fuels are offered on the market, but for the purposes of this Strategy the classification of the State Statistical Office meets the goals for forecast of the energy consumption.

If we look at the data on the structure of road motor vehicles according to the fuel they use we can see that vehicles that use petrol and diesel fuel are dominating. Only recently we can see more significant share of vehicles that use combination of petrol and LPG. The consumption of fuel-oil mixture as a fuel and of the electricity in road motor vehicles in Macedonia is marginal.

Regarding the structure of road motor vehicles according to the type of vehicles, the passenger automobiles are by far dominant with a share of 88%. They are followed by the cargo vehicles with around 6% and any other types with a share of less than 2%.

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[62] National Transport Strategy, Ministry of Transportation and Communications of the Republic of Macedonia, 2007

[63] White paper – European Transport Policy for 2010: Time to decide (2003)

[64] "The Future of Transport", Focus Groups' Report, EC, DG Energy and Transport, 20.02.2009

Taking into account the situation of the vehicle structure according to types of vehicles and according to fuels, the model we used to forecast the energy consumption in the road traffic identifies the following vehicle categories and fuel types: car – petrol, car – diesel, car – petrol and LPG combination, commercial vehicles – diesel and mopeds and motorcycles - petrol.

Due to the small number of petrol commercial vehicles and especially due to the marginal number of vehicles that use fuel-oil mixture or electricity, there categories were omitted in order to simplify the model.

The assessment of the energy consumption in road traffic was made using a mathematical model which calculates the energy consumption in certain year according to the vehicle type and share of the relevant type in the total number of vehicles for that year, the type of fuel and the share of that fuel in the fuel consumption for that year in the road traffic, the motorization level in the relevant year, population, fuel economy and vehicle types, annual mileage of the relevant vehicle type.

The motorization level in a country is developing according to "S" curve. In the initial period we can see slow growth of the motorization (beginning of motorization of the population), followed by a period of intensive growth and in the last part of the curve we can see slower growth again, due to saturation phase. The saturation level varies among countries and is between 500 and 800 vehicles per 1000 inhabitants.

If we monitor the motorization in the Republic of Macedonia in a longer period of time, we can see the growth pattern. According to the data given in Figure 5.1.4.1 we can see clearly defined curve of the motorization level growth from 1952 to 1987. After that we can see distortion of trend and its reinstatement until 1993. In the 1993-2006 period we can see distortions of the motorization level growth. It is the transition period and a period of instable economic growth which had strong influence on the traffic.

The basic issue of the forecast of the motorization level is the assessment of the timeframe when the growth trend will be reinstated. For that purpose we define two scenarios (Figure 5.1.4.1):

- Baseline scenario that envisages establishment of a stabile economic growth and return of the trend of the motorization, starting from 2010
- Scenario of "slower growth" that envisages establishment of a stable economic growth and return of the trend of the motorization, starting from 2013 as well as energy savings in accordance with the NEEAP.

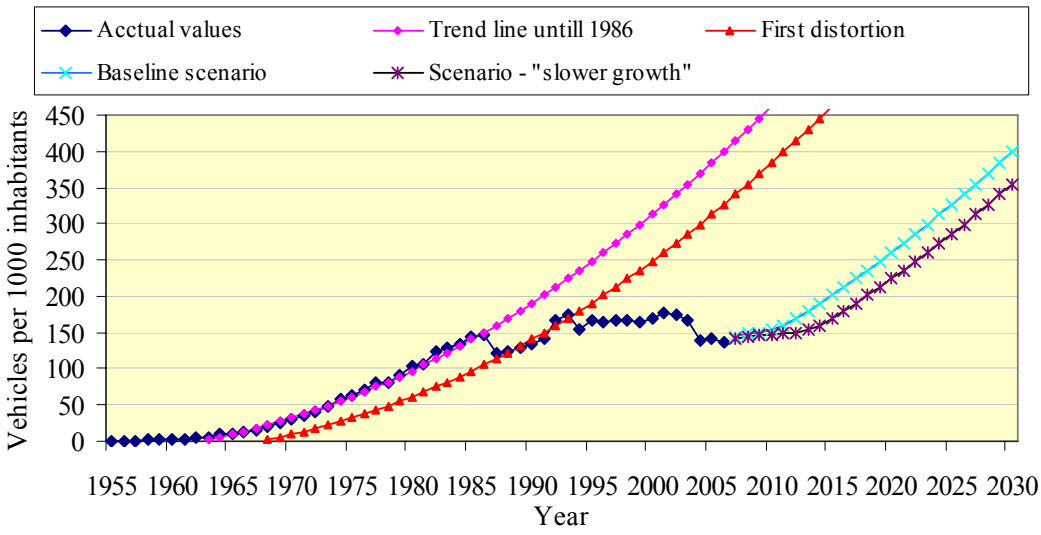

Figure 5.1.4.1. Curve of development of the motorization level in the Republic of Macedonia and forecast of the development of the motorization level

According to the baseline scenario, the motorization level in 2020 will reach 260 vehicles per 1000 inhabitants while according to the scenario of "slower growth" that value would be 225 vehicles per 1000 inhabitants. These values are on the same level as the countries like Slovenia, Poland, Bulgaria had in 1996. That means that Macedonia will continue to be significantly behind the EU member countries.

The population forecast in the Republic of Macedonia is taken from the last forecasts of the Department of Economic and Social Affairs of the United Nations[65]. According to their assessment, the Macedonian population will decrease and from the current 2.036 million inhabitants, in 2020 it will be around 2.025 million and until 2030 it will further decrease to 1.966 million inhabitants.

The vehicle structure according to the fuel they use is forecasted according to the existing trends, based on the analysis of the annual number of new vehicles sold in Macedonia and the possibility for renewal of the vehicle fleet, as well as based on the prognoses of the fuel efficiency and attractiveness of certain types of vehicles. The scenario for the vehicle structure by types of fuel is in line with the National Transport Strategy of Macedonia where the goals for sustainable environment emphasize the need to use cleaner fuels and alternative propulsion. According to these forecasts, the share of petrol vehicles will drop from the current 73% to around 63% in 2020 (average rate of 0.67% per year). The share of diesel vehicles will increase from the current 23% to around 28.6% in 2020 (average annual growth rate of 0.33%), while the share of vehicles that use petrol-LPG combination will grow from 3.6% to around 8.5% (average annual growth rate of 0.34%).

The diesel vehicles will also use biodiesel, and the petrol vehicles will use bioethanol. The possibility for application of radically new types of propulsion, such as fuel cells and hydrogen as fuel, according to some experts[66] will not be that fast, as a result of the problems with the expensive production of hydrogen and problems of transport and storing of the hydrogen. However we can expect expansion of hybrid vehicles (mostly with diesel and electric engine) which will be taken in this model indirectly through the fuel efficiency of diesel vehicles.

The vehicle structure according to vehicle types shows a great deal of stability over a longer period of time. Within the framework of this model we assume than the present distribution of 88% passenger vehicles, 10% commercial vehicles and 2% motorcycles will remain unchanged during the entire forecasted period.

The researches show that since the early 1980s the fuel efficiency of the vehicles is improving, averagely by 1.4% per year in global proportions.[67]

Better results are expected in commercial vehicles and even today there are cargo vehicles with fuel efficiency under 25 liters/100 km.

Assuming linear improvement of the average fuel efficiency of the vehicle fleet in Macedonia during the next 13 years from the starting values in 2007 to the forecasted values in 2020 we have calculated the average fuel efficiency of the vehicle types and fuels included in the model. This model values take into account the current situation of a very old vehicle fleet (around 13.6 years in 2006), as well as a relatively slow renewal of the vehicle fleet in Macedonia where the average annual sale of new vehicles is only 3.5% of the total vehicle fleet.

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[65] Population Division of the Department of Economic and Social Affairs of the United Nations Secretariat, World Population Prospects: The 2006 Revision and World Urbanization Prospects: The 2005 Revision, http://esa.un.org/unpp

[66] MANAGING TRANSPORT CHALLENGES WHEN OIL PRICES RISE, S. Donovan, T. Litman et. al. NZ Transport Agency Research Report 357, Wellington, 2008.

[67] MANAGING TRANSPORT CHALLENGES WHEN OIL PRICES RISE, S. Donovan, T. Litman et. al. NZ Transport Agency Research Report 357, Wellington, 2008

Finally, the average annual mileage of certain vehicle types and fuel types is variable and this is most difficult to assess and forecast. The basic problem is lack of any data about the average mileage of the vehicles in Macedonia.

The use of vehicles depends on many factors, but mainly on the living standard of the population and the economic growth. Therefore, in the scenarios with stronger economic indicators, in the forecasted period we can expect an increase of the average annual mileage of the vehicles.

The proposed values for this variable were obtained and calibrated based on testing of the model for the years with known energy consumption and based on the assumption that the economy growth will cause growth of the average annual mileage of the vehicles.

Energy consumption in the air traffic

The air traffic in Macedonia is international passenger traffic, while the transport of goods is only for smaller shipments in the cargo area of the passenger aircrafts. This type of traffic is realized through the two airports in Skopje and Ohrid. The total volume of passengers on these airports was relatively stable with around 550,000 passengers per year, except in the years of the Kosovo refugee crisis (1999 and 2000). Out of this figure, Skopje Airport has a share of 90% of the total number of passengers and Ohrid Airport has around 10%.

The goods transported from both airports are in marginal quantity relative to the total cargo transport in Macedonia, and they have a decreasing trend.

The analysis of the data about the number of transported passengers and consumed fuel - kerosene show that there is a linear correlation for the period until 2002 (Figure 5.1.4.2).

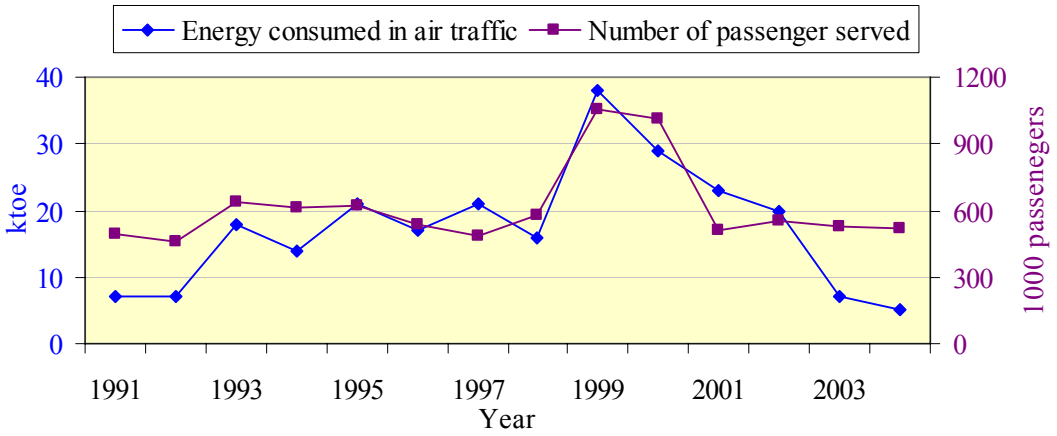

Figure 5.1.4.2. Correlation between the number of passenger served and energy consumed in air traffic

Since 2003 the kerosene in Macedonia is more expensive than in the other countries and most of the airliners avoid buying fuel in Macedonia.

According to data from the European Energy and Transport Commission[68], the air traffic experiences biggest expansion at the end of the previous century and at the beginning of this century. In the period between 1990 and 1995 the recorded growth was 3%, in the period between 1995 and 2000 the recorded growth was 5% and in the period from 2000 to 2005 the growth was 2.5%.

[68] EU Energy and Transport Figures, Statistical Pocket Book 2007/2008, European Commission, DG Energy and transport

Giving the Macedonian airports under concession, as well as the expected economic growth and visa facilitation are factors that are expected to induce growth of the number passengers in air traffic in our country. With an annual growth of 2.5% after 2011, the annual number of passenger served in the Macedonian airports will grow from 600 thousand to around 750 thousand in 2020.

If we assume that the correlation between the number of passengers and consumed energy remains the same, we can assess the expected kerosene consumption

Energy consumption in railway traffic

The railway traffic in Macedonia is in a difficult position. Obsolete infrastructure and vehicle fleet, unfavorable political environment and frequent blockades of the borders, small transport distances and demand for large capital investments put the railway traffic in a marginal role. As we can see in Figure 5.1.4.3 the situation of the passenger transport is especially bad, with stagnation in recent years.

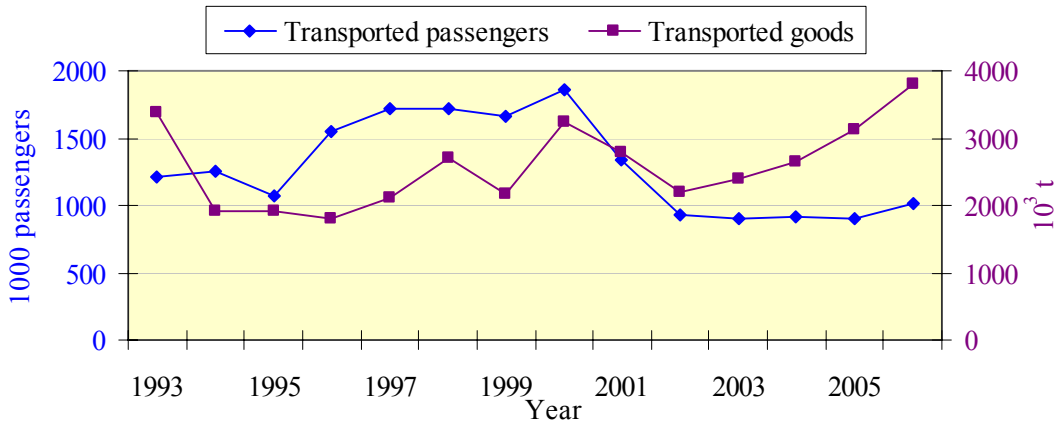

Figure 5.1.4.3. Trends in the railway traffic

The diesel consumption in the railway traffic is only applicable in the sections which are not electrified. In future we cannot expect any significant growth of the diesel consumption in the railways. In case of investments in the railways it will mean electrification of the railroads or construction of new ones which will also be electrified. If the investments do not occur, as a result of the weak competitiveness of the railways, we can expect only weak growth of diesel consumption. For the purposes of the model, we assumed an annual diesel energy consumption growth of 2%.

Results of the model for forecasting the petroleum products consumption

Baseline scenario

The forecasted petroleum products consumption in the traffic until 2020, according to traffic types, according to the baseline scenario is given in Figure 5.1.4.4. The consumption of certain petroleum products will be within the dynamics shown in Table 5.1.4.3 and Figure 5.1.4.5.

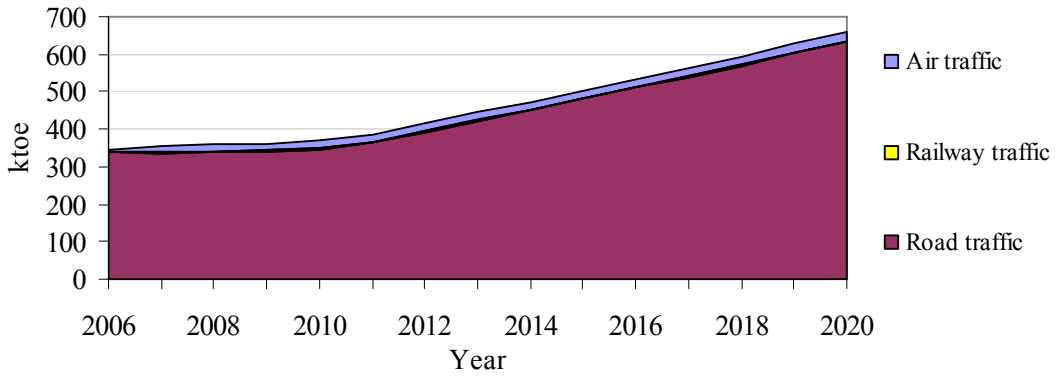

Figure 5.1.4.4. Forecast of the distribution of the petroleum products consumption according to traffic types – baseline scenario

Table 5.1.4.3. Forecast of the consumption of individual petroleum products in the transport sector – baseline scenario (ktoe)

	ktoe														
	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
Petrol	112	120	122	123	125	129	136	142	149	156	162	169	175	182	188
Diesel	192	206	206	206	208	221	239	259	279	299	319	340	361	382	403
LPG	37	13	14	15	16	18	20	23	26	29	32	35	38	42	45
Kerosene	5	19	19	19	19	19	19	20	20	21	21	22	22	23	23
TOTAL	**347**	**358**	**361**	**363**	**368**	**386**	**414**	**444**	**473**	**504**	**534**	**565**	**596**	**628**	**659**

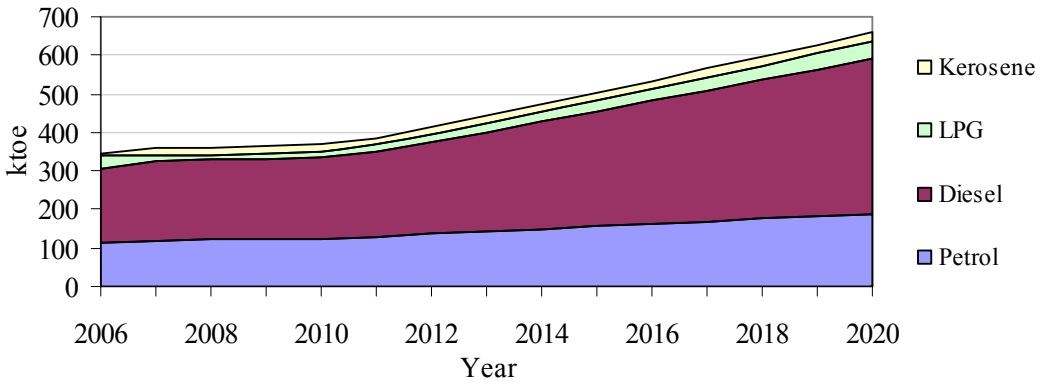

Figure 5.1.4.5. Consumption of certain types of petroleum products in the transport sector according to baseline scenario

As we can see in Table 5.1.4.3, in 2007 there were interventions in the kerosene and LPG compared to 2006.

Regarding the kerosene consumption we envisaged a reinstatement of the correlation between the number of passengers and kerosene consumed, which applied until 2002 and which was distorted with the higher price of kerosene in Macedonia compared to the other countries. After 2007 we envisage an average growth of kerosene consumption of 1.48% or, in total, of 21% until 2020. Kerosene consumption in 2020 will be 23 ktoe.

Since the petrol stations in the Republic of Macedonia sell LPG which is not only for traffic but also for other purposes, the statistical data were corrected for the purposes of the assessment of the LPG consumption in the transport sector. The real consumption

of LPG in 2006 in the traffic is estimated to be around 11 ktoe. The LPG consumption in 2020, according to this scenario will be 4 times higher and will be 45 ktoe.

The petrol consumption will grow with an annual rate of 3.51%. In 2020 it will be 188 ktoe and will be 57% higher than the consumption in 2007. The growth rate of the consumption of diesel fuels in traffic is much higher, 5.3% and in 2020, with it will reach an amount of 403 ktoe and will be doubled compared to the one in 2007.

The total consumption of petroleum products in the period 2007 to 2020 will grow with an average annual rate of 4.81% and in 2020 it will be 659 ktoe, i.e. 84% higher than in 2007.

The share of petroleum products in the transport sector in Macedonia in 2020, according to the baseline scenario is given in Figure 5.1.4.6. The diesel is dominant with 61% or 1% more than in 2006 (section 4.4.4)[69]. The share of petrol continues to be high, 28.5% but compared to 2006 it is reduced by 6.5% while the share of kerosene increases by 2% and the share of the LPG by 3.4%.

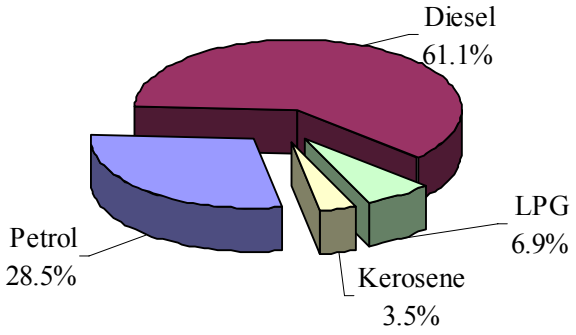

Figure 5.1.4.6. Percentage share of certain petroleum products in the total consumption of the transport sector in 2020 – baseline scenario

Scenario with slower growth

The forecast of the petroleum products consumption until 2020 according to this scenario is given in Table 5.1.4.4 and Figure 5.1.4.7.

Table 5.1.4.4. Forecast of the consumption of individual petroleum products in the transport sector – "slower growth" scenario (ktoe)

	ktoe														
	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
Petrol	112	118	119	120	120	119	119	121	125	131	138	144	150	156	162
Diesel	192	201	201	200	198	204	210	220	234	252	271	290	309	328	347
LPG	37	12	14	15	16	17	18	20	21	24	27	30	33	36	39
Kerosene	5	19	19	19	19	19	19	20	20	21	21	22	22	23	23
TOTAL	**346**	**351**	**352**	**354**	**352**	**359**	**366**	**381**	**400**	**428**	**456**	**485**	**513**	**542**	**571**

[69] With correction of the statistical data on LPG.

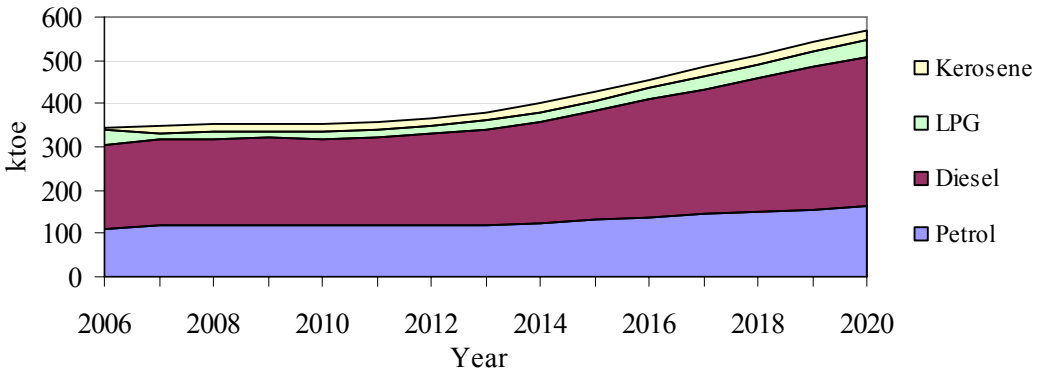

Figure 5.1.4.7. Consumption of certain types of petroleum products in the transport sector according to the "slower growth" scenario

Due to the reasons explained in the analysis of the baseline scenario, in this case 2007 is also taken as a baseline year.

The diesel consumption will grow with an average rate of 4.3% and in 2020 it will be 347 ktoe which is 56 ktoe less than the consumption envisaged in the baseline scenario.

The petrol consumption will grow with an average rate of 2.5% and with 162 ktoe in 2020 will be 26 ktoe less than in the baseline scenario. LPG until 2020 is forecasted to reach a consumption of 39 ktoe, 6 ktoe less than in the baseline scenario.

According to this scenario the kerosene consumption is expected to grow with the same average rate as in the baseline scenario (1.48%) and in 2020 it will be 23 ktoe.

The total consumption of petroleum products in 2020, according to the slower growth scenario will be 571 ktoe and it will be 88 ktoe or 13% less than the forecasted consumption in 2020 in the baseline scenario. The average annual growth rate of the consumption of petroleum products in the traffic in the 2007-2020 period according to this scenario will be 3.81%. The petroleum products consumption in traffic in 2020 will be 63% higher than in 2007.

Figure 5.1.4.8 provides the share of certain petroleum products in the transport sector in 2020 according to the "slower growth" scenario. As we can see in the figure, the percentage share of the individual petroleum products is almost equal to the baseline scenario.

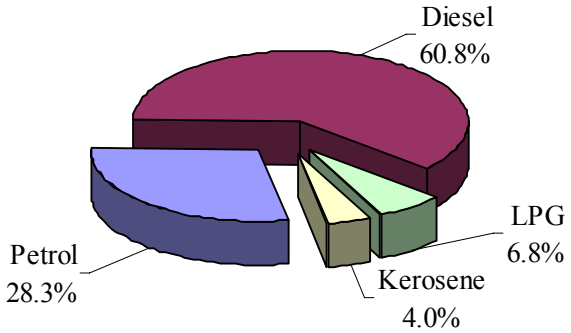

Figure 5.1.4.8. Percentage share of certain petroleum products in the total consumption of the transport sector in 2020 - "slower growth" scenario

Electricity consumption in the transportation sector

The direct electricity consumption in the transportation sector in the Republic of Macedonia is the electricity consumed in the railway traffic, at the electrified sections.

In order to overcome the poor situation of the railway traffic it is necessary to realize large capital investments in the infrastructure and vehicle fleet, as well as a stable political situation in the region and adoption and application of new management concepts and functioning of the railways in the wider region. These prerequisites are hard to realize within the forecasted period.

Instead of that, we assume that the same railway infrastructure will remain and the existing trend of gradual return to the old positions of the railways in the passenger and cargo transport in the time before the independence of the Republic of Macedonia will continue. An average annual growth of electricity consumption of 2.8% will be realized. With that growth, in 2020 the level of transport and consumption of electricity will be equal to the level immediately before the independence of the Republic of Macedonia. (Table 5.1.4.5).

Table 5.1.4.5. Electricity consumption in the railways traffic in the Republic of Macedonia

	2006	2008	2010	2012	2014	2016	2018	2020
GWh per year	23	23	23	23	35	47	47	47

Natural gas consumption in the transport

The use of natural gas in the traffic in Macedonia is only symbolic. The only attempt for its use was made by JSP Skopje with technical adaptation of 30 of the existing diesel buses in the Skopje urban transport, for combined use of natural gas and diesel. The need for technical adaptation of the vehicles, the necessary large space for tanks in the vehicles and inexistence of a network that sells this type of fuel are limitation factors for a more significant application of this fuel type in the traffic. This, combined with the announcements for increasing of the natural gas prices on the global market, as well as the dependence of Macedonia on import of this fuel leads to an assumption that in the upcoming period the natural gas will not have a significant role in the Macedonian transport sector.

Consumption of biofuels in the transport sector

According to the EU recommendations for wider application of biofuels in order to protect the environment, it is planned to use the biofuels in the traffic with a share of 10% of the total consumption of petrol and diesel in the traffic in Macedonia in 2020. According to this Directive the final energy consumption in traffic includes only petrol, diesel fuel and biofuel in the road and railroad traffic and the electricity consumption. The share of RES includes all forms of RES used in traffic. Macedonia plans to have a less than 1% share of electricity in the final energy consumption in road and railroad traffic in 2020. In addition, the share of other RES, other than biofuels, will be less than 1%. Therefore, the proclaimed target can be calculated through the share of biofuels in the consumption of petrol and diesel fuels in traffic.

The consumption of biofuels until 2020 will reach the value of around 56ktoe/year according to the baseline scenario and around 48ktoe/year according to the scenario with slower growth.

These quantities of biofuel would substitute relevant quantities of diesel consumption.

5.1.5. Agriculture and forestry

The energy consumption in this sector is three times lower than in the developed countries if calculated per capita and approximately the same if calculated per GDP unit. Therefore we can assume that the energy consumption in this sector will start to grow and will follow the GDP growth. We should take into account the measures undertaken by the Government for more rapid development of this sector. We expect gradual growth of the use of geothermal energy for heating of greenhouse complexes.

The total consumption of this sector is relatively small, less than 2% of the total final energy consumption in Macedonia and will not have any significant influence on the total energy balances.

According to the ***baseline scenario*** it is envisaged that by 2020 the level of use of geothermal energy of 32.8ktoe (Table 5.1.5.1 and Figure 5.1.5.1). Electricity and petroleum products will grow with an average rate of around 1.6% to 1.4% respectively. The total energy consumption in this sector in the analyzed period will grow with an average rate of 5% per year. In 2020 it will reach 59 ktoe (690 GWh, 2483 TJ).

Table 5.1.5.1. Energy consumption in agriculture and forestry according to baseline scenario (ktoe)

	ktoe								%	
	2006	2008	2010	2012	2014	2016	2018	2020	P1	P2
Petroleum products	19	19	20	20	21	22	22	23	1.37	21.05
Geothermal	8	8.5	9	10	12,3	16	22	32.8	10.6	
Biomass	1	1	1	1	1	1	1	1	0	0
Electricity	2	2	2	2	2.5	2.5	2.5	2.5	1.61	25
TOTAL	**30**	**30.5**	**32**	**33**	**36.8**	**41,5**	**47,5**	**59,3**	4.99	97.67

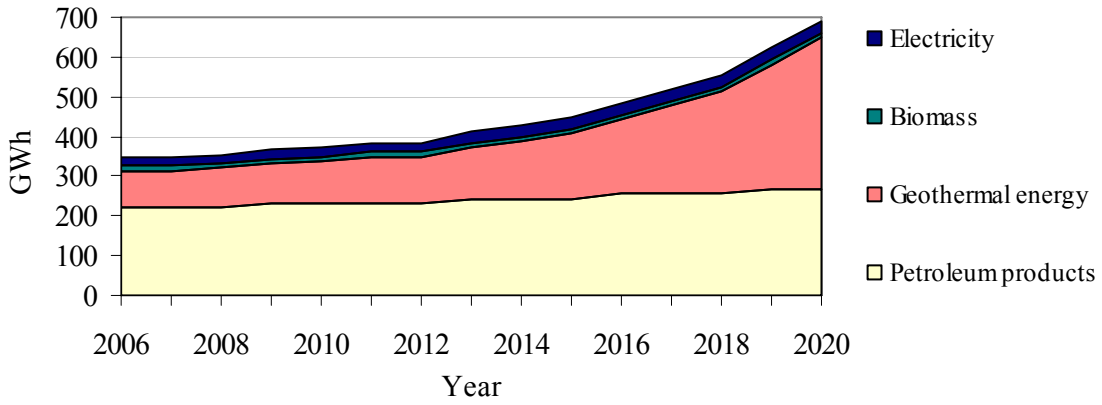

Figure 5.1.5.1. Energy consumption in agriculture and forestry - baseline scenario

According to the ***Scenario with strengthened energy efficiency measures*** it is assumed that the electricity and petroleum products will grow slower. The electricity and petroleum products will grow with an average rate of around 1.6% and 0.4% respectively (table 5.1.5.2 and figure 5.1.5.2). As a result of the increased use of geothermal energy, the total consumption of energy in this sector in the analyzed period will grow with an average rate of 5.9% and by 2020 it will reach 66.5 ktoe (773 GWh, 2784 TJ).

Table 5.1.5.2. Energy consumption in agriculture and forestry according to the Scenario with strengthened energy efficiency measures (ktoe)

	ktoe								%	
	2006	2008	2010	2012	2014	2016	2018	2020	P1	P2
Petroleum products	19	19	19	19	20	20	20	20	0.37	5.26
Geothermal	8	8	9	11	15	20.5	29	43	12.76	
Biomass	1	1	1	1	1	1	1	1		
Electricity	2	2	2	2	2.5	2.5	2.5	2.5	1.61	25.00
TOTAL	**30**	**30**	**31**	**33**	**38.5**	**44**	**52.5**	**66.5**	**5.85**	

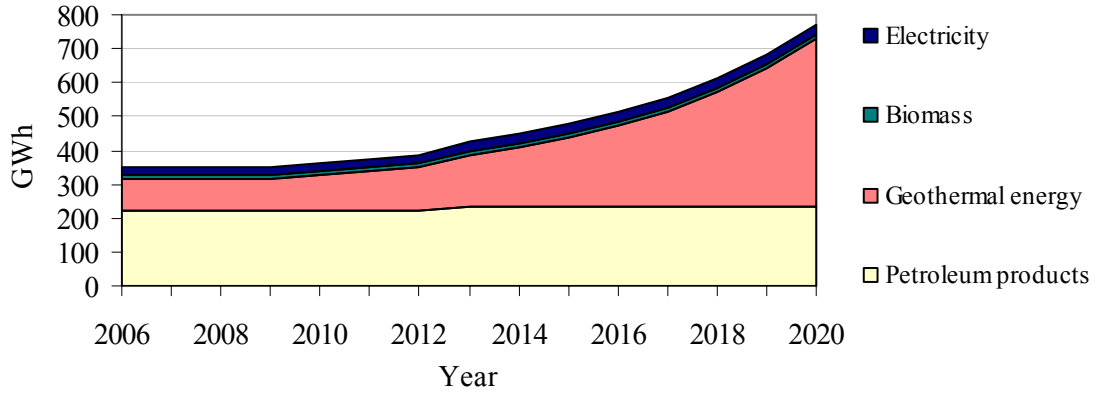

Figure 5.1.5.2. Energy consumption in agriculture and forestry according to the Scenario with strengthened energy efficiency measures

5.1.6. Non-energy demand

The energy consumption for non-energy use in Macedonia in 2006 was 29 ktoe (337 GWh, 1210 TJ), i.e. 1.7% of the total final energy consumption in Macedonia. In the last ten years, the consumption varied within the interval of 16 ktoe to 43 ktoe (Table 4.4.6.1). In the developed European countries it is stagnating in the last ten years. We cannot notice any significant change in this consumption in Macedonia in the period until 2020.

5.1.7. Total final energy needs in the period 2008-2020 by sectors

Basline scenario

The total final energy consumption until 2020 (Table 5.1.7.1 and Figure 5.1.7.1) will grow with an average annual rate of 2.6% and in 2020 it will be 2618 ktoe. The total growth is 44%, i.e. compared to 2006 the demand will be 800 ktoe higher. The largest growth can be seen in transport sector and in agriculture and forestry, with around 90% compared to 2006.

After certain stagnation of the final energy consumption it expected that it will start to grow after 2010 by 3.6% per year.

Table 5.1.7.1. Total final energy demand according to baseline scenario (ktoe)[70]

	ktoe															%	
	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	P1	P2
Industry	578	621	632	534	517	570	607	630	652	675	698	722	746	770	794	2.3	37.4
Residential	609	617	625	633	642	652	661	672	683	694	707	720	733	747	760	1.6	24.9
Comm. and service	225	230	235	240	246	251	257	263	269	275	283	291	298	306	313	2.4	39.4
Transport	348	360	363	365	370	388	416	447	476	508	538	569	600	632	663	4.7	90.4
Agr. and Forestry	30	30	30	32	32	33	33	36	37	39	42	44	48	53	59	4.99	97.7
Non-energy use	29	29	29	29	29	29	29	29	29	29	29	29	29	29	29	0.0	0.0
TOTAL	**1818**	**1887**	**1914**	**1832**	**1836**	**1923**	**2004**	**2076**	**2147**	**2220**	**2297**	**2375**	**2453**	**2535**	**2618**	**2.6**	**44.0**

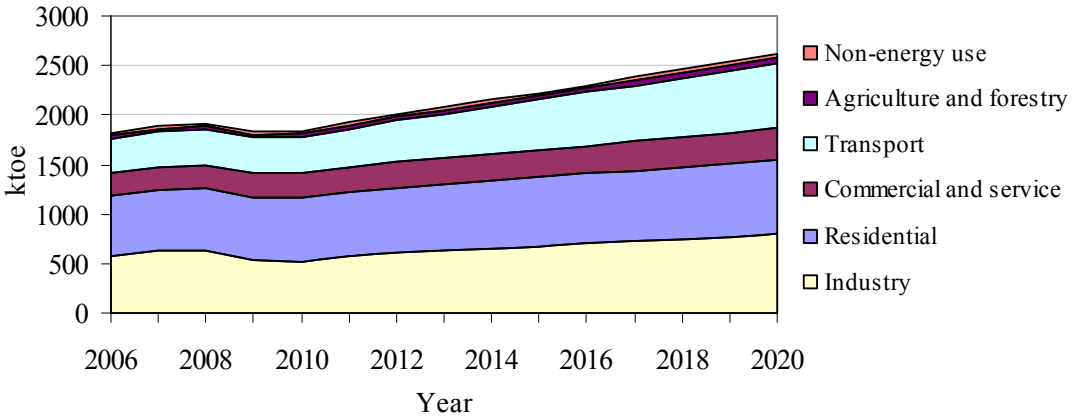

Figure 5.1.7.1. Total final energy demand according to baseline scenario

According to Figure 5.1.7.2 in 2020 the industry and the residential sector have largest energy demand with a share of 30% each. They are followed by the transport sector with around 25% and commercial and service sector with 12% and the agriculture and forestry with 2% and the other demand in other non-energy sector with 1%.

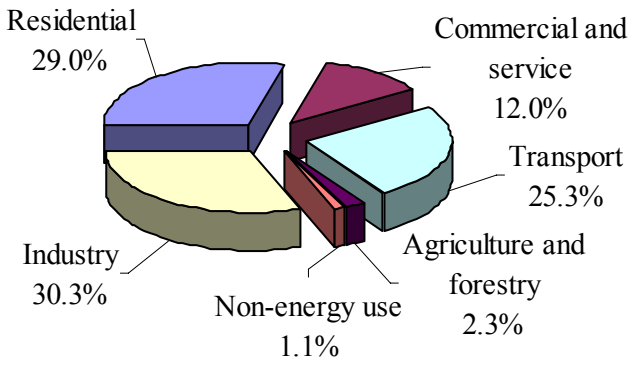

Figure 5.1.7.2. Percentage share of the sectors in the final energy demand in 2020 – baseline scenario

[70] The consumption of energy for 2006 also takes into account the unregistered consumption of biomass and electricity as well as solar energy which is also not registered in the IEA data.

Scenario with strengthened energy efficiency measures

According to the Scenario with strengthened energy efficiency measures the final energy demand will grow with an average annual rate of 2.2% and in 2020 they will reach 2466 ktoe (Figure 5.1.7.3 and Table 5.1.7.2) which is 648 ktoe more than in 2006.

Table 5.1.7.2 Total final energy demand according to the Scenario with strengthened energy efficiency measures (ktoe)[71]

	ktoe															%	
	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	P1%	P2%
Industry	578	621	632	533	517	570	603	621	640	658	677	696	717	737	758	2.0	31.2
Residential	609	619	627	630	633	639	646	656	667	679	693	706	719	733	745	1.5	22.4
Comm. and service	225	228	232	236	239	244	249	254	260	264	270	275	281	287	292	1.9	30.1
Transport	348	353	354	356	354	361	368	384	403	432	460	489	517	546	575	3.7	65.2
Agr. and Forestry	30	30	30	31	31	32	33	37	39	41	44	48	53	59	67	5.9	121.7
Non-energy use	29	29	29	29	29	29	29	29	29	29	29	29	29	29	29	0.0	0.0
TOTAL	**1818**	**1880**	**1906**	**1814**	**1803**	**1875**	**1928**	**1981**	**2037**	**2104**	**2172**	**2244**	**2315**	**2390**	**2466**	**2.2**	**35.6**

The highest total growth of the demand in 2020 compared to 2006 can be seen in the agriculture and forestry with around 100%, followed by the transport sector with around 65%.

According to this scenario, the total final energy consumption in 2020 will be by 152 ktoe lower than the consumption according to the baseline scenario.

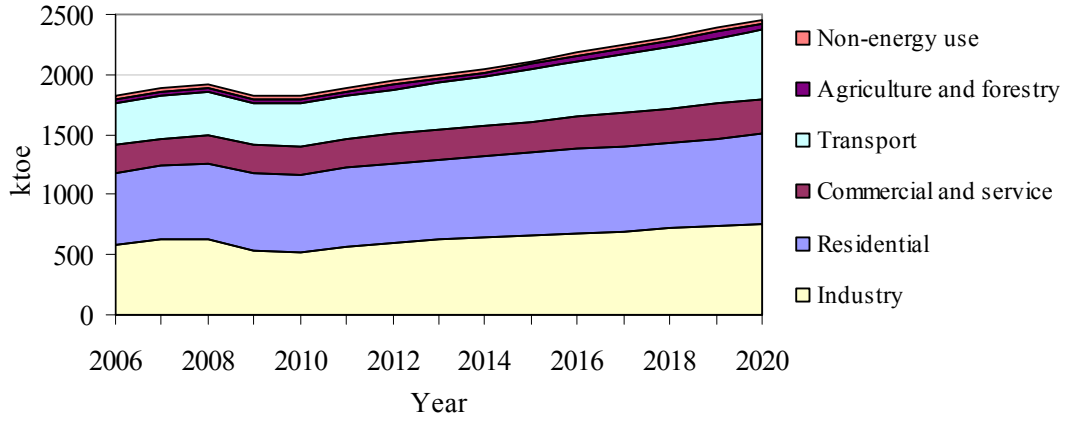

Figure 5.1.7.3. Final energy demand according to the Scenario with strengthened energy efficiency measures

The share of the final energy demand by sectors, given in Figure 5.1.7.4 shows that according to this scenario the industry and the residential sector have the largest share, i.e. 30.7% and 30.2% respectively. The transport sector has a share of 23.3% and the commercial and service sector 11.9%. The smallest share is in the agriculture and forestry with 2.7% and non-energy use with 1.2%.

[71] The consumption of energy for 2006 also takes into account the unregistered consumption of biomass and electricity as well as solar energy which is also not registered in the IEA data.

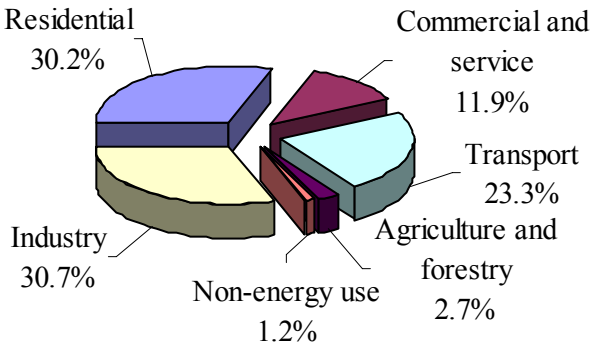

Figure 5.1.7.4. Percentage share of the sectors in the final energy demand in 2020 – Scenario with strengthened energy efficiency measures

5.2. FINAL ENERGY NEEDS IN THE PERIOD 2008-2020 BY FUELS

The final energy demand according to fuels has been directly derived from the analyzed energy demand by sector.

Baseline scenario

The final energy demand by fuels until 2020, according to baseline scenario is given in Table 5.2.1 and Figure 5.2.1. The average annual growth rate in the 2006-2020 period is 2.6% and in 2020 the final energy consumption will reach the value of 2618 ktoe which is 800 ktoe more than in 2006.

Table 5.2.1 Final energy demand until 2020, according to the baseline scenario (ktoe)[72]

	ktoe															%	
	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	P1	P2
Electricity	612	648	661	618	629	675	696	718	738	760	781	802	822	843	864	2.5	41
Heat	118	120	121	119	119	121	123	125	127	129	131	134	136	138	140	1.2	18
Petroleum prod. and biof.	711	729	736	720	724	749	784	822	858	896	936	975	1014	1055	1093	3.1	54
Natural gas	34	35	36	38	40	42	45	50	54	59	65	73	81	89	98	7.8	186
Coal	117	127	132	107	92	102	119	123	126	130	133	137	140	144	147	1.6	26
Biomass for comb.	215	217	218	219	220	222	223	225	227	228	230	231	233	234	236	0.7	10
Geothermal	9	9	9	10	10	11	11	12	14	15	18	20	24	28	34	9.7	264
Solar	0.8	0.9	0.9	1.0	1.1	1.4	1.6	1.9	2.2	2.6	3.1	3.5	4.0	4.6	5.2	14.5	567
TOTAL	**1818**	**1887**	**1914**	**1832**	**1836**	**1923**	**2004**	**2076**	**2147**	**2220**	**2297**	**2375**	**2453**	**2535**	**2618**	**2.6**	**44**

The total growth of final energy demand in 2020 compared to the baseline year 2006 is 44%.

The consumption of electricity in the reviewed period will increase by nearly 3000 GWh, from around 7100 GWh in 2006, to more than 10000 GWh in 2020.

The solar energy has the highest growth rate of around 14.5%, followed by the natural gas with 7.8%, geothermal energy with 9.7% and petroleum products and biofuels combined with 3.1%. The growth rate of the electricity is 2.5%. The lowest growth rates are forecasted for coal, 1.6%, heat, 1.2% and biomass for combustion, 0.7%.

[72] The 2006 energy consumption also includes the unregistered consumption of biomass and electricity as well as the solar energy which is not recorded in the IEA data

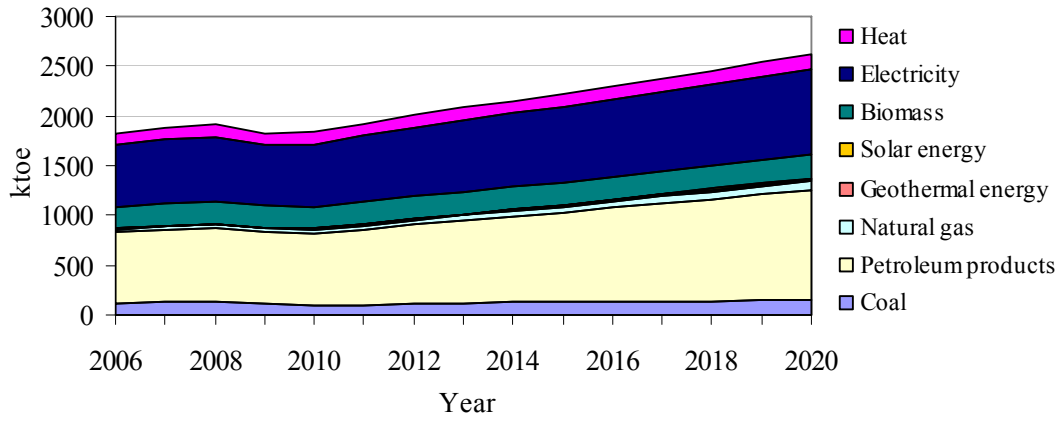

Figure 5.2.1. Final energy demand until 2020 according to baseline scenario

The expected growth of the heat consumption is based on the current situation in Macedonia and experiences of the developed countries. According to the baseline scenario, the heat consumption in the 2006-2020 period will increase by 18% or from 1376 GWh (118 ktoe, 4954 TJ) in 2006 to 1628 GWh (140 ktoe, 5861 TJ) in 2020.

Figure 5.2.2 shows the comparison of the relative share of the final energy demand in 2006 and 2020 according to fuels, according to the baseline scenario. As we can see, the petroleum products will have a larger share of around 42%, while the electricity will have a lower share with around 33%, compared to 34%. The biomass will have a lower share with 9%. The coal and heat will have shares lower by 1%. The share of natural gas will increase from 2% to nearly 4%. The shares of geothermal and solar energy will also increase.

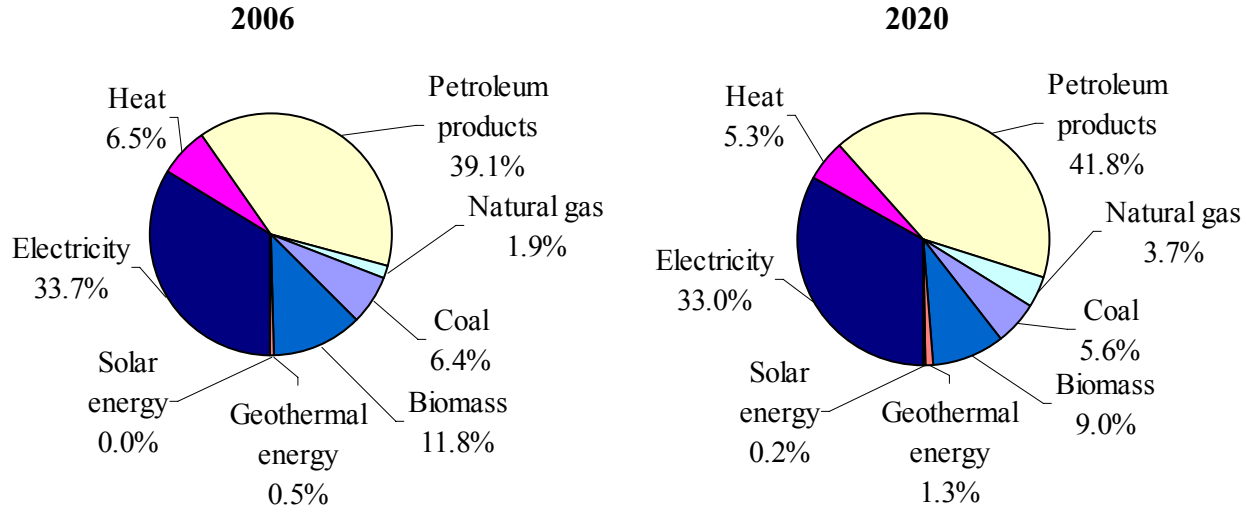

Figure 5.2.2. Percentage distribution of the final energy demand according to fuels in the baseline scenario

Scenario with strengthened energy efficiency measures

The final energy demand according to fuels until 2020, according to this scenario (Figure 5.2.3 and Table 5.2.2) have an average growth rate of 2.16% and in 2020 they will reach the volume of 2466 ktoe which is 648 ktoe more than in 2006. The total growth of the final energy demand in 2020 compared to 2006 is 35.6%.

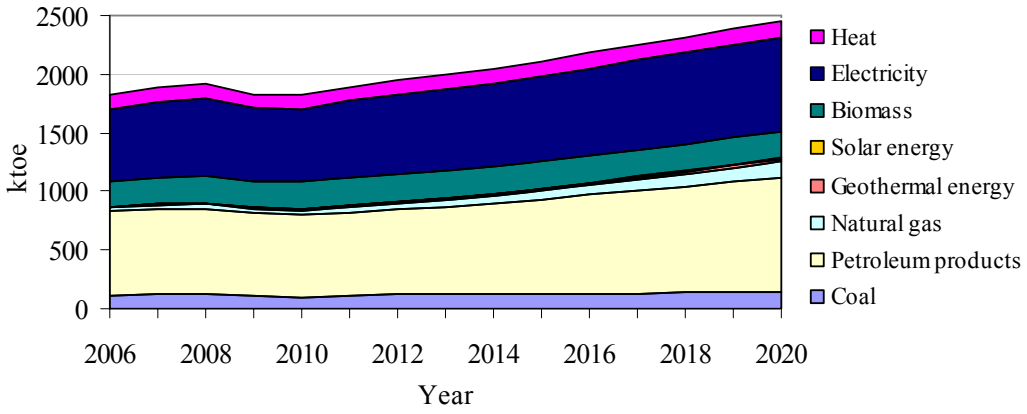

Figure 5.2.3 Final energy demand until 2020 according to the Scenario with strengthened energy efficiency measures

Table 5.2.2 Final energy demand until 2020 according to the Scenario with strengthened energy efficiency measures (ktoe)[73]

	ktoe															%	
	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	P1	P2
Electricity	612	649	663	615	619	659	674	691	706	724	741	758	774	791	807	2.0	32.0
Heat	118	120	121	119	119	120	121	123	125	127	129	131	133	135	137	1.0	15.5
Petroleum prod. and biof.	711	721	724	705	700	713	725	745	769	802	835	869	902	937	971	2.2	36.5
Natural gas	34	35	36	37	40	45	51	59	67	75	84	95	107	118	130	10.0	
Coal	117	127	132	107	92	102	119	122	125	127	130	133	136	138	141	1.3	20.5
Biomass for comb.	215	217	218	219	220	222	223	224	226	227	228	228	228	228	227	0.4	5.7
Geothermal	9	9	9	10	10	11	12	14	16	19	22	26	31	37	45	11.7	
Solar	1	1	1	1	2	2	2	2	3	3	4	5	6	7	8	17.8	
TOTAL	**1818**	**1880**	**1905**	**1814**	**1803**	**1875**	**1928**	**1981**	**2037**	**2104**	**2172**	**2244**	**2315**	**2390**	**2466**	**2.2**	**35.6**

The solar energy has the highest rate, again, with 17.8%, followed by natural gas with 10% and geothermal energy with 11.7%. The growth rate of the other fuels is within the boundaries of 1% - 2%.

The demand for electricity in 2020 will be 650 GWh lower than in the baseline scenario.

According to this scenario, the total growth of heat consumption in the above mentioned period is 15.5% and in 2020 the total heat consumption will be 1590 GWh (137 ktoe, 5724 TJ).

Figure 5.2.4 shows the percentage shares of individual fuels in the final energy demand in 2020 according to the Scenario with strengthened energy efficiency measures. The petroleum products have the largest share, again, with 39%, followed by the electricity with slightly less than 33%, biomass, 9%, coal, 6%, heat, 6%, natural gas, 5%, geothermal energy, 2% and solar energy, 0.3%. The percentage share of the other fuels is approximately the same as in the baseline scenario.

[73] The 2006 energy consumption also includes the unregistered consumption of biomass and electricity as well as the solar energy which is not recorded in the IEA data

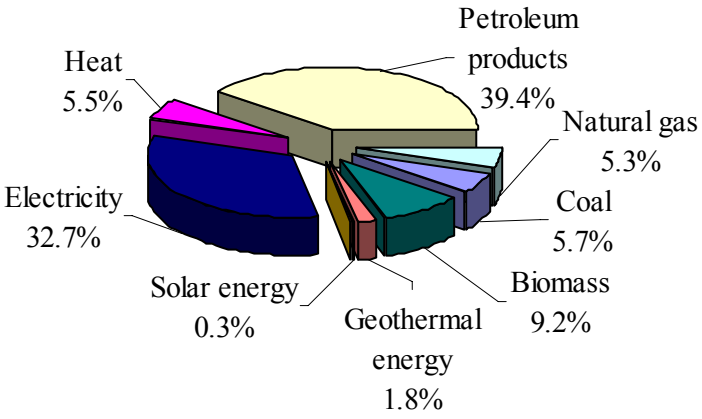

Figure 5.2.4 Percentage distribution of the final energy demand in 2020 according to individual sectors in the Scenario with strengthened energy efficiency measures

According to this scenario, the natural gas will increase its share on the account of petroleum products and the share of solar and geothermal energy will increase compared to the baseline scenario.

6. POSSIBILITIES FOR MEETING THE ENERGY NEEDS IN THE PERIOD 2008-2020

The analyses of the possibilities for providing the necessary energy take into account that Macedonia is a part of the Regional Energy Market which, after 2015, will be completely liberalized and will become an integral part of the wider European market. Accordingly, complete transparency, competitiveness and nondiscrimination in the energy sector, taking into account the liberalization of the sector in the domain of production as well as in the domain of supply with fuels, especially electricity, is a prerequisite for realization of the planned scenarios.

In order to provide energy security it is planned to have greater diversity of energy resources by types, sources and suppliers. In that sense, we envisage an active role of the Regional Energy Market and European Energy Community as well as reduction of the high dependence of Macedonia of imported energy with maximal possible utilization of the domestic resources.

6.1. POSSIBILITIES FOR MEETING THE ELECTRICAL AND HEAT ENERGY NEEDS IN THE PERIOD 2008-2020

6.1.1. Electricity

Considering the necessary place of the electricity in the energy balance of the state, this type of energy was subject to proper and relevant attention. Multiple scenarios were developed. In the baseline scenario we analyzed the increase of electricity at an annual rate of 2.5% which is relevant to the increase which derives from the baseline scenario, per sectors. The realization of the scenario with strengthened energy efficiency measures, the planned supply with electricity at an annual growth rate of 2.5% will provide additional security of the electricity supply. Having in mind the structure of our industry, in the Strategy we analyzed also another scenario with possible annual growth rate of 3% in the case of accelerated growth of the steel and Ferro-alloys industry.

The development of the electrical energy system in Macedonia, in the area of potential facilities and capacities for production, is based on the real possibilities whereas we considered the demand for electricity, the situation with the current production system, the availability of the local resources and the available energy sources from import.

The base year in the development period in 2007 is a structure of the real consumption in Macedonia in 2006 which features a burden factor of 60.7%. In the base year, the necessary initial energy is 8590 GWh and the necessary maximum annual power is 1616 MW.

Candidates of the thermo power plant and the hydro power plant in the electrical-energy system in Macedonia

The candidates for development of the Macedonian EPS production system, in their nature, can be segmented in two categories: thermal power plants and hydro power plants[74]. Thermal power plants are the thermal power plants of natural gas, lignite and nuclear power plant. Hydro-energy facilities are the large hydropower plants, together with the other renewable energy sources. The other RES in the balances include small

[74] As per the WASP software package that was used to make the calculations for development of the EES of Macedonia

hydropower plants, photovoltaic plants, and biomass fired combined heat and power facilities. The wind power plants are analyzed together with the thermal power plants and the storage hydropower plants that provide the necessary power during periods with insufficient wind speed. The generation from wind power plants will contribute mainly toward fuel saving in the thermal power plants, and partly in the energy balance when used together with the storage hydropower plants.

The table 6.1.1.1 includes technical and financial[75] parameters of the candidates for thermal power plants in Macedonia until 2020.

Candidates from the heat facilities are the combined heat and power plants running on gas: CHP Skopje AD [76] (234 MW) which is in construction phase and, according to the plans, should be up and running in 2010. The CHP KOGEL[77] (30MW) which is in final phase of construction and is expected to be up and running in 2010 and CHP Energetika (300 MW) the tender for which was announced recently. The thermal-power plants running on lignite which are candidates are: TPP Bitola 4, TPP Mariovo and TPP Negotino[78] - all of these having identical parameters (300 MW) and which, according to the research so far, could run on lignite excavated from underground pits and underground excavations.

In line with the efforts for integration in the free regional electricity market, as a part of the wider European market, the import of energy will always be an option for meeting the energy demand of the country under most favorable technical and economical parameters.

Table 6.1.1.2 provides the basic parameters of the candidates for hydro power plants in Macedonia. Input parameters of the calculations for all HPP include the available production capabilities in dry, average and wet hydrology[79].

HPP Sv. Petka which is under construction is planned to be running in 2010.

Price of the generated electricity

The total electricity price at the power plant is formed using the price of investment, the price of fuel and operational costs.

Fuel price. For the new lignite thermal power plants it is planned to get the fuel from pit excavation with price of 15 € per ton of lignite[80] with caloric value of the lignite of 8500 kJ/kg. The lignite thermal power plants with modern technology that fulfils the environmental conditions cost around 1200 €/kW and they have efficiency coefficient of 40%. The above parameters show that the lignite price is 1.59 c€/kWh.

The envisaged natural gas thermal power plants are with technology of combined heat and power production. The calculations of the price of the generated electricity do not take into account the valorization of the generated thermal energy. The price of natural gas is taken as 231 € per 1000 Nm^3 with caloric value of 35,000 kJ/ Nm^3. The cost of the investment for this type of plant is around 650 €/kW and they have an efficiency coefficient of 51% (only for electricity production). The price of the fuel is 4.62 c€/kWh.

[75] UBS Investment Research: European power prices

[76] CHP Skopje AD (TE-TO AD Skopje) is joint stock company established by Toplifikacija AD and Russian SINTEZ Holding Group

[77] CHP KOGEL is the first private, market oriented facility in the country. It will sell the electricity and heat based on market principles.

[78] According to ELEM

[79] Probability of hydrology: dry – 12%, average – 74% and wet – 14%.

[80] The feasibility study for pit exploitation of coal for the purposes of Bitola TPP from the Zhivojno mine, prepared by RI-PIERM, Mining Institute Ltd. Skopje etc. February 2004.

The nuclear power plants are facilities with high investments and low fuel costs. In order to establish the price of the electricity from NPP we took to international experiences and data according to which the cost of investment is 2000 €/kW and the fuel cost is 1.09 c€/kWh.

Cost of investment. The value of the investment for certain types of thermal power plants (TPP) and nuclear power plants (NPP), as well as the period of construction with interest rate for the time of construction are given in Table 6.1.1.1 and for the hydro power plants are given in Table 6.1.1.2. The last columns include the investment costs taking into account the repayment of the investment loans.

Table 6.1.1.1 Parameters for investment costs for TPP and NPP

	Investment	P	*Investment	IDC	Period of construction	**Investment
	€/kW	(MW)	(M€)	(%)	(години)	(M€)
TPP lignite	1200	300	360	7	4	425
TPP gas	650	234	152	7	2	169
NPP	2000	1000	2000	7	7	2597

** Over Night Investment*
***Investment with loan repayment for the period of construction with IDC interest rate*
IDC (Interest During Construction) – rate which is paid for the credit during the construction period

Table 6.1.1.2. Parameters for investment costs for HPP

HPP	Investment	P	* Investment	IDC	Period of constr.	** Investment
	€/kW	(MW)	(M€)	(%)	(years)	(M€)
Boshkov Most	1026	68.2	70	7	4	83
L. Pole and HPP Crn K.	5625	8.0	45	7	4	53
Galishte	1034	193.5	200	7	7	260
Chebren	956	333.0	319	7	7	414
Gradec	2857	54.6	156	7	7	203
Veles	2699	93.0	251	7	7	326

** Over Night Investment*
***Investment with loan repayment for the period of construction with IDC interest rate*
IDC (Interest During Construction) – rate which is paid for the credit during the construction period

Tables 6.1.1.3 and 6.1.1.4 provide the economic parameters of the discount rate and annual value of the investments which are necessary for valuation of the investment costs of the generated electricity.

Table 6.1.1.3. Forming the investment costs for generated electricity in thermal and nuclear power plants

	**Invest-ment	Discount rate	Period of exploitation	Annualized rate of investment	Annual production	Annual operation	Invest. price of electricity
	(M€)	(%)	(years)	M€/god	(GWh)	h/yaer	c€ / kWh
TPP lignite	425	7	30	34.26	2100	7000	1.63
TPP gas	169	7	20	15.88	1750	7479	0.91
NPP	2597	7	60	185.03	7500	7500	2.46

Table 6.1.1.4. Investment costs for electricity generated in hydro power plants

	**Invest-ment	Discount rate	Period of exploitation	Annualized rate of investment	Annual production	Invest. price of electricity
	(M€)	(%)	(years)	M€/god	(GWh)	c€ / kWh
Boshkov Most	83	7	50	5.99	134	**4.47**
L. Pole and HPP Crn K.	53	7	50	3.85	140	**2.75**
Galishte	260	7	50	18.82	264	**7.13**
Chebren	414	7	50	29.98	*447	**6.71**
Gradec	203	7	50	14.68	245	**5.99**
Veles	326	7	50	23.63	298	**7.93**

**Chebren is pump storage hydropower plant with 840 (tur) / 786 (pum) i.e. effective production of 447=840-0,5x786 (GWh)*

Total price of the generated electricity. The Table 6.1.1.5 and Table 6.1.1.6 provide the individual components that form the total electricity price on the power plant threshold such as: investment cost, fuel and operational costs. The operational costs are taken from the international experience for relevant production facilities**.**

Table 6.1.1.5. Forming the total costs for generated electricity

	Investment	Fuel	O&M	**TOTAL**
	c€/kWh			**c€/kWh**
TPP lignite	1.63	1.59	0.77	**4.00**
TPP gas	0.91	4.62	0.23	**5.76**
NPP	2.46	1.09	1.77	**5.32**

Table 6.1.1.6. Forming the total costs for generated electricity in the hydro power plants

	Investment	O&M	**TOTAL**
	c€/kWh		**c€/kWh**
Boshkov Most	4.47	0.23	**4.70**
L. Pole and HPP Crn K.	2.75	0.23	**2.98**
Galishte	7.13	0.23	**7.36**
Chebren	6.71	0.23	**6.94**
Gradec	5.99	0.23	**6.22**
Veles	7.93	0.23	**8.16**

We can conclude that the price of the generated electricity in the planned structures will be competitive on the electricity market[81].

Scenarios for development of production capacities in the EPS of Macedonia until 2020

Considering the possibilities of the existing production capacities in Macedonia, the real potential candidates as well as in accordance with the development of the consumption, we analyzed four scenarios for development of a production system of electricity in the EPS of Macedonia.

All development scenarios are geared by the following general principles of development:

- Maximum engagement of the existing thermal power plant using lignite with surface excavation

[81] According to "UBS Investment Research: European Power Prices", (Nov 2007) it is expected that the electricity pricing in the region averagely, will be stabilized at around 70 €/kWh until 2013 and then it will continue to increased.

- Utilization of the hydro potential in Macedonia
- Utilization of the natural gas for production of electricity
- Utilization of the renewable energy sources.

Scenario 1 – Increase in the consumption by 2.5%

In the first option for development of the EPS in Macedonia we worked with increased consumption by 2.5%. According to this scenario CHP Skopje and CHP KOGEL, HPP Sv. Petka would start to work in 2010, CHP Energetika in 2014, HPP Boshkov Most in 2015, Lukovo Pole with HPP Crn Kamen and HPP Galishte in 2016, HPP Gradec in 2017 and HPP Chebren and TPP Bitola 4 in 2019.

The small HPPs together with the photovoltaic power plants and the biomass power plants have been taken integrally with a development dynamics of 50 MW each and annual production of 140 GWh every five years (2015, 2020, 2025 and 2030). This dynamic of the development of the RES means that their total power in 2020 will be 100 MW and the annual generation will be 280 GWh. In addition, the plan is to build 90 MW– 180 MW wind power plants with annual generation of 180 GWh – 360 GWh, by 2020. Due to the necessary reserve power for them, this generation will contribute mostly for fuel savings in the thermal power plants and only partially in the energy balance when used together with the storage power plants.

Table 6.1.1.7 and the Figure 6.1.1.1 show the production of electricity at average hydrology for this scenario.

Table 6.1.1.7. Generation for average hydrology in GWh for individual facilities for scenario 1[82]

	GWh									
	Bitola	**Oslomej**	**Heavy fuel oil**	**Gas SK.+ KOGEL**	**Gas Energetika**	**Bitola 4**	**Import**	**Hydro**	**Thermo**	**Total**
2007	4276	663	1225	0	0	0	898	1526	6164	8588
2008	4288	667	1267	0	0	0	1053	1526	6222	8801
2009	4297	670	1309	0	0	0	1216	1526	6276	9018
2010	4097	633	940	1702	0	0	291	1587	7372	9250
2011	4104	633	941	1913	0	0	303	1587	7591	9481
2012	4152	635	1005	1929	0	0	409	1587	7721	9717
2013	4196	644	1060	1941	0	0	533	1587	7841	9961
2014	3845	594	562	1790	1812	0	20	1587	8603	10210
2015	3872	599	496	1802	1831	0	4	1861	8600	10465
2016	3851	596	459	1762	1790	0	5	2263	8458	10726
2017	3865	598	475	1761	1783	0	5	2508	8482	10995
2018	3922	604	573	1804	1850	0	10	2508	8753	11271
2019	3694	541	173	1484	1213	1598	1	2849	8703	11553
2020	3700	502	160	1546	1253	1690	2	2989	8851	11842

[82] In 2007 and 2008 the projections are made in case of average hydrology and in case of using the oil fired TPP Negotino. In reality this didn't happened and the import of electricity was significant

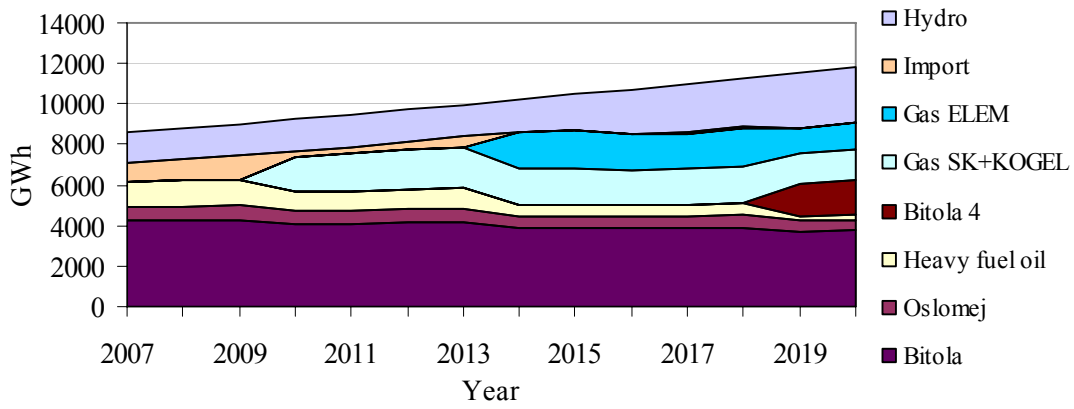

Figure 6.1.1.1. Coverage of the consumption for average hydrology for scenario 1

Figure 6.1.1.2 shows the coverage of the demand for electricity for dry hydrology.

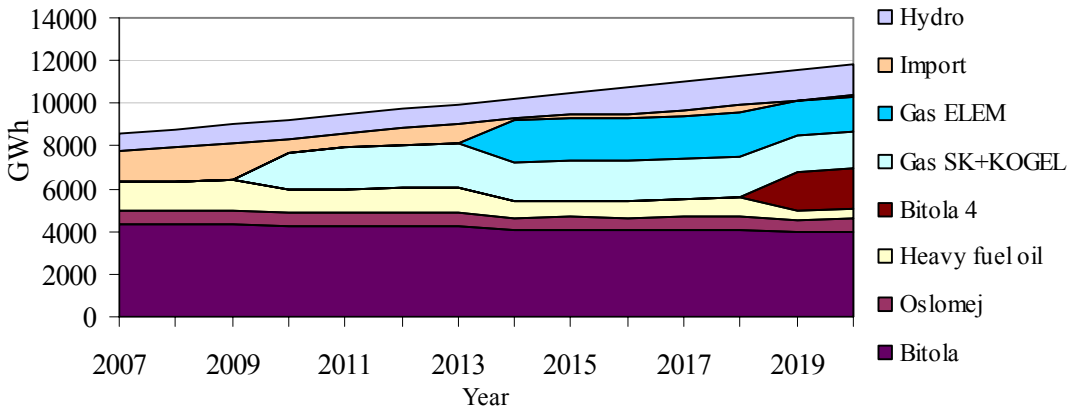

Figure 6.1.1.2. Coverage of the consumption for dry hydrology for scenario 1

The production of the individual power plants given in the relevant tables and figures is necessary for meeting of the planned electricity consumption in Macedonia. Any additional production can be exported.

Scenario 2 – Growth of the consumption by 3.0%

This development scenario does not differ essentially from the first scenario – the only difference here is that the annual consumption rate increase is 3.0%. This increased demand for electricity will only change the dynamics of entry into operation of TPP Bitola and HPP Chebren which instead in 2019 should be operational in 2018, while the other production facilities become operational according to the same dynamics of the previous scenario.

The Table 6.1.1.8 and Figure 6.1.1.3 show the production of electricity with average hydrology for this scenario.

Table 6.1.1.8. Production for average hydrology in GWh for individual facilities for Scenario 2

	GWh									
	Bitola	**Oslomej**	**Heavy fuel oil**	**Gas SK.+ KOGEL**	**Gas Energetika**	**Bitola 4**	**Import**	**Hydro**	**Thermo**	**Total**
2007	4271	663	1210	0	0	0	920	1526	6144	8590
2008	4284	668	1260	0	0	0	1109	1526	6212	8847
2009	4295	671	1308	0	0	0	1312	1526	6274	9112
2010	4084	630	910	1908	0	0	267	1587	7532	9386
2011	4142	635	992	1926	0	0	386	1587	7695	9668
2012	4195	644	1060	1941	0	0	531	1587	7840	9958
2013	4238	651	1119	1962	0	0	699	1587	7970	10256
2014	3935	604	658	1832	1894	0	53	1587	8923	10563
2015	3953	608	654	1849	1918	0	38	1861	8982	10881
2016	3922	673	593	1845	1880	0	31	2263	8913	11207
2017	3942	677	613	1859	1893	0	51	2508	8984	11543
2018	3842	565	224	1665	1375	1369	2	2849	9040	11891
2019	3844	559	283	1617	1365	1720	9	2849	9388	12246
2020	3858	563	266	1657	1471	1802	10	2989	9617	12616

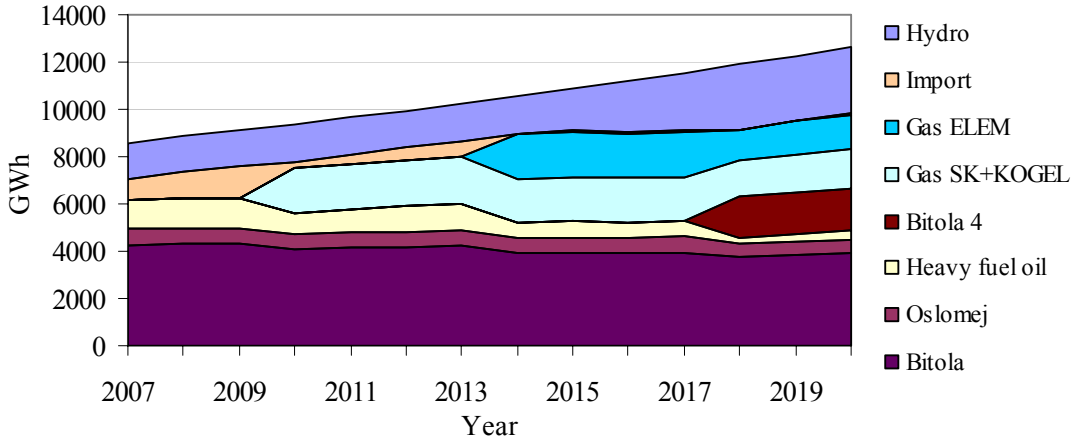

Figure 6.1.1.3. Coverage of the consumption for average hydrology for Scenario 2

The figure 6.1.1.4 shows the coverage of the demand for electricity for dry hydrology.

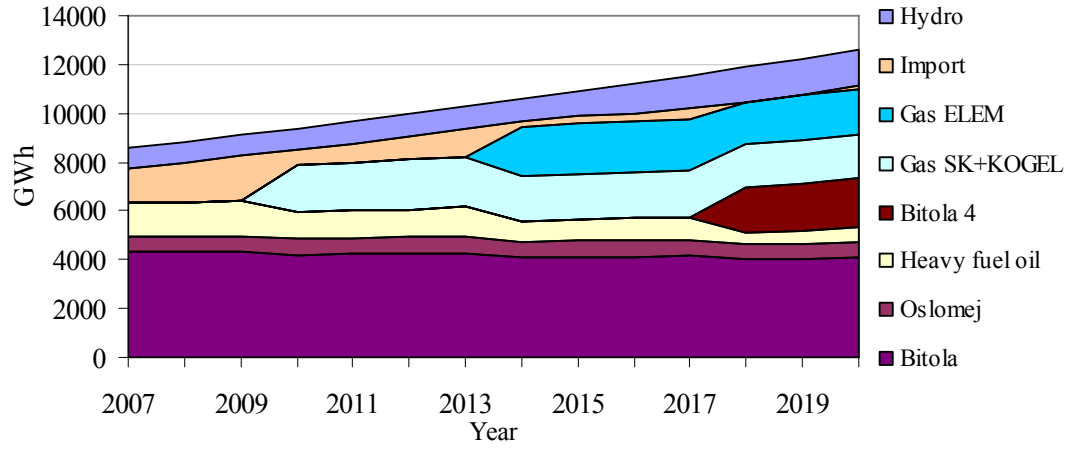

Figure 6.1.1.4. Coverage of the consumption for dry hydrology for Scenario 2

In addition the above, we analyzed two more scenarios: scenario with electricity consumption growth with stronger energy efficiency measures and scenario with slower investment in construction of production facilities.

From the analysis of the four scenarios we can conclude the following:

- The baseline scenario envisages growth of the electricity consumption by 2.5% on average. The table and the figures show evident lack of generation facilities in the first years of development until 2010 when the two gas combined heat and power plants CHP Skopje and CHP KOGEL will become operational. With the construction of CHP Energetika in 2014 the electricity generation in Macedonia will equal the consumption. In the period until 2020 the hydropower plants: Boshkov Most, the system Lukovo Pole System with HPP Crn Kamen, Galishte, Chebren, Gradec and the thermal power plant Bitola 4 are planned. With the realization of this scenario, the generation capacities in Macedonia in 2020 together with an additional generation of around 100 GWh (8.6 ktoe) per year from wind power plants (through savings of accumulated water) in average hydrologic conditions, will provide nearly 14,000 GWh (1204 ktoe) per year without heavy fuel oil fired thermal power plant TPP Negotino. This electricity generation is nearly 2000 GWh (172 ktoe) higher than the planned consumption.

  In order to realize this scenario, in addition to the relatively certain putting into operation of CHP Skopje and CHP KOGEL in 2010, it is very important that CHP Energetika is put into operation on time.
- If the Scenario with strengthened energy efficiency measures is realized, the electricity consumption will be 660 GWh (60 ktoe) lower than in the baseline scenario. This scenario, together with the optimistic scenario for electricity generation from RES in the amount of 250 GWh (21 ktoe), will provide for a more relaxed investment activity. The hydropower plants can be delayed for an additional two years, TPP Bitola 4 can be postponed for after 2020 and TPP Oslomej will stop working in 2018. However, until CHP Energetika is operational, there will be a significant lack of electricity which can be offset by the generation of the heavy fuel oil fired TPP Negotino or from imports.
- If the scenario with average growth rate of 3% is realized, the electricity consumption in 2020 will be higher by 800 GWh (69 ktoe) compared to the baseline scenario. This does not change the dynamics of construction significantly, only HPP Chebren and TPP Bitola 4 will have to become operational one year earlier. In average hydrologic conditions, without the heavy fuel oil fired TPP Negotino, in the period 2014 – 2017, the demand for imports will be around 200 GWh (17 ktoe), and when the TPP Bitola 4 is constructed in 2018, the generation will be 1500 GWh – 1000 GWh (86-129 ktoe) higher than the demand until 2020.
- In case of slower investment in the generation capacities, which would mean to move the construction of CHP Energetika from 2014 to 2017, and move the hydropower plant Gradec from 2017 to 2020, Galishte 2016 to 2019 and Chebren from 2019 to 2022, as well as to close TPP Oslomej by the end of 2016, the demand for electricity with a growth rate of 2.5% would exceed the generation in 2010 by 1100 GWh (95 ktoe), 2000 GWh (172 ktoe) in 2016, and around 800 GWh – 1000 GWh (69-86 ktoe)in 2017 and 2018 in average hydrologic conditions and by an additional 1000

GWh (86 ktoe) in dry hydrologic conditions. Part of this difference of about 250 GWh (21 ktoe), would be offset with more intensive construction of small hydropower plants and other renewable electricity sources and the remaining 1000 GWh to 3000 GWh (86-258 ktoe), depending of the hydrologic conditions from imports.

The realization of the envisaged new production facilities construction dynamics ***will improve the diversity and the security of the electricity supply.*** In the previous period, in case of average hydrology, 80% of the electricity was generated in coal thermal power plants and 20% from renewable energy sources (hydro power plants). In 2020 it is planned that the production of electricity in coal thermal power plants will be between 42% and 51% depending on the scenario, from natural gas and renewable energy sources between 24% and 28% each and from heavy fuel oil thermal power plant 2% - 3%.

Considering that the Regional Energy Market will be completely organized by 2015, the production and sale of electricity will depend only on the competitiveness of any individual entity in the region. Balanced production and consumption of electricity in Macedonia will mean balanced export and import, and not obligation to sell and buy within the boundaries of the country. If any of the production facilities is not able to generate electricity with competitive prices or if it cannot fulfill the environmental standards it will have to be modernized or closed and new and more modern one will have to be constructed. The electricity imports, however, will largely depend on the total trade deficit of Macedonia and of the possibilities to provide foreign currency.

The calculations given in section 6.1.1 show that the price of electricity that will be generated in the planned thermal power plants and hydro power plants will be competitive on the Regional Electricity Market.

The development of the electricity sector will greatly depend on the obligations arising from the Kyoto protocol and which will arise after it expires, as well as on the price to be paid by companies in the EU member states to exceed the allowed greenhouse gas emissions and the obligations accepted by the candidate countries for EU membership during the period of accession. With a price of 40 € per emitted tone of CO_2, the production price of the electricity generated in lignite fired thermal power plants shall be almost double. Considering that 54% of the electricity in the southeastern European countries is generated from coal and that additional large coal fired capacities are planned, it is clear that if there are high prices for greenhouse gasses emissions from coal fired thermal power plants, then the electricity price in the region will increase, thereby increasing the competitive capability of our thermal power plants. The development of the electricity and power sector will also depend on the readiness and abilities of our negotiating team to present the vulnerability of our overall economy if Macedonia is made to, for environmental reasons, give up the lignite or if it must pay an economically unsustainable price to use the lignite for production of electricity. Our economy cannot be expected, by 2020, to achieve sufficient foreign currency inflow in order to secure electricity imports equal to the electricity generated in our thermal power plants. Furthermore, if a facility like TPP Bitola is closed, that creates an issue with several thousand employees in the company and hundreds of small and medium companies that cooperate with the TPP.

The basic benefit from the construction of the large HPPs is related to the increase of the share of RES. With the accession of Macedonia in EU, Macedonia will have an obligation to increase the share of RES in the final energy consumption to at least 21%. Macedonia will not be able to fulfill this obligation without constructing large hydropower plants. Heat generating RES do not have sufficient additional capacities to

cover the necessary difference while electricity generation RES will not be competitive neither with its price of production nor with its available capacity.

The Macedonian Electricity and Power System features large variations of the necessary capacity during the year and during 24 hours. In cases when certain quantities of water are used for irrigation, it will not reduce the maximum power but only the total electricity generation which is not of primary significance. The price of water used for irrigation will contribute to justify the feasibility of such a hydropower project.

Last but not least, the hydropower plants Chebren and Galishte are also a prerequisite for the construction of the nuclear power plant in Mariovo. The hydro nuclear power complex will be characterized with especially high range of power variations, from minimal power, when the energy from the nuclear power plant would be used to pump the water, to maximal, when the nuclear power plant and the hydropower plants would operate at their maximum powers. In addition, the accumulated water would be used for cooling of the nuclear power plant condenser.

6.1.2. Heat

According to the base scenario and in accordance with the analysis from Chapter 5, the consumption of heat in the period 2006-2020 will be increased by 18% - from 1376 GWh (118 ktoe, 4954 TJ) in 2006 to 1628 GWh (140 ktoe, 5861 TJ) in 2020. According to the scenario with strengthened measures for energy efficiency, the total growth in the above mentioned period is 15% and in the 2020 and the total consumption of heat energy will be 1590 GWh (137 ktoe, 5724 TJ). A significant growth of the distributive consumption is not expected in the analyzed period. For heating of the homes it is necessary to provide faster and more significant penetration of the natural gas in all cities in Macedonia.

Considering the fact that CHP Skopje and CHP KOGEL will become operational in 2010 and CHP Energetika in 2014 which, together with the existing reserved (existing) boilers of Toplifikacija AD Skopje which will cover the consumption of heat energy in Skopje as well as the capacities of the existing boilers in Macedonia, no problems are expected in covering the relevant increased consumption of the heat. We also envisage additional construction of small combined heat and power plants for production of electricity and heat from natural gas in the towns that will be covered with gasification or with natural gas under pressure as well as combined heat and power plants on biomass to cover the demand for heat in certain companies and/or distribution consumption in areas where it is economically feasible. For each of the city areas it is necessary to perform individual technical and economic analysis for the feasibility of construction of central heating system.

6.2. DEMAND FOR PRIMARY ENERGY IN THE PERIOD 2008-2020

The demand for primary energy are achieved by collecting the primary energy necessary to produce electricity and heat and the primary energy necessary for the fuels that are used in the same form as final energy.

6.2.1. Coal

The demand for coal is shown in the Figure 6.2.1.1 and in the Table 6.2.1.1. As we can see, in the total coal quantity, the lignite has the greatest participation, used to produce electricity (around 90%) while the coal which is used to produce heat participates with less than 1%.

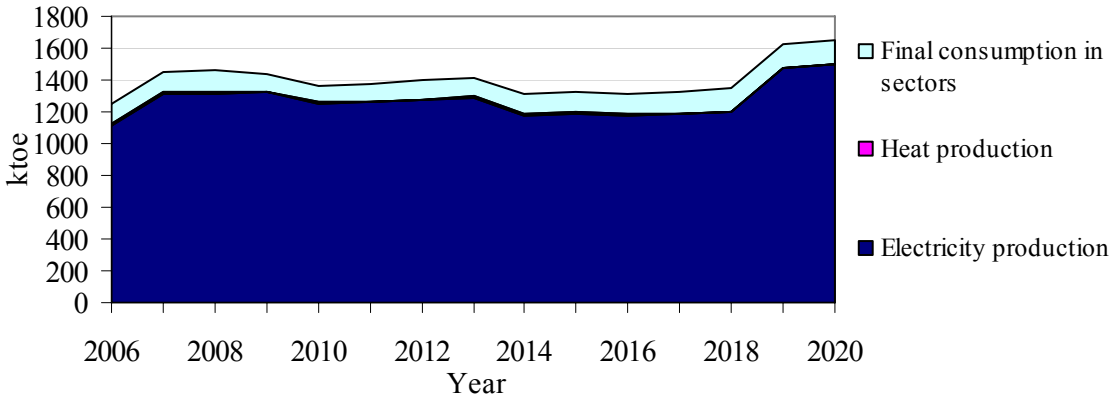

Figure 6.2.1.1. The demand for coal by 2020

Table 6.2.1.1. The demand for coal by 2020, baseline scenario (ktoe)

	ktoe			
	For electricity production	For heat production	For final consumption in sectors	Total
2006	1113	14	117	1254[83]
2007	1311	9	127	1447
2008	1316	9	132	1457
2009	1319	9	107	1435
2010	1256	9	92	1357
2011	1258	9	102	1369
2012	1269	9	119	1397
2013	1283	9	123	1415
2014	1176	9	126	1311
2015	1183	9	130	1322
2016	1175	4	133	1312
2017	1179	4	137	1320
2018	1196	4	140	1340
2019	1469	4	143	1616
2020	1494	4	147	1645

The consumption of coal in the thermal power plants is reduced when the combined heat and power plants running on natural gas are put into use in the grid (2010 and 2014) and increased when the new thermal power plant running on coal will be put into operation in 2019.

The consumption of coal in the thermal power plants, according to the scenario with growth rate of electricity of 3%, will essentially remain the same – only the increase of the consumption will be moved from 2019 to 2018.

6.2.2. Oil, petroleum products and biofuels

The necessary quantity of oil and petroleum products, according to the baseline scenario, is shown on Figure 6.2.2.1 and in the Table 6.2.2.1. Most of the petroleum products are consumed as final energy, mainly in the transport. This also includes the biofuels whose percentage share will increase to an amount of at least 10% of the diesel and petrol fuel consumption in 2020.

[83] Статистичка разлика 10 ktoe

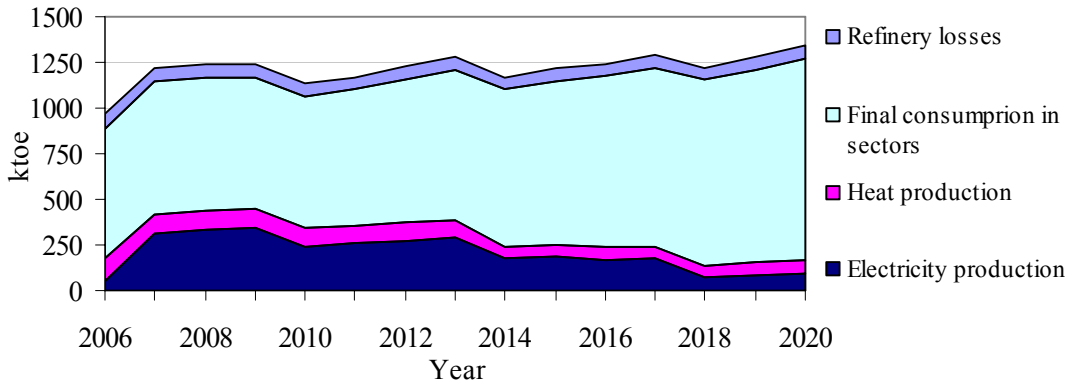

Figure 6.2.2.1. The demand for oil and petroleum products by 2020, baseline scenario

Table 6.2.2.1. The demand for oil and petroleum products by 2020, baseline scenario (ktoe)

ktoe					
	For electricity production	For heat production	For final consumption in sectors	Total petroleum products	Total oil
2006	57	119	711	887	965
2007	316	105	729	1150	1219
2008	329	106	736	1171	1241
2009	341	105	720	1166	1236
2010	237	105	724	1066	1130
2011	259	95	749	1103	1169
2012	276	95	784	1155	1224
2013	292	95	822	1209	1281
2014	172	69	858	1099	1165
2015	184	69	896	1149	1218
2016	168	69	936	1173	1244
2017	173	69	975	1217	1290
2018	71	69	1014	1154	1224
2019	87	69	1055	1211	1283
2020	95	69	1093	1257	1333

According to the scenario which includes strengthened measures for energy efficiency, the consumption of petroleum products in 2020 will be smaller by around 120 ktoe (9%) than the consumption foreseen in the baseline scenario.

6.2.3. Natural gas

The demand for natural gas, according to the baseline scenario, is shown on Table 6.2.3.1 and on Figure 6.2.3.1.

The consumption of natural gas mainly depends from putting into operation of the combined heat and power plants. When forecasting the electricity production we took into account the capacity of the existing gas pipeline. As we can see, in the analyzed period and according to the baseline scenario, the gas will be used up to the capacity of 1,000 million Nm^3 per year (2018). If the scenario with features the increase in consumption of electricity by 3% is realized, then the consumption of natural gas by 2020 will increase for additional around 70 million Nm^3 and if the scenario which

forecasts greater penetration of the natural gas in the residential sector is realized, then the consumption of the natural gas will increase for additional 45 million Nm^3 per year. These two assumptions oppose each other and cannot be realized in the same time. Therefore, it is realistic to expect that the total consumption of the natural gas by 2020 will be between 1000 to 1070 million Nm^3 (800 до 860 ktoe) per year.

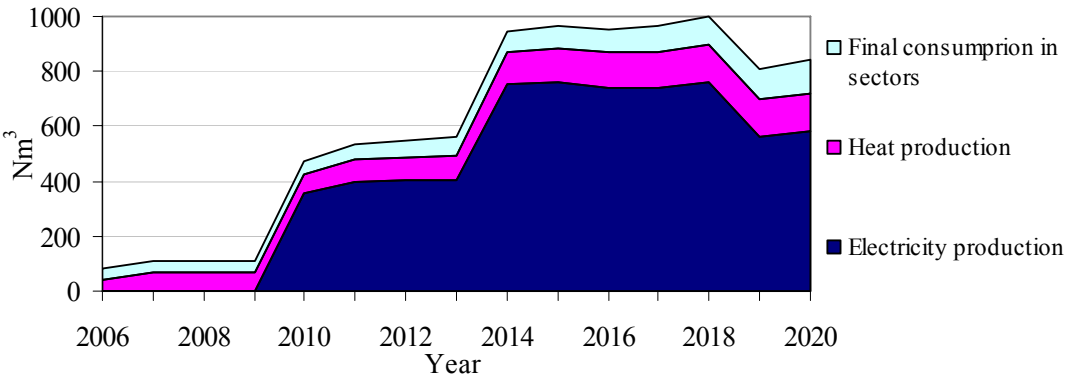

Figure 6.2.3.1. The demand for natural gas by 2020

Table 6.2.3.1. The demand for natural gas by 2020, baseline scenario

	For electricity production		For heat production		For final consumption in sectors		Total	
	ktoe	10^6 Nm^3	ktoe	10^6 Nm^3	ktoe	10^6 Nm^3	ktoe	10^6 Nm^3
2006	0	0	32	40	34	42	66	82
2007	0	0	46	57	40	50	86	107
2008	0	0	53	67	40	50	93	117
2009	0	0	53	66	38	47	91	113
2010	285	356	53	66	40	50	378	472
2011	320	400	65	81	42	52	427	533
2012	323	403	67	83	45	56	435	542
2013	325	406	69	86	50	62	444	554
2014	602	752	97	121	54	67	753	940
2015	608	759	99	124	59	74	766	957
2016	594	742	101	126	65	81	760	949
2017	593	741	103	129	73	91	769	961
2018	611	763	105	132	81	101	797	996
2019	451	563	108	134	89	111	648	808
2020	468	585	108	134	98	122	674	841

This consumption does not take into account the two planned combined heat and power plant of Toplifikacija AD Skopje Sever AD (with electrical power of 40 MW and heating power of 30 MW) and CHP “Zapad” (with electrical power of 200 MW and heating power of 160 MW), as well as CHP “Energetika” from ELEM (2x15 MW) with total consumption of natural gas of more than 400 million Nm^3 per year.

Considering all the above mentioned demands, the total demand for natural gas in the period 2015-2020 is estimated at more than 1400 million Nm^3 (1120 ktoe) per year. However, the construction of three large CHPs in Skopje until 2020 is not realistic. And it would be feasible to expect that the consumption of natural gas in Macedonia until 2020 will grow to a value of 1100 million Nm^3 per year.

6.2.4. Renewable energy sources

Biomass for combustion[84]

The demand for biomass as final energy is shown in the Table 5.2.1. We need to add to this demand also the consumption of biomass of 13 ktoe – 17 ktoe for production of electricity and heat. Therefore, the total consumption of the biomass by 2020 will increase up to 249 ktoe (2900 GWh), i.e. 244 ktoe (2840 GWh) for the baseline scenario and the scenario with strengthened energy efficiency measures, respectively.

Hydro power

The hydro power for production of electricity is planned at the level of 2920 GWh (251 ktoe) of which 2620 GWh (225 ktoe) would be obtained from large HPPs and the remaining 300 GWh (26 ktoe) would be generated by small HPPs (Section 6.1.1). However in the case of slow investments in construction of the large HPPs, their generation in 2020 can be as little as 2000 GWh – 2300 GWh (172-198 ktoe), and the small HPPs can be expected to generate over 400 GWh (34 ktoe).

Geothermal energy

The consumption of geothermal energy as final energy (Tables 5.2.1), together with the losses in the distribution in the amount of around 10%, make the demand for primary energy. The expected total consumption of geothermal energy in 2020 is 38 ktoe to 50 ktoe (440 GWh to 570 GWh, 1584 TJ to 2052 TJ).

Solar energy

The solar energy will be used as heating source for the residential sector and in the commercial and service sector, as well as partially in the industry in the amount of 5.2 ktoe up to 8 ktoe (60 GWh - 95 GWh) in 2020 for the baseline scenario and for the scenario with increased use of solar energy. When we add to this the portion of the solar energy used for production of electricity of 1,2 ktoe – 3,6 ktoe (14 GWh – 42 GWh), the total utilization of the solar energy in 2020 will be, approximately, 6.4 ktoe-11.6 ktoe (74 GWh-134.9 GWh).

Wind energy

It is planned that the wind energy used for production of electricity in 2020 will be, approximately 15,5 ktoe - 31 ktoe (180 GWh - 360 GWh).

6.2.5. The balance of primary energy

The table 6.2.5.1 shows the total consumption of primary energy in accordance with the baseline scenario. The total consumption of primary in 2020 will be 4211 ktoe and will be greater than the consumption in 2006 by 50% (P2). The average annual rate of primary energy growth will be 2.93% (P1).

The average annual rate of growth in the coal consumption is almost 2% and 2.3% of the oil. The biomass consumption in 2020 will be greater than that in 2006 by almost 14%. The consumption of the natural gas of 66 ktoe (82 million Nm^3) will increase to over 800 ktoe (1000 million Nm^3) in the period 2014 - 2020. However, the total demand

[84] The demand for biofuels by 2020 is shown in the Chapter 5.1.4. The demand for energy in the transport sector is also provided in the Table 5.1.4.7.

for natural gas will exceed beyond the capacity of the existing gas pipeline (Section 6.2.3).

The use of geothermal energy will increase 3.8 times by 2020. The solar and wind energy will be used by 2020 with 7 ktoe and 15 ktoe, respectively..

The import of electricity should be understood only as a difference between the imported and exported electricity to the total demand of electricity in Macedonia. Each of the producers and consumers will be able to choose where to sell and from whom to buy in the frames of the regional and European market, in accordance with the preferred market conditions.

Table 6.2.5.1. The demand for primary energy by 2020, baseline scenario, (ktoe)

	ktoe															%	
	2006[85]	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	P1	P2
Coal	1254	1447	1457	1435	1357	1369	1397	1415	1311	1322	1312	1320	1340	1616	1645	1,96	31,2
Oil and biofuels.	965	1219	1241	1236	1130	1169	1224	1281	1165	1218	1244	1290	1224	1283	1333	2,33	38,1
Natural gas	66	86	93	91	378	427	435	444	753	766	760	769	797	648	674		
Biomass (combst.)	218	220	221	222	223	225	228	231	234	236	239	241	244	246	249	0,95	14,1
Hydro	142	85	131	131	136	136	136	136	136	148	192	213	213	242	251	4,15	76,8
Geothermal	10	10	10	11	12	12	13	14	15	17	19	22	26	31	38	9,67	263,9
Solar	1	1	1	1	1	1	2	3	3	4	4	5	6	6	7		
Wind	0	0	0	0	0	0	4	4	4	8	12	12	12	15	15		
Electricity	154	216	220	105	25	26	35	46	0	0	0	0	0	0	0		
TOTAL	**2810**	**3284**	**3374**	**3232**	**3261**	**3365**	**3473**	**3574**	**3621**	**3719**	**3781**	**3872**	**3861**	**4087**	**4211**	2,93	49,8

In 2020 (Figure 6.2.5.1) we will mostly use coal (39%), petroleum products together with the biofuels (31.6%) and the natural gas (16%). The biomass for combustion and the hydro power will participate each with around 6%. The solar and wind energy together will contribute with about 0.6% and the geothermal with around 1% in the primary energy production.

The global economic crisis took place during the preparation of the strategy and it also hit Macedonia. Due to that, the initial assumptions for GDP growth in the period 2009-2020 of 6.7% were corrected to 5.8% and accordingly new analyses and assessments were conducted about the energy consumption.

With the projected annual average growth rate of the GDP of 5.8% in the period 2009-2020 (5.66% for the period 2009-2020), the specific energy consumption per GDP unit (in 2020) according to the base scenario will be 0.49 toe/1000US$2000. In 2006 the specific energy consumption was 0.71 toe/1000US$2000. This is an ***improvement of the energy efficiency, expressed through this parameter, by 31%.***

The consumption of primary energy, according to the scenario with strengthened energy efficiency measures, relevant to the final energy demand according this scenario (Table 5.2.2) and the needs for fuels for production of electricity and heat, in 2020 will be 6.7% smaller (by 281 ktoe) than the consumption according to the base scenario and will be 3930 ktoe. The specific consumption of energy per GDP unit in 2020, according to the scenario with strengthened energy efficiency measures, would be 0.46 toe/1000US$2000. This is an ***improvement of the energy efficiency in 2020***, in comparison to 2006, expressed through this parameter, ***by 35% which is an additional 4% more compared to the baseline scenario.***

[85] Во потрошувачката на биомасата за согорување во 2006 година пресметана е и неидентификуваната потрошувачка

Table 6.2.5.2. Projected change in energy consumption and energy indicators

	PEC		FEC		GDP	PEC/GDP		Popu-lation	PEC/inhabit.	
	BS	EEf	BS	EEf		BS	EEf		BS	EEf
	ktoe		ktoe		10^6 $	toe/1000$		10^6	toe/inhabitant	
2006	2810		1818		3952	0.71		2.036	1.38	
2020	4211	3930	2618	2466	8546	0.49	0.46	2.025	2.08	1.94
P1 (%)	2.9	2.4	2.6	2.2	5.7	-2.6	-3.1	0.0	3.0	2.5
P2 (%)	50	40	44	36	116	-31	-35	-1	51	41

PEC – Primary energy consumption; FEC – Final energy consumption; (In PEC and FEC the unidentified consumption of biomass and electricity is included); GDP – Gross domestic product; BS – Baseline scenario; EEf – Scenario with improved energy efficiency; P1 – Average annual growth rate; P2 – Total growth; $ - USA$2000

In the final phase of preparation of the Strategy it became clear (despite the fact that all assumption models in the world failed) that the crisis is deeper and it is possible (the depth of the crisis was assessed differently every day) to achieve smaller GDP growth in Macedonia in the period 2009 - 2020. In that case the projected energy consumption growth will not be changed significantly. In certain sectors, there will be reduction of the energy consumption compared to the projected and the investment in energy saving and energy efficiency improvement will also be reduced. As a result of that, greater specific energy consumption per unit GDP in 2020 will be realized compared to the planned. However, our calculations show that even in that case, the energy intensity in 2020 will be by at least 30% lower than in 2006.

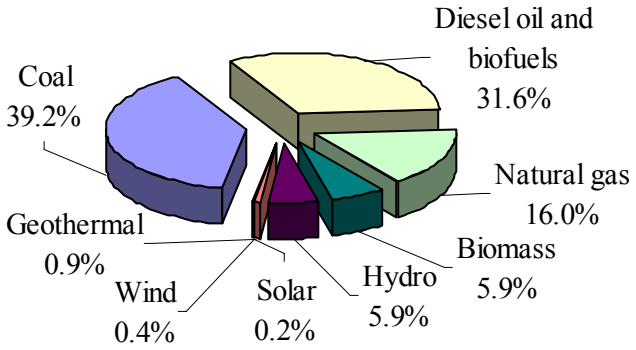

Figure 6.2.5.1. Production of primary energy in 2020

The ratio of the final energy consumption and the consumption of primary energy of 0.65 in 2006 will be reduced by 0.56 in 2010 by including the thermal power plant Negotino (with relatively low level of efficiency) and with average hydrology (relative to the high hydrology in 2006) and then it starts to increase gradually by involving new hydro power plants and thermal power plans with high level of efficiency, and reaches 0.62 in 2020. This ratio is almost the same in both scenarios.

By the year of 2020 it is foreseen to improve the energy diversity in the primary energy supply. The coal, together with the oil and petroleum products shall reduce the percentage share of 81% in 2006 to 70.8% in 2020, while the participation of the natural gas of 2.4% in 2006 will be increased to 16% in 2020 and the participation of the renewable energy sources in the total primary energy in the same period will be increased from 11.5% to 13.3%.

6.3. POSSIBILITIES FOR MEETING THE PRIMARY ENERGY NEEDSIN THE PERIOD 2008-2020

6.3.1. Coal

Securing the coal for the demand of the three units of the thermal power plant "Bitola"

Basically the concept for long-term continuous operation of the Bitola thermal power plant, must be based on securing of all conditions for simultaneous work of all three mines: Surface mine Suvodol-MCS, Brod-Gneotino and Suvodol-UCS, (Figure 6.3.1.1).

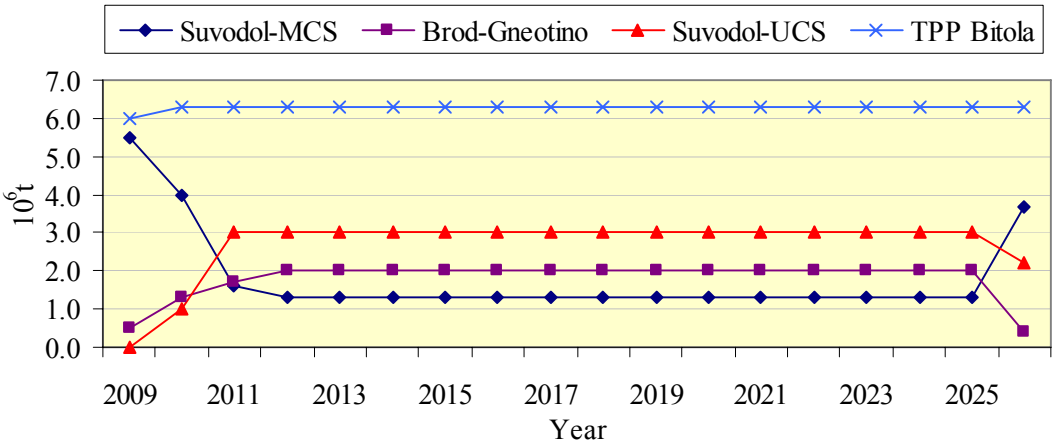

Figure 6.3.1.1. Dynamics and quantities of coal produced in individual mines for the demand of the Bitola thermal power plant 1, 2 and 3, in the period 2009-2026

It is especially important to ensure all the prerequisites for realization of the established dynamics for exploitation of the mines. The epilogue from any eventual prolonging will be enable increased consumption of coal from the Surface mine Suvodol-main coal seam, lack of possibility for homogenization of the coals and domination of the exploitation of coal featured with relatively low efficiency and greater quantity of dust, directly conditioned with increased cumulative consumption of coal, with evident impacts on the combustion process and, ultimately, inability to satisfy the demand for continuous work of the three units of the Bitola thermal power plant, in accordance with the energy projection.

Taking into account that the Suvodol mine is in final exploitation phase, it is also possible that there will be some imports of specific quantities of coal (around 10% of the total demand) in order to meet the demand in specific periods.

Securing of coal for the TPP Oslomej

In the recent years, TPP Oslomej runs with almost half of its capacity. One of the reasons for this situation is the untimely opening of new mines. Therefore special attention should be devoted to this problem.

According to the dynamics show on Figure 6.3.1.2 we can ascertain that, in the balancing of the annual demand of the Oslomej thermal power plant, in order to achieve its production continuity, it is necessary to include the coal potential from the Popovjani site, starting from the year of 2016.

We can also rely on import of small quantities of lignite.

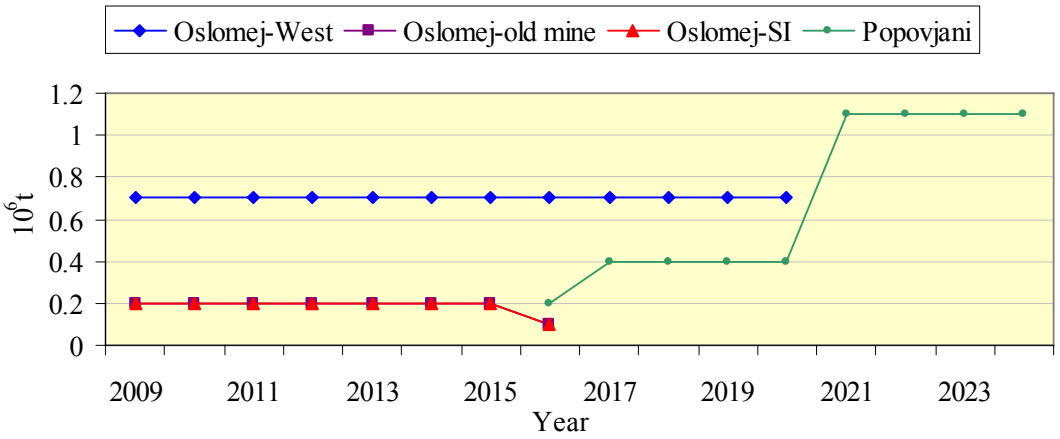

Figure 6.3.1.2. Dynamics of the annual production of coal per individual sites for the demand of the Oslomej thermal power plant

Since the Popovjani site is not sufficiently explored, the summary includes only prognosis for its potential. We need to emphasize the need for additional research that would enable development of Report about the reserves of coal and Feasibility Study for its eventual exploitation.

Securing of coal for the TPP Bitola 4

The ***Zhivojno*** site is planned to be used for the demand of the thermal power plant Bitola 4. The exploitation of the coal will be from a pit. The price of the coal obtained from the Zhivojno mine is estimated to be 15 Euros per ton[86] and it is quite lower than the coal price of same quality that would be imported. In addition, this is local energy fuel and this is reducing the import dependency and increases the employment and the growth of the local economy. The transport of larger quantities of coal from import is a complex problem both from technical as well as from environmental aspect.

6.3.2. Natural gas

Main directions for development of the transmission grid

The development of the main directions of the transmission grid is in line with the expected consumption of natural gas in specific parts in the Republic of Macedonia.

The first investment which needs to be realized in the gas supply system of the Republic of Macedonia is the completion of the gas ring in the city of Skopje. This will enable the use of natural gas in the south and western part of the city which already have consumers that are able to immediately start using this fuel – these are the Clinical Center complex and the Heating Plant "Zapad" of the Toplifikacija AD Skopje heating company.

The main pipeline Klecovce-Sv. Nikole-Stip-Radovis-Strumica-Gevgelija in total length of 166 km and pipe diameter of 500 mm with a section to Sv. Nikole-Veles (26 km) has a special strategic importance due to the possibility for connection to the gas pipelines on the south and south-east of Macedonia. This main pipeline would cover all the initial needs for natural gas in the central part of the state with significant number of industrial consumers which could be connected immediately.

[86] Feasibility study for pit exploitation of coal for the purposes of the TPP Bitola from the Zhivojno site", developed by RI-PIERM, Mining Institute LLC Skopje, and others, February 2004.

The next investment should be the main pipeline Skopje-Tetovo-Gostivar, in total length of 65 km. This main pipeline will cover the complete energy consumption in this exceptionally developed part of the country where many small industrial facilities and new housing structures were built in the last decade. From Gostivar, this main pipeline will continue to Kicevo (around 40 km) with possibility for connection of the adjacent cities Debar and Krushevo and other smaller settlements.

The next main pipelines will be Stip-Negotino-Kavadarci-Prilep-Bitola (106 km), and later to Ohrid and Struga (77 km) with possibility for connection to Albanian transmission systems.

Some of the smaller cities may be supplied through so called virtual gas pipelines (transport of natural gas in pressure tanks), a system which is already used in the neighboring countries.

One of the realistic options for supply of the Balkans with natural gas is the liquid natural gas (LNG) through gates which will be constructed in the Thessaloniki Port and in one of the future large ports in the Republic of Albania, Montenegro and/or Croatia. The Thessaloniki Port already has a smaller gate for LNG, but it is necessary to construct a new gate in order to increase the capacity.

The last supply pipeline which would covert the needs of the south-east part of the country is Petric-Strumica. The length of this pipeline will be around 40 km and the pipe diameter will not exceed 350 mm.

This main pipeline would cover the needs of this part of the country which according to the preliminary analyses should not exceed 70 million Nm^3. The largest share in this quantity would be the consumption of the greenhouses for growing various agricultural species.

Possible sources for supply with natural gas

Considering the above analysis of the expected demand for natural gas it turns out that the existing capacity of the main pipeline will not be able to meet the demand for natural gas. In such situation, the Republic of Macedonia should consider additional connections to the regional pipelines that are planned in the region.

Realistic sources for supply with gas in the future, in this region are the following (Figure 6.3.2.1):

- The existing direction for supply of the Republic of Macedonia with natural gas. The source is in Western Siberia, through the following transport corridor: Russia, Ukraine, Moldova, Romania, Bulgaria (Russian gas);
- South flow, South section. Bulgaria-Greece-Albania-Italy. Russian gas or mixture of Russian and Caspian gas;
- South flow, North section. Bulgaria-Serbia-Croatia-Slovenia. Russian gas or a mixture of Russian and Caspian gas;
- Blue flow. Russian gas through Bulgaria;
- White flow. Caspian gas through Romania;
- NABUKO. Caspian gas through Romania;
- Points of entry for liquid natural gas in the ports in Greece, Albania, Montenegro and/or Croatia. Algerian and Arabic liquid natural gas. Transportation through new gas pipelines that will connect the ports with the main gas pipelines in the countries of the region.

Figure 6.3.2.1. Possible directions of supply with natural gas

Considering the list of possible sources for supply with natural gas in the region we can conclude that the region in the future has quite good possibilities for gas supply which can entirely cover the demand for natural gas in the following 30 years.

The optimistic prognoses for good and sufficient supply of the region with natural gas derive also from the possibilities to bring gas with the proposed lines from different real sources of natural gas. What is even more important, these real sources of natural gas are among the most important sources of natural gas.

As it is mentioned in the list of possible sources and routes of supply in the region, this gas will be supplied from:

- Russian sources in Western and Eastern Siberia and from other sources controlled by the Russian Federation;
- From the Caspian sources of natural gas in Turkmenistan, Azerbaijan, Kazakhstan;
- From the gas sources in Iran and Iraq;
- From Algeria and Arabic countries.

With such diversity of supply in the region, the gas should be one of the most serious sources for covering of the energy demand of the region in the future. This especially applies to the smaller countries that are not very rich with energy, such as the Republic of Macedonia.

From all the above mentioned supply routes, most of them should already serve the region by 2015. The most important in this group are the following:

- The South flow, the Northern branch which can seriously increase the possibilities for supply of the country with natural gas from Eastern or North-Eastern side.
- The South flow, the South branch which can seriously increase the possibilities for supply of the country with natural gas from South-Western side.

It is very realistic to expect the gates for liquid natural gas at the ports in Greece and Albania to be put in place before 2015. It is also very realistic that the connection of these ports with the main pipeline in the country will be realised until 2015. Depending

on the decision of the Republic of Macedonia, whether to connect to LNG gates in Albania or Greece, the connection points will be Western Macedonia or Negotino.

The Republic of Macedonia in the upcoming period needs to decide from where and how it will bring into the country the additional quantities of natural gas of around 200 – 300 million Nm^3 per year for the period 2015 – 2020 as well as additional 300 – 700 million Nm^3 per year (a total of 500 – 1000 million Nm^3 per year) in the period to 2030.

Since the consumption of the natural gas in Macedonia in 2020 will participate with high percentage (16%) in the total consumption, and in order to ensure reliable supply with energy, it is necessary to provide diversity in the supply with natural gas. This will be ensured in the best way if Macedonia connects to the planned regional ring that would connect Macedonia, Albania, Montenegro, Croatia, Bosnia and Herzegovina, Serbia and Kosovo (indicated on figure 6.3.2.1 with a solid line) and which will provide a possibility for supply from many different sources. The other above analyzed directions for supply from the south, east and west side are also possible.

Macedonia does not have prerequisites for construction of reservoir of natural gas that will ensure reliability in the supply. The renting of reservoir space in the neighboring countries is one of the options available to the natural gas suppliers and/or to the larger consumers.

6.3.3. Oil and petroleum products

The planned consumption of petroleum products in 2020 is lower than the projected capacity of OKTA Oil Refinery which is 2.5 million tons per year and is also lower than the maximum achieved capacity of 1.36 million tons in 1988. Therefore no specific problems are expected in the supply of petroleum products.

Since the import of petroleum products will be free from custom duties starting from 2011, OKTA will have to maintain its competitiveness with additional investments in the improvement of the efficiency and environment protection. Otherwise, the market will impose import of petroleum products instead of crude oil.

6.3.4. Renewable energy sources

With a share of renewable energy sources (RES) of 13.8% in the final energy consumption in 2005, Macedonia belongs to the countries with a relatively high utilization of this type of energy[87]. Having in mind that these are environmentally acceptable domestic resources, the maximal possible utilization of RES is one of the priority activities envisaged in the Strategy.

In the past period, out of the renewable sources, Macedonia primarily used hydropower (for production of electricity), biomass (mostly wooden mass for heat in the residential sector), the geothermal energy (mostly for heating the greenhouses), and some solar energy (for hot water in the households) and biofuels. In the future the plan is to increase the previously mentioned RES and to additionally use wind and solar power and biogas for production of electricity as well as waste biomass for combined heat and power generation.

[87] In the base year, 2005 (in accordance with the Directive 2009/28/EC), only 10 EU-27 member states had higher share of RES.

Hydropower

Macedonia has available technical potential for hydropower for generation of about 5500 GWh (473 ktoe) of electricity per year in average hydrologic conditions.[88] From this potential, the total installed power of the existing hydropower plants is 580 MW (tables 3.2.1.2 and 3.2.3.1) and their average annual generation is about 1500 GWh (129 ktoe) which is 27% of the available potential. According to the Study, construction of new hydropower plants with an annual generation of about 2500 GWh (215 ktoe) is planned, which would make the total production reach a level of 4000 GWh (344 ktoe) or 71% of the available technical potential.

The Strategy plans for the construction of 6 new large hydropower plants in the period to 2020 (HPP Sv. Petka until 2010, HPP Boshkov Most until 2015, Lukovo Pole with HPP Crn Kamen and HPP Galishte until 2016, HPP Gradec until 2017 and HPP Chebren until 2019, Table 6.4.1.1) with a total installed power of about 690 MW (Table 6.1.1.2 plus Sv. Petka) and with average annual generation of about 1200 GWh. Having in mind that the concession awarding activities (tenders) have not been successful, there is a possibility for delaying the construction of these power plants. If their construction is delayed by about a few years, it can be expected that the construction of HPP Gradec and HPP Chebren will finish after 2020. In that case, the generation of the new large hydropower plants in 2020 would be 600 GWh (52 ktoe).

The available potential for construction of small hydropower plants on possibly 400 locations is assessed[89] at 255 MW. According to the average generation of available small hydropower plants, the annual production of these new 255 MW would be 670 GWh (58 ktoe). The Ministry of Economy has issued three tenders for construction (concession) of a total of 71 small hydropower plants with a total power of 65 MW. Their annual production would be about 175 GWh (15 ktoe). In spite of some administrative problems as well as problems related to the unclear hydrology of the locations, the Strategy stipulates a realistic expectation to construct a total of 80 MW of small hydropower plants until 2020 with an annual production of 210 GWh (18 ktoe). At the same time the Strategy envisages an optimistic scenario, which involves the construction of 120 MW of small hydropower plants with an annual production of 310 GWh (27 ktoe).

Wind energy

In the past period several studies have been made to determine the wind energy potential in Macedonia and to select most favorable sites for wind power plants construction. In accordance with the prepared wind energy atlas[90] a selection has been made of 15 most favorable locations for construction of wind power plants. Detailed measurements have been made in four locations and data are being processed. Preparations for measurements on additional five locations are underway. In addition, a study is being prepared for absorption capacity of the electricity and power system of Macedonia for wind power plants.[91]

Based on past investigations, one may realistically expect the construction of 90 – 180 MW wind power plants to 2020 with annual generation of 180 – 360 GWh (15.5-31 ktoe).

[88] Study of Electrotek and MASA on the energy potential of Macedonia.
[89] Study of the hydropower potential of small HPPs, 1980.
[90] Wind Energy Resource Atlas and Site Screening of the Republic of Macedonia, AWSTruewind, June 2005
[91] The Study is financed by the World Bank and it is intended for MEPSO.

The lower limit is at a level of 5% of the electricity generation capacities in Macedonia in 2010 and according to past experiences this would not cause any problems for the electricity and power system. The capacity of systems similar to ours is estimated at 10%. The planned upper limit of 180 MW wind power plants would be 6% of the planned electricity generation capacity of Macedonia in 2020.

Photovoltaic Solar Energy

Macedonia has available a solid solar potential and has high feed-in tariffs for electricity obtained from solar energy, however Macedonia does not have its own production of this technology and the cost of the feed-in tariffs is fully covered by the electricity consumers without an indirect benefit to the economy. Therefore, high penetration of photovoltaics in Macedonia is not planned in spite the high interest for their construction due the high tariffs. The Strategy also envisages the construction of total of 10 – 30 MW photovoltaics to 2020 with an annual production of 20 – 60 GWh (1.2 - 3.6 ktoe).

Waste biomass for combined heat and power generation

Activities are under way in Macedonia to determine this type of potential, however there are still no specific results. According to our estimates it is possible to construct a total of 5 – 10 MW to 2020 with an annual production of 25 – 50 GWh (2.1 - 4.3 ktoe).

Biogas

The potential for electricity generation from biogas has also not been sufficiently investigated. The Strategy envisages that these facilities will have a total power of 7 – 10 MW to 2020 with an annual generation of 20 – 30 GWh (1.7 - 2.6 ktoe).

Biomass for combustion

Biomass for combustion participates with 11.8% in the final energy consumption (final energy without losses and own consumption) in Macedonia in 2006 and it is a significant fuel for fulfilling the energy demands. The biomass is especially present in the residential sector and it fulfills 30% - 33% of the total energy demand. About 430000 households (76%) use biomass for heating.

Out of the total biomass used for energy purposes, the share of wood and wooden coal is 80%. The Republic of Macedonia uses part of the grape wine branches, rice shells and branches of fruit trees for energy purposes, but most of the straw is mainly used for fertilizers, fodder and for production of cellulose. Therefore it is unavailable for energy purposes.

The planned utilization of biomass for combustion which will be used as heat in 2020 is greater, by less than 10% than the consumption in 2006 when the registered and unregistered consumption are taken cumulatively. Table 6.5.1 presents statistical information[92] for 2005 which does not include the unregistered consumption. In the period until 2020 the unregistered consumption is expected to gradually decline and to become registered. Having this in mind, the total consumption for the period 2006 - 2020 will increase by only 10% which at the level of the available potential in spite of the fact that the registered consumption will increase by more than 40%.

[92] © OECD/IEA, [2008], IEA Online Database: Energy Balances of Non-OECD and OECD Countries and Energy Statistics of Non-OECD and OECD Countries

According to the baseline scenario, the consumption of biomass for combustion in 2020, which will be used as heat, will be 236 ktoe (2740 GWh) which is approximately equal to the available potential.

The scenario with strengthened energy efficiency measures envisages a growth of the consumption of biomass for combustion for this purpose, in the period 2006 - 2020 of only 5.7% to an amount of 227 ktoe (2640 GWh) in 2020.

If the waste biomass for combined heat and power production is taken into account, then the consumption of biomass for combustion in 2020 will be 244 – 249 ktoe (2840 – 2900 GWh). This represents an increase of the consumption of biomass for combustion in the above period by 12 - 14%.

Solar Energy as Heat

In the past period the utilization of solar energy as heat was at a low level in the energy balance of Macedonia. At the same time, Macedonia uses very little solar power both with respect to the countries from the region as well as with respect to much more northern countries. With only about 4000 collection systems for utilization of solar power for heating of water in 2006, the share of the solar power in the total final energy consumption was just 7.4 GWh (0.6 ktoe) or 0.04%.

Since 2007, the Government is financially supporting the introduction of solar collectors however this is not enough for a more massive introduction of this fuel in Macedonia. The main reason is the low price of electricity and therefore the funds invested in the introduction of solar power as heat in the residential sector have an investment return period of 10 years.

To achieve a larger penetration of solar energy for production of heat in the residential sector it is necessary to increase the financial support and change the subsidy method from ad hoc into a continuous support mode. The support by the Government would reduce as the electricity price increases until the time when it reaches market value. One of the measures to stimulate the introduction of solar collectors could be the provision of soft loans to exchange asbestos roofs and in the same time install solar systems.

Regarding the greater level of introduction of solar systems in industry especially in the industries that consume larger quantities of hot water (dairy, meat and textile) where the return on the invested funds is of the order of 2 to 3 years it is necessary to stimulate the domestic producers for massive production of solar systems and facilitate the export and administrative procedures. This would improve the quality of the systems and would achieve economic benefits.

The strategy envisages utilization of solar power as heat primarily in the residential sector. Until 2020, 60000 - 90000 installations in the residential sector are planed and the total utilization of solar power (together with the commercial sector and industry) would be 60 – 90 GWh (5.2 - 7.7 ktoe) per year.

Geothermal energy

Geothermal energy as final energy is planned at the level of 400 – 520 GWh (34-45 ktoe, 1440 - 1872 TJ) until 2020 and it has a significant contribution in the utilization of RES. In order to achieve this objective in addition to the previously undertaken activities for utilizing the existing sources and find new ones, the Government needs to take additional action. The start of the activities for oil investigations will certainly contribute new sources with higher temperature. Geothermal energy will participate in

the primary energy consumption in 2020 with 440 – 570 GWh (38 - 49 ktoe, 1584 - 2052 TJ).

Biofuels

The participation of biofuels in the total fuel consumption in traffic in 2008 was a modest 0.2%.

With the fulfillment of the obligations stipulated in the Directive for participation of biofuels at a level of at least 10% in the total petrol and diesel fuel consumption in traffic in 2020, the share of this type of fuel should be 560 – 655 GWh (48 - 56 ktoe).

The provision of biomass for production of biofuels has not been sufficiently investigated and special studies and stimulating measures are needed to resolve this issue. According to the analysis so far, the maximum capacities of Macedonia for production of biomass for that use, together with recycling of the used oils and the utilization of animal origin fat, could yield production of biofuels in the amount of around 12 ktoe per year[93]. However, we should not neglect the possibility to exceed this amount with the development of new technologies for biofuel production. In addition to the incentives for production of raw materials, it is especially significant to introduce incentives for production and use of biofuels. Having in mind that the directive allows import of biofuels the stimulations and obligations to use biofuels should be most important.

6.3.5. Share of the Renewable Energy Sources in Final Energy Consumption and Electricity Generation

The share of RES in the final energy consumption is defined[94] as the ratio of energy obtained from RES and the final energy consumption, where:

- the energy from RES is a sum of:
  - electricity produced from all RES,
  - final consumption of RES for heating and cooling, and
  - biofuels used in traffic;
- the final energy consumption is defined as the sum of:
  - final energy consumption (from industry, residential sector, traffic, commercial and service sector, forestry and agriculture sector),
  - electricity and heat losses in distribution, and
  - own consumption of power companies (for generation of electricity and heat)

The base year according to the Directive is 2005. The production of electricity in 2005 from hydropower plants depends on the power of all hydropower plants in the country in that year and the generation corresponding to the average relative generation per unit of power in the last 15 years. The result of this calculation is the generation for the installed capacity in 2005 and for average hydrologic condition for the last 15 years. Similarly, the planned generation in the period until 2020 is calculated for average hydrologic conditions. Similar procedure is applied to wind energy but the average is taken from the last 4 years.

Table 6.3.5.1 presents the share of RES and the final energy consumption (FEC) for the lowest limits (LL), the upper limits (UL) and the planned values (PV). The planned values can be achieved with all possible combinations of RES and the final

[93] Slave Armenski, Energy from biodisel production (in Renewable energy sources of Macedonia, K. Popovski and others, MAGA, Skopje, 2006).
[94] Directive 2009/28/EC

energy consumption within the presented limits. The percentage share of RES in Macedonia according to the real average values will grow from 13.8% in 2005 to 21% in 2020. This percentage corresponds to the obligations of the EU member states. The calculation for the EU member states is based on the percentage share of RES in 2005 plus 5.5% for each member state and plus certain percentage commensurate of the gross domestic product per capita (for example for Romania this is 0.7%). For Macedonia the target would be 20.5% (13.8+5.5+1.2)[95]. According to the adopted EU practice, this percentage is rounded to 21%.

Table 6.3.5.1. Share of the renewable energy sources in the final energy consumption (GWh)

	GWh			
	2005	**2020 LL**	**2020 UL**	**2020 PV**
Electricity from RES	**1144**	**2539**	**3482**	**2889**
Hydro power plants	1144	2300	3000	2650
Large hydro power plants	1090	2000	2600	2350
Small hydro power plants	54	300	400	300
Wind power plants	0	180	360	180
Photovoltaics	0	14	42	14
Biomass	0	25	50	25
Biogas	0	20	30	20
Heat from RES	**1872**	**3100**	**3350**	**3210**
Biomass	1756	2640	2740	2700
Solar energy	0	60	90	80
Geothermal energy	116	400	520	430
Biofuels	**0**	**560**	**655**	**600**
TOTAL RES	**3016**	**6199**	**7487**	**6699**
Final energy consumption	**21783**	**32873**	**30825**	**31850**
RES share (%)	**13.8**	**18.9**	**24.3**	**21.0**

Considering an electricity generation growth with an average annual rate of 3%, 2% and 2.5% and electricity generation from RES according to the LL (2539 GWh, table 6.3.5.2) UL (3482 GWh) PV (2924 GWh) the percentage share of RES in the electricity generation in 2020 would be 20.1%, 31.5% and 24.7% respectively.

|Table 6.3.5.2. Share of the RES in the electricity generation

Electricity from RES	2020 LL	2020 UL	2020 PV
GWh	**2539**	**3482**	**2924**
Total electricity generation with growth rate	3%	2%	2,5%
GWh	**12616**	**11060**	**11842**
RES share (%)	**20.1**	**31.5**	**24.7**

[95] Study for RES of the Republic of Macedonia, MANU, draft version, February 2010

6.4. ACTIVITIES PLANNED ON THE EXISTING ENERGY INFRASTRUCTURE AND CONSTRUCTION OF NEW ENERGY FACILITIES

6.4.1. Electricity sector

The Strategy foresees by the year of 2020 to revitalize and use the existing thermal power plants running on lignite and heavy oil for production of electricity with power of 1010 MW and construction of a new facility with power of 300 MW. It is foreseen to finish the revitalization and the use of existing hydro power plants with installed power of 580 MW and construction of new ones, with total installed power of 690 MW (Table 6.4.1.1). By 2020 it is foreseen to use the natural gas in three combined heat and power plants for production of electricity and heat (CHP) with total installed power for production of electricity of 564 MW.

In order to maintain the conditions and capacity of the existing lignite thermal power plants it is planned to ***revitalize the equipment of the Bitola and Oslomej thermal power plants*** by increasing their power for more than 30 MW. In addition, it is also necessary to integrate new systems for desulphurization of the smoke gasses by 31 December 2017, in accordance with the obligations deriving from the Directive 2001/80/EC. Since the existing coal-powered thermal power plants will be at the end of their life, it is necessary to carry out detailed technical and economic analysis for replacement of the thermal power plant Bitola 1 and 2 as well as the Oslomej thermal power plant with new one of 600 MW instead of revitalizing them and mounting desulphurization systems. This will meet the environmental requirements imposed by the said Directive and, due to the greater efficiency coefficient it will reduce the greenhouse gasses and it will save significant amount of coal.

It is also necessary to ***reconstruct the Negotino thermal power plant*** which will enable greater flexibility in order to increase its involvement in the electric and power system in Macedonia and it will contribute both to increased production of electricity as well as its integration in the variable regime of work. In the phase of increase of the flexibility of this power plant, it is necessary to upgrade the regulation system and integrated modern turbines regulator that will enable this thermal power plant to fit into the regulation system, providing primary and secondary regulation of the overall Macedonian electrical and power system. In such conditions, the capacities of the system will increase to accept greater power from wind-powered and solar-powered power plants. Taking into account the Directive 1999/32/EC for reduction of the quantity of sulfur in particular liquid fuels and the Directive for change of 93/12/EEC, the thermal power plant Negotino will be able to operate with the planned dynamics, without disruption of the obligations that derive from the Directive 2001/80/EC. The Strategy does not envisage change of the status of JSC TPP Negotino from the legal aspect or change of the fuel. Our recommendation is to use TPP Negotino on heavy fuel oil as a cold and/or rotating reserve when it is economically feasible or when the electricity needs cannot be met from imports.

In the upcoming period it is planned to finalize the ***revitalization of the hydro power plants,*** including installation of a new generator (second phase) thus increasing their total installed power by around 50 MW.

In the period from 2010 to 2020 many new CHP and hydro-powered facilities will be put into operation.

The Scenarios assume that the activities that were initiated at the existing hydro power plants will be finished, a follows: increase in the installed capacity of hydro power plant Matka and putting into operation of hydro power plant Sv.Petka in 2010.

Putting into operation of HPP Boshkov Most in 2015, Lukovo Pole with HPP Crn Kamen in 2016, HPP Galishte in 2016, HPP Gradec in 2017 and HPP Chebren in 2018-2019

When putting in operation of HPP Chebren a correction was made of the loading factor of the consumption from 60.7% in 2020 to 65% in 2030 which is done gradually due to the engagement of HPP Chebren as a consumer in late night hours when the pumping regime is operational.

The last of the large potential hydro power plants is HPP Veles which starts its operation in 2021. The construction of the planned hydro power plants will mean that in the electricity and power system, in addition to the existing HPPs with total power of 580 MW, new ones will be included with a total power of 780 MW which will increase the production of electricity from the power plants more than double.

Table 6.4.1.1. Time dynamics for construction of the new production capacities in Macedonia, for both scenarios

	SCENARIO 1*	SCENARIO 1a**	SCENARIO 2
	Consumption growth rate 2.5%	**Consumption growth rate 2.5%**	**Consumption growth rate 3.0%**
2010	**CHP Skopje, CHP KOGEL, HPP Sv. Petka**	**CHP Skopje, CHP KOGEL, HPP Sv. Petka**	**CHP Skopje, CHP KOGEL, HPP Sv. Petka**
2014	**CHP Energetika**		**CHP Energetika**
2015	**HPP Boshkov Most**	**HPP Boshkov Most, Lukovo pole**	**HPP Boshkov Most**
2016	**HPP Galishte, Lukovo pole**		**HPP Galishte, Lukovo pole**
2017	**HPP Gradec**	**CHP Energetika**	**HPP Gradec**
2018		**HPP Gradec**	**TPP Bitola 4, HPP Chebren**
2019	**TPP Bitola 4, HPP Chebren**	**TPP Bitola 4, HPP Galishte**	

*Baselone scenario; ** Scenario with slower investment activities (chapther 6.1.1)

The strategy also plans for the construction of the two biggest hydro power plants in the Vardar valley, namely HPP Gradec and HPP Veles, for which the technical documentation has been prepared at the level of a preliminary design. This solution is most favorable from the point of view of erosion and sedimentation. For the other ten smaller hydro power plants along the river Vardar, the technical documentation is only at the level of a preliminary solution and therefore they could not have been planned for at the time when the Strategy was prepared. If investors are found and a large part or the entire capacity of the Vardar valley is utilized it would increase the electricity production and the stability of the electric power system of Macedonia.

The Vardar valley project is very complex and requires solid documentation in order to make appropriate decisions. According to the present plans for construction of hydropower plants on the Varder valley and according to the envisaged time schedule it is necessary to relocate the railroad on sections that will be flooded by the relevant reservoirs. For this purpose additional investments are necessary and these have been taken into account in the Strategy. However, a new modern railroad (with two gages) should be constructed on the strategic section Tabanovce – Gevgelija. It is our opinion that the construction of this railroad should start as soon as possible and should be followed immediately by the construction of the hydropower plants in the Vardar Valley.

The small HPP, including the photovoltaic power plant and the biomass facilities are taken integrally, with development dynamics of 50 MW each and annual production

of 140 GWh every five years (2015, 2020, 2025 and 2030). This development dynamics of RES means that in 2020 the design total capacity of these facilities will be 100 MW and the annual generation will be 280 GWh. In addition, 90 – 180 MW wind power plants are planned until 2020 with annual production of 180 – 360 GWh. Because of the necessary reserve power for them, this generation will contribute mainly for fuel savings in the thermal power plants and only partly in the energy balance when used in combination with storage hydropower plants.

With this kind of presupposed dynamics for construction of the potential hydro power plants, the total hydro capacities in Macedonia (both present and future ones) by the end of 2020 will be around 1350 MW with average annual production of around 2800 GWh.

The gas thermal power plants with combined production of electricity and heat are considered with the dynamics of their entry into operation in accordance with the existing and current activities. CHP Skopje of Toplifikacija AD Skopje with installed power of 234 MW will enter into operation in 2010 and CHP KOGEL with installed power of 30 MW in 2010. The third gas CHP Energetika with power of 300 MW, the tender for which is announced, enters into operation in 2014.

With these activities we finalize the utilization of the existing pipeline for production of electricity. By constructing the three foreseen gas CHP with total installed power of 564 MW the maximum annual production can be up to 4000 GWh for which 800 million Nm^3 of gas are needed.

For construction of additional gas thermal power plants it is necessary to construct new gas pipelines to Macedonia.

In 2018-2019 it is necessary to put into operation the lignite powered thermal power plant from pit excavation, with installed power of 300 MW. The existing infrastructure of TPP Bitola gives certain advantage compared to the other locations of the new thermal power plant Bitola 4.

According to the analyses presented in Section 6.1.1 the core activities that have to be implemented to satisfy the electricity demand can be summarized as follows:

- strengthened measures and activities for energy savings and improvement of the energy efficiency,
- construction of the second large natural gas fired CHP in Skopje as soon as possible and construction of small natural gas fired CHPs where it is economically justified;
- revitalization of the existing production capacities,
- strengthened measures and activities for rapid and wide spread penetration of natural gas and solar energy in the residential sector,
- greater and rapid penetration of the renewable energy sources for electricity generation (including the large hydropower plants and small CHP using waste biomass),
- preparatory activities for new thermal power plants and/or nuclear power plant.

Construction of mines

The surface excavation ***Brod-Gneotino*** currently in opening phase and is state owned – in the frames of ELEM AD Company – Power Plants of Macedonia. According to the expectations, the planned annual capacity of $2x10^6$ tons will be reached in the third year from the start of exploitation of the coal, i.e. during 2011 and no later than the beginning of 2012.

The exploitation of the surface mine ***Suvodol-underlying coal seams*** is planned to start in 2010 and in 2011 to reach the planning capacity of 3×10^6 t/year.

For the demand of the new thermal power plant Bitola 4, the plan is to open the ***Zhivojno*** mine. The exploitation of the coal will be from a pit. The price of the coal obtained from the Zhivojno mine is estimated to be 15 Euros per ton[96] and it is quite lower than the coal price of same quality that would be imported.

The period of achievement of the optimum planned capacity of Zhivojno mine (of 3 million tons of coal per year) is estimated to be 5 years from the moment of securing the necessary investment funds. Since Macedonia has no experience in the pit exploitation of lignite, it is necessary to start with the activities quite early (2010 - 2011).

Development of the transmission grid of Macedonia

In order to realize the energy strategy for construction of new electrical and power facilities, specific activities are necessary to improve the infrastructure of the transmission grid in Macedonia. According to MEPSO[97], the activities for improvement of the transmission grid refer to revitalization of the existing and construction of new power lines of 110 kV within Macedonia, as well as investment activities for connecting the EPS of Macedonia with the EPS of the neighboring countries with over 400 kV power lines. The Table 6.4.1.2 shows the ongoing and short-term planned activities in the power transmission grid of Macedonia.

Table 6.4.1.2. Planned short-term activities for improvement of the transmission grid

Voltage level	Section / Project	Length (km)	Investment (millions €)
110 kV	Double - system OH power line TS Bitola 3 – TS Bitola 4	12	3.25
110 kV	HPP Matka -TS Skopje 3	8	1.6
400 kV	Macedonia – Srbija , Shtip – Nish	70 (MK)	14

Additional revitalizations planned:

- Four substations 400/110 kV (Skopje 1, Skopje 4, Bitola 2 and Dubrovo) with investment of 6.25 million euros;
- Reconstruction of the 110 kV power lines on the Vrutok-Tetovo section by constructing double-system over head power lines, construction of the SS Petrovec and the connecting 110 kV power line for SS Petrovec as well as construction of multiple 110 kV power line fields with a total credit value of 27 million Euros with a period for realization by 2009;
- Construction of new 2×110 kV power line SS Bitola 3 – SS Bitola 4, reconstruction of the existing 110 kV power line SS Skopje 1 – SS Tetovo 1, revitalization and upgrade of the SS 110/x kV (revitalization of the HV equipment, management, protection, etc.) in a total credit value of around 25 million Euros, with a period of realization by 2011.

The planned power transmission facilities for the period after 2010 are the following. The initial feasibility studies/elaborates are being developed:

- 400 kV interconnectivity power line Macedonia – Albania at 16.7 million Euros,
- 400 kV interconnectivity power line Macedonia – Kosovo A., 6.4 million Euros,

[96] Feasibility study for pit exploitation of coal for the purposes of the TPP Bitola from the Zhivojno site", developed by RI-PIERM, Mining Institute LLC Skopje, and others, February 2004.
[97] MEPSO – future facilities for electricity transmission

- 110 kV power line for connecting the HPP Boshkov Most to the transmission grid. 4.65 million Euros.

The Figure 3.2.2.1 shows an overview of the existing and the planned infrastructure of the transmission grid in Macedonia.

The construction and realization of the hydro system at Crna Reka river, by building the HPP Chebren and HPP Galishte we are going to realize the 400 kV connection of these two hydro power plants to the EPS of Macedonia. The closest here is the Bitola-Dubrovo link. The additional investment and strengthening of this production knot with 400 kV transformers and power lines at the Mariovo location will be needed after 2020 when the plan is to have in operation the lignite thermal power plant Mariovo with 300 MW, or a nuclear power plant with 1000 MW.

In order to improve the transmission infrastructure in the Western part of Macedonia we also need 400 kV grid due to the high concentration of installed power in the form of hydro power plants in that part of the country.

Development of the electricity distribution system

Additional investments are needed in the distribution system of Macedonia in order to improve the quality of delivered electricity and reliability of the supply. Here we need to emphasize also the need to bring to minimum the unregistered and unpaid consumption of electricity. In this regard it is necessary to engage more the Ministry of Interior and the judiciary in order to provide smooth realization of the working obligations of the EVN Macedonia staff regarding the timely and good quality resolution of the court complaints and enforcement of the judgments.

6.4.2. Sector for heat production

Activities planned for the existing energy infrastructure of Toplifikacija AD for the period by 2012, 2020 and by 2030

The increase of the energy efficiency and reduction of the energy losses will be achieved by Toplifikacija by:

- *Installing additional heating surfaces (utilizers)* in order to fully utilize the waste heat of the boilers, i.e. the energy that is included in the smoke gasses;
- Installation of instruments for continuous measuring of the oxygen content in the resulting smoke gasses;
- Regular maintenance of the already installed thermal insulation and continuous upgrade with new one.

The increased reliability of the Toplifikacija will be enabled with:

- Regular maintenance of the facilities in the heating plants,
- Regular maintenance of the central heating network,
- Integration of the sophisticated management equipment,
- Replacement of the existing mechanical equipment for regulation with automatic equipment,
- Integration of equipment and software for continuous monitoring and management with the production process and delivery of heat.

The revitalization and modernization of the equipment is done on a continuous basis and this will continue in the following period, as follows:

- Replacement of the existing economizers of the boilers with new types. The plan is to replace all the existing types of economizers with new ones in the next ten years;
- Replacement of the screens from the stock sections of the boilers. The plan is to replace all the existing screens from the stock sections of the boilers in the next 20 years;
- Modernization of the old automatics, measurement-regulatory and protective equipment;
- Integration of measurement-regulation equipment for partial heating of residential buildings.

The increased prices of the fuels makes very possible the probability that every household will purchase and install equipment for measurement of the heat energy used, at the level of each apartment.

Toplifikacija AD is already involved in the construction of the first steam-gas combined heat and power facility with electricity production capacity of 230 MW and heat production capacity of 160 MW. Its regular operation and opening will be in the first half of 2010.

By 2011 it is planned to construct and put into operation the combined heat and power facility of the Skopje Sever heating plant facility with installed electrical power of 40 MW and heating power of 30 MW. This facility will be able to produce 280 GWh electricity and 60 GWh heat every year.

By 2013 it is planned to construct and put into operation the CHP facility in the Western part of the City of Skopje, with installed electrical power of 200 MW and 160 MW of heating power. This combined heat and power facility should cover the basic demand for heat energy of the central heating users connected to the heating plant "Zapad". The Heating Plant "Zapad" will cover the highest demand of these users in a similar way done by the heating plant east, supplemented by CHP Skopje AD. This facility will be able to produce 1600 GWh of electricity and 200 GWh of heat.

6.4.3. Sector for oil and petroleum products

The investment activities in OKTA will be focused mainly on the modernization of the refinery in order to increase the energy efficiency and reduce the energy losses, improve the environmental protection, increase the reliability in the operation and construction of new petrol stations. In addition, the following investment activities are planned:

- **2009:**
  - Isomerization facility – production of high quality engine petrol;
  - Facility for waste waters treatment;
- **2010-2015:**
  - Reconstruction of the infrastructure for loading of the petroleum products
  - Radar system – upgrade of the existing measurement system on the reservoirs level
  - Upgrade of the thermal power plant in OKTA for production of industrial steam and electricity
  - Upgrade and improvement of the HDS facility
  - Expansion in order to satisfy the increased demand for energy in the analyzed period

In the frames of this sector it is planned to build the AMBO oil pipeline which is supposed to connect the Bulgarian port of Burgas in the Black Sea with the Albanian Port of Valona in the Adriatic Sea, via Macedonia.[98] This oil pipeline should be around 900 kms long and have a capacity of around 120 tons of oil per day. The three states have already defined the points of entry and exist at the borders and have signed the Convention for Construction, Exploitation and Maintenance of the Oil Pipeline, which is also ratified in the relevant Parliaments. The funds for construction of this oil pipeline are estimated to be around 1.5 billion USD. The Project is supported by the US Government which financed the development of the Feasibility Study for the oil pipeline. The expectations are that this oil pipeline will be constructed before 2015.

The benefits from the construction of AMBO oil pipeline are multiple: additional reliability in the supply with oil, collection of the transit fee and engagement of local companies in the construction process.

6.4.4. Sector for natural gas

The possible activities in the Sector for Natural Gas are explained in details in the Section 6.3.3. Here we need to re-emphasize the need for regional connectivity of Macedonia with new gas pipeline network.

[98] Bulgaria-Macedonia-Albania Oil Pipeline Project, W&C Draft, Washington, D.C., March 2000

7. ENVIRONMENTAL IMPACT

The key objectives of the European Policy on Energy and Environment include: reliability in the energy supply, competitiveness, increased energy efficiency and renewable energy sources, as well as environmental sustainability. The realization of the objectives is monitored by using the following six questions[99]:

- How large are the impacts of the production and use of the energy on the environment
- What are the trends in the composition of energy fuels and the relevant consequences for the environment
- How quickly are the technologies based on renewable energy sources implemented
- Do the production systems of energy become more efficient
- Are the costs in relation to the environmental impact, properly included in the energy price
- What are the trends for energy consumption in the residential sector and what are the policies for improvement of the energy efficiency

These are the guidelines which should be used for building and harmonization of the energy policy of the Republic of Macedonia in the upcoming period, taking into account the national specifics. The implementation of these objectives results in sustainable energy development since, in addition to the benefits for the environment it will also provide for economic and social benefits.

7.1. POLLUTION OVERVIEW

In Macedonia, almost 90% of the primary energy is generated from fossil fuels, mainly lignite and heavy fuel oil. Most of that is transformed into electricity or heat in the thermal power plants. The environmental components that are affected from the operation of the thermal power plants can be grouped in three clusters: air, water and soil and, indirectly, impact on the flora, fauna and especially on the health and quality of life of the people. In Macedonia, the environmentally most burdened component from these thermal power plants is the air. The thermal power plants using fossil fuels pollute the air with particles and gasses (SO_2, NO_x, CO) with direct negative impact on the life and assets in their environment. There is also pollution with gasses (CO_2, CH_4, N_2O) with global negative effect through the greenhouse effect.

Local pollution

In most of the cases the emission of SO_2 is high and goes many times over the maximum allowed thresholds. However, in particular cases the ground concentrations of SO_2 in the vicinity of thermal power plants are within the maximum allowed limits – such as, for example, the maximum amounts of ground concentrations of SO_2 in the vicinity of the heating facilities “Istok” and “Zapad” of Toplifikacija AD Skopje, when using heavy fuel oil with 2% of sulfur, reach up to 28%, i.e 57% of the maximum allowed concentrations[100]. In the past period, the concentrations of SO_2 in the vicinity of

[99] European Agency on Environment (EEA): Energy and environment 2008, Report No..6/2008; http://reports.eea.europa.eu/eea_report_2008_6/en/Energyandenvironmentreport2008.pdf

[100] G. Kanevche, Calculation of the ground concentratrion of the pollutants in the vicinity of the heating plants ”Istok“ and ”Zapad“, Ellaborate for Toplifikacija AD Skopje, 2007.

TPP Bitola goes over the maximum limit in only small number of cases[101]. However, the remaining reserves of lignite from Suvodol and especially from underlying seams, as well as the reserves from Brod – Gneotino and Zhivojno feature with increased percentage of combustive sulfur.

The thermal power plants are large polluters of waters. In addition to the fact that there are clearly set obligations for treatment of the waste waters, still this issue has not been properly addressed. It is very important to provide treatment of all waste waters released in Crna Reka river (and not only from the thermal power plants) before the filling up starts of the planned accumulations of Chebren and Galishte.

The pollution of the soil is very important when it comes to mines. For each of the mines there are elaborates for environmental protection – it is just necessary to properly enforce them.

Global pollution

The total emissions of greenhouse gasses in the Republic of Macedonia for the period 1990-2002 are between 11.9 to 14.4 Mt CO_2-eq. The emissions for the year of 2000 are 14318 kt CO_2-eq, i.e. 7.16 t CO_2-eq. per capita[102]. The main polluter is the energy sector which contributes to around 70% in the total emissions. In the frames of this sector the emissions of CO_2 are dominant.

7.2. STRATEGIC AND LEGISLATIVE ASPECTS

On strategic level, the environmental policy (as part of the Policy for Sustainable Development) is regulated in the following documents: National Strategy for Sustainable Development[103] and the National Environmental Action Plan (NEAP).

In the National Strategy for Sustainable Development the energy and the climate changes are altogether identified as one of the key challenges in Macedonian circumstances, which is in accordance with the European Strategy for Sustainable Development[104]. NEAP defines the problems in the environment and the policies in the relevant media and sectors (the energy is one of the sectors in the NEAP). The local self-government units design strategic documents on local level – Local Environmental Action Plans (LEAPs). From the energy aspect, the LEAPs need to include measures and activities for energy efficiency and renewable energy sources.

The Law on Environment[105] includes legislation for the environmental impact assessment (EIA), system for integrated license for integrated prevention and pollution control (IPPC), mainly through the concept of "best available technologies" and it also foresees adoption of the relevant legislation for environmental plans for management and environmental audits. In addition, the Law on Environment includes eco-labeling which, from the energy aspect, has significant contribution for the energy efficiency on the consumption side.

In addition, when constructing new energy capacities the obligations from the international conventions, signed by the Republic of Macedonia, primarily the Convention on Environmental Impact Assessment in a Transboundary Context and the

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[101] G.Kanevche., REK Bitola – environmenta aspects, Round Table: REK Bitola - its perspectives as the main energetic pillar of the Republic of Macedonia, ZEMAK, Bitola, 2003

[102] Source: Second National Communication under the United Nations Framework Convention on Climate Change , Ministry of Environment and Spatial Planning, UNDP-GEF, November 2008

[103] It is expected to the adopted in 2009

[104] Council of the European Union: Renewed Strategy on Sustainable Development (EU SDS), June 2006

[105] Official Gazette of the Republic of Macedonia No. 53/2005

Convention on Biological Diversity, as well as the Convention on Wetlands of International Importance, especially as Waterfowl Habitat, Convention on the Conservation of Migratory Species of Wild Animals and the Convention on the Conservation of European Wildlife and Natural Habitats, should be taken into account.

7.3. CLIMATE CHANGES

The Republic of Macedonia ratified the United Nations Framework Convention on Climate Changes (UNFCCC), as well as the Kyoto Protocol as a country which is not included in the Annex I. In the national legislation some aspects of the climate changes included in the Law on Environment, such as the development of inventory of greenhouse gases as well as action plan including measures and activities for reduction in the increase of the greenhouse gasses emissions and mitigate the adverse impacts from the climate changes. Furthermore, in the amended Law on Environment there is an Article that concerns the Clean Development Mechanism (CDM).

The Ministry of Environment and Physical Planning (MoEPP) coordinates all the activities related to the Convention and the Protocol. It is the designated national authority (DNA) for application of the Kyoto Protocol. The CDM is the only flexible mechanism which can be used by the Republic of Macedonia. The Government has adopted a Strategy on CDM for the first period of obligations according to the Kyoto Protocol 2008 - 2012[106] in which the following priorities are identified for the energy sector: revitalization of the large power plants; gasification (switching from coal and oil based to gas); combined heat and power plant production of heat and electricity; energy efficiency in the industry; and the hydro power and geothermal energy.

7.3.1. Greenhouse gasses emissions

Especially important part from the energy aspect in the National Reports on Climate Changes[107] is the thematic area for mitigating climate change. In Macedonian circumstances, this analysis includes the following sectors – "Electrical energy", "industrial energy transformations and heating", "transport", "waste" and "agriculture". For each of the sectors several development scenarios are designed, for the period 2008 untill 2025 – baseline scenario and environmentally improved scenarios which include relevant measures/ practices/ projects/ interventions for reduction of the emissions (Figure 7.3.1.1).

According to the scenario based only on coal (the so called "black option"), the emissions will increase from around 13800 kt CO_2-eq. in 1990 to 21500 kt CO_2-eq. in 2020. According to the second, improved environmental scenario, due to the introduction of gas power plants for combined heat and power production, reduction of the growth of consumption of electricity and increased use of renewable energy sources, by the year of 2020 the emissions will be around 15000 kt CO_2-eq., which is 30% less compared to the baseline scenario. In this regard, the specific emission of the greenhouse gasses from the electricity sector (the grid factor), from around 1.2 kg/kWh in 2006, according to the baseline scenario, remains on approximately same level, with a slight increase, while according to the environmentally improved scenario, is reduced to around 0.9 kg/kWh, i.e. by 22%.

[106] www.moepp.gov.mk
[107] The Government adopted two National Reports on climate changes (the second one in November 2008)

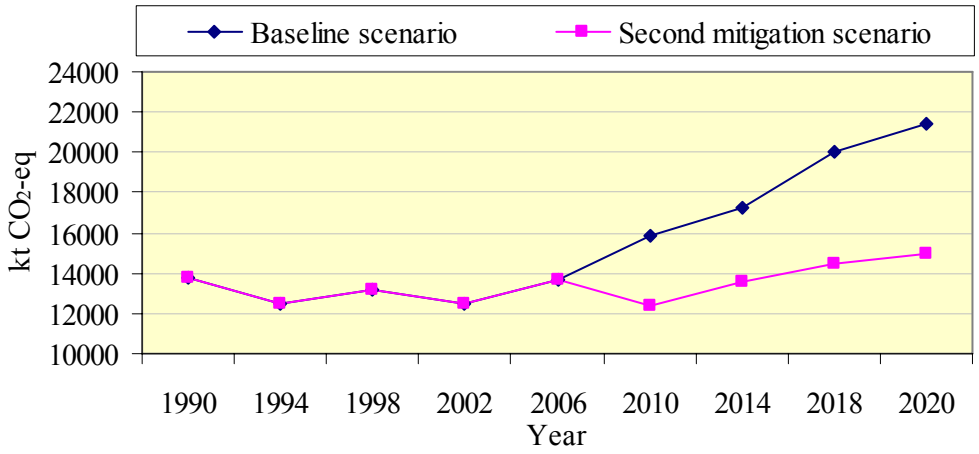

Figure 7.3.1.1. Projections of the total emissions of greenhouse gasses

7.3.2. Obligations

Presently, as a country not belonging to Annex I, Macedonia has no quantified obligations to reduce the emissions of the greenhouse gasses. As an EU candidate country (membership perspective), Macedonia would have to be included in the joint European efforts and goals regarding the climate changes. The specific obligations that can be expected would be in a form of limiting the increase of emissions of the greenhouse gasses. Therefore, when planning the future projects in the energy sector, the following two key elements must be considered:

- Increased operational costs for the coal thermal power plants due to the obligation to purchases licenses for emission of the greenhouse gasses;
- Increased investment costs when constructing new and revitalizing coal thermal power plants due to the requirement to use BAT ("clean coal" technologies), i.e. in general, for compliance to the European standards for large plants. [108]

In the meantime, Macedonia must be properly prepared from institutional, legislative and technical aspects. In this sense it is especially important to undertake pilot preparation projects for realization of the emissions trading scheme (ETS) in Macedonian circumstances, by introducing national registers and national plan for allocation of emission licenses between the polluters. Furthermore, it is necessary to work on strengthening of the negotiating capacities of Macedonia in the process of determination of the quantified obligations.

[108] Large Combustion Plant Directive

8. THE ENERGY PRICE POLICY

8.1. KEY ECONOMIC PROBLEMS OF THE ENERGY SECTOR OF MACEDONIA

The key economic problems that burden the energy sector of the Republic of Macedonia can be summarized as follows: **(1)** increased energy deficiency; **(2)** depressed price of energy (for many years), especially the price of electricity which discouraged saving this precious resources and destimulated a very important function of the entrepreneurship behavior of the companies – replacement of the more expensive resources with cheaper resources; **(3)** the depressed price of the fuels produced losses and lack of funds for investments in the maintenance, modernization, expansion and construction of new plants in the energy sector; **(4)** unfavorable industry structure which sets high energy intensity – almost 1/3 of the total electricity consumption in Macedonia goes to energy-intensive sectors and industries. Here we have to take into account the fact that Macedonia belongs to the countries with anemic economic growth and slow structural changes. The slow structural changes will have an impact on maintenance of the stable structure of energy consumption, without swift fundamental structural shifts. The empirical experiences show that serious structural changes require 15 to 20 years; **(5)** high total losses of electricity (both technical and commercial); **(6)** low energy efficiency; (**7)** lack of complex programs for energy savings, especially in the residential sector, but also in other sectors which are important consumers. This situation yields low energy sustainability of the Republic of Macedonia i.e. low capacity of the country to ensure reliable supply of energy (production, transmission, distribution and supply), in a manner that will not jeopardize the long-term development potential of the energy sector and the economy as a whole, i.e. will not jeopardize the security of the future generations.[109] According to the calculations of the experts from the European Bank for Reconstruction and Development, the Sustainable Energy Index of Macedonia is 0.36 and it is twice lower than the one of Germany, Spain, UK and the Netherlands but it is almost twice lower than the one of Slovenia, Lithuania and Romania.

Due to this situation, it is obvious that the import of energy becomes growing and more important item in the total import of the Macedonian economy. If the value of the energy import in 2002 was 323 million USD, in 2004 this amount reached 398 million USD, 618 million USD in 2005 and around 680 million USD in 2006[110]. In this context very worrying is the issue of greater import dependency of the country from electricity – trend of increase in the imports of electricity which was especially increased after 1999. In 2006 the import dependency of electricity went beyond 25%[111]. These trends are result of increased economic activity in the country, restarting of the industry capacities that belong to the group of large energy consumers, but also result in the increase in the price of crude oil and petroleum products, including the prices of other fuels on the world market. The participation of the energy deficit in the total trade deficit of the country was increased from around 27% in 2003, to 38% in 2006[112]. The negative effects from the high energy dependency reflect on the current account of the payment balance in the country (through the trade deficit) and on the total payment-balance position of Macedonia. They also have impact of the national reserves in foreign

[109] EBRD Transition report, London 2008
[110] Ministry of Economy of the Republic of Macedonia – the Energy Balances for the relevant years
[111] © OECD/IEA, [2008], IEA Online Database: Energy Balances of Non-OECD and OECD Countries and Energy Statistics of Non-OECD and OECD Countries
[112] NBRM, 2006

currency, on the indebtedness of the private sector and on a longer term could have effect on the exchange rate of the national currency. The negative effects on the inflation index, although presently they are low (around 11% whereas the transmission mechanism are realized mainly through the increased costs of the residential sector for energy – electricity, solid fuels and oil and less through the costs related to the use of transport means and services) must not be underestimated on the longer term. The key determinants of the price of particular types of energy and the forecasts by the relevant institutions, confirm that the energy price will continue to be maintained on the high level[113].

8.2. ECONOMIC REGULATION OF THE SECTOR AND THE PRICE POLICY

8.2.1. The role of the regulatory body

In the energy sector there are elements of natural monopoly (this is treated as a domain of market lack of success in the modern microeconomic science) therefore it is necessary to make it subject to economic regulation. The economic regulation is focused towards the control of prices, conditions for entry in and existing out of the sectors and the standards related to the goods and service. The basic task of the economic regulation is directly related to the question on how to achieve consistency between the main objective of the companies – maximizing profit and public welfare.

The regulation of the energy sector is vested in the Energy Regulatory Commission in the Republic of Macedonia. In order for this Commission to successfully realize this important function, it is necessary:

- To be politically independent and to ensure transparent and fair regulation for all economic entities in the sector – local and international
- The management and other staff must be appointed on the basis of their merit and competencies, professionalism and expertise. Significant breakthrough was made with the adoption of the Law on Energy in 2006 (Article 26). The Law requires that the members of the Energy Regulatory Commission must be experts in the energy sector "...with minimum 10 years of working experience in the last 15 years, whereas in the last five years this experience must be in technical, legal, financial, advisory, economic or academic institutions of the energy sector". However, further specification is needed in the Law on Energy (the section that regulates the Regulatory Body) in order to avoid any ambiguousness and incorrect interpretations.

The process of deregulation and liberalization of the market with electricity, natural gas and heat is directly conditioned with the clear distinction of the production, supply, transmission and distribution. In these circumstances, only the transmission and distribution will remain as a natural monopoly subject to regulation. In the same time, the involvement of the regulators in the prescription of standards (for quality, security, etc.) will become more significant.

The processes of deregulation and liberalization of the electricity market on regional level, emphasize also the problem of the so called global concentration of the transmission capacities – problem that derives from the increased scope and frequency of exchange and trade with electricity. In this constellation of circumstances, we have increasing appetites of the transmission companies for increase of the service price and

[113] UBS Investment Research: European power prices, P. Lekander, A. Gandolfi, S. Comper, A. Wright, November 2007

making large profits (extra profits), to the detriment of electricity consumers or producers of electricity that would like to export electricity. In order to resolve this problem, most of the transmission companies use auctions for rental of the transmission capacities on annual, monthly, weekly, even on daily basis. In this context, it is proposed that the Macedonian transmission system operator – MEPSO should engage in implementing joint procedures for management of the congestions and opening an Office for coordinated allocation of the cross-border transmission capacities[114]. By doing so, the transparency in the work will avoid the artificially created congestions will be and increase the competitiveness and reliability in the transmission and supply of electricity. In order to achieve these goals, but also due to the fact in Macedonia there is already an ongoing process of liberalization of the electricity market (meaning that more and more beneficiaries of electricity will be able to freely choose their supplier of electricity). Macedonia needs, as soon as possible, to introduce an electricity exchange. Being a country which imports large quantities of electricity, Macedonia needs transparent procurements of this fuel type. The selection of the model needs to serve the necessary time period for quick realization of the project. In this sense, it is necessary to analyze the opportunities for opening a regional electricity exchange or access to some of the existing, already developed, exchanges of electricity that would open their platform to Macedonia and for introduction of a national exchange.

The process of deregulation and liberalization of the electricity market is conditioned also with the implementation of the Agreement for Establishment of the Energy Community according to which a market price for electricity and for the natural gas will be introduced by 2015 also for the residential sector.

The Government of the Republic of Macedonia, at its session held on 1st October 2009, has adopted a ***Action Plan*** for further harmonization of the national legislation with the EU legislation in the area of electricity and natural gas[115] which covers most of the above analyzed problems and protection of the socially vulnerable categories of consumers.

The Stabilization and Association Agreement with the European Union Foresees gradual abolishment of the custom duties for import of liquid fuels – by 2011 these will be completely abolished. This will liberalize the market of petroleum products and it will practically become liberalized and will operate in accordance with the principles of the market economy.

8.2.2. Prices policy

The policy for establishment of fuel prices has the crucial role in the improvement of the investment climate in the sector and ensuring its long-term and sustainable development.

Electricity

The world practice knows two basic methods for regulation of the electricity price.

According to the *first method,* the natural monopoly is guaranteed a fixed rate of investment return. This method of price regulation of the natural monopoly is also called a regulation of the profit rate - the World Bank experts use the term cost plus regulation[116]. The greatest weakness of this method can be seen in the fact that it has

[114] According to the Amendments to the Regulation 1228/2003 establishing 8. region and according to the Memorandum of understanding from 2nd March 2009 signed by MEPSO.
[115] Action Plan for further harmonization of the national legislation with the EU legislation in the area of electricity and natural gas, Government of RM, 1st October 2009.
[116] World Bank, July 23 2004, p. 23

negative implications on the efficiency in the work of the economic entities. On top of that, in this method of price regulation, in the regulated company there is tendency for use of as large a capital mass as possible, or for overestimating of the mass of the invested capital, with final intention to increase the base for realization of profit.

The second method is named by the World Bank experts as multi-year tariff mechanism[117]. In this method, the Regulatory Commission sets the price on the level that will enable covering of the costs planned for specific number of years (between 5 to 7 years). After establishing the price for longer period of time, it stimulates the company to reduce the production costs and to increase the profit in the frames of the determined price. After such a time period has expired and the time comes to re-establish the price again, it is established on a lower level (due to the reduction in the costs) which is beneficial for the consumers. This method is preferable for the transitional countries.

In the two methods there is a dilemma on what to take as basis for establishment of the capital costs – the book value or the costs for capital replacement. Since the capital replacement costs have the tendency to increase (as we explained before), the acceptance of this method of expressing the costs will result in an increased electricity price. Therefore, for transitional countries (such as Macedonia) it is more acceptable to show the capital costs through their book value, except if it significantly underestimated according to the International Accounting Standards.

The long term maintenance of the unreal and highly depressed price of electricity in the Republic of Macedonia, as it was already explained, already delivers negative (short-term and long-term) economic implications in the area of production and consumption of electricity, as well as in the area of development of the electricity and power sector.

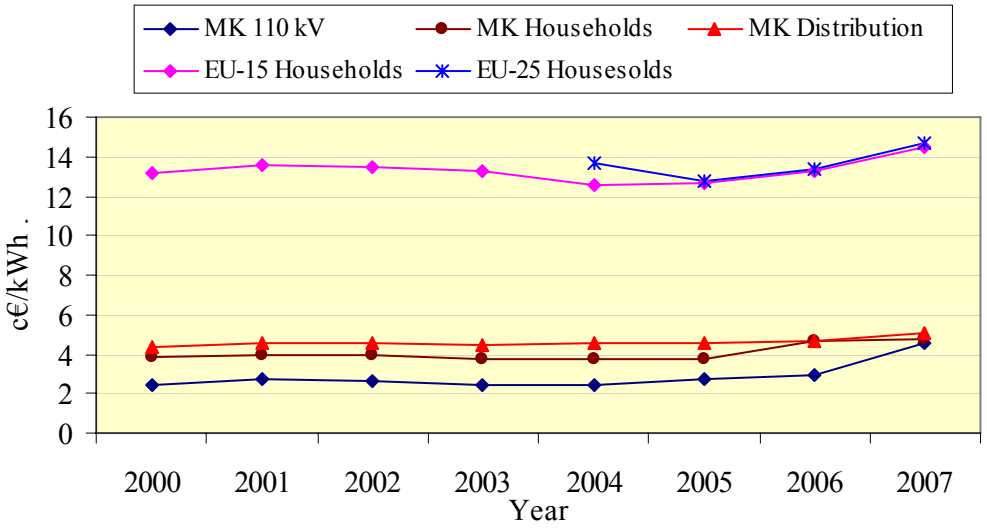

Figure 8.2.2.1. Electricity price tendency in Macedonia and in the EU

The Figure 8.2.2.1 shows the tendency of the electricity price in Macedonia and in the EU[118]. We can see that in the last couple of years the electricity price shows some increase, but it is lagging behind the price of electricity in the EU courtiers. In 2007 the average price of electricity for the residential sector in the Republic of Macedonia is three times smaller than the one for the residential sector sector in the European Union.

[117] multi year tariff mechanism - World Bank, July 23 2004, p. 23

[118] *Eurostat, December 2008 for EU and for the residential sector in Macedonia, Regulatory Energy Commission of the Republic of Macedonia, annual reports for the consumers of 110 kV and of the distribution grid*

The price of electricity for the residential sector in Macedonia is lower also compared to the countries in the region. In Bulgaria it is 50% higher. In Romania, Slovenia, Greece and Croatia it is around two times greater than the price in Macedonia. The electricity price for the households in Macedonia is lower than the price is Serbia and Kosovo.

The electricity price is determined by the Energy Regulatory Commission in accordance with the established methodology. The price approved for the electricity produced, for the transmission and distribution, **should** enable the companies to cover the costs with included fair rate for investment return. In the tariff methodology no subsidies are foreseen, nor welfare or any similar measures.

In 2008 the large consumers were moved into the category of eligible consumers – they will independently purchase electricity per market prices.

After 2015, once the electricity market in Macedonia is fully liberalized, in accordance with the obligations undertaken by the Republic of Macedonia in the Agreement for establishment of the Energy Community, all consumers, including the residential sector, will be entitled to choose their own supplier of fuels and electricity per market conditions from any local or international provider that will be licensed for that activity.

Electricity tariff consumers from the industry and commercial and service sector must be transferred to the category of eligible consumers as soon as possible. The protection of the competition ability of certain industries, if necessary, should be provided by other economic measures. By the year of 2015 the electricity price for the residential sector should grow gradually to the market value in order to prevent the rapid growth in 2015. Together with the electricity price increase for the residential sector it is necessary to activate the measures for protection of the socially endangered electricity consumers. With the current electricity price, all population groups are subsidized, and the poorest 20% get only 3% of the subsidies.[119]

The market price of the electricity is prerequisite for:

- Introduction of the natural gas in the residential and in the commercial and service sector
- Massive use of the solar energy and heat pumps for heat generation
- More intensive investment activity in the energy sector
- Reduction of the electricity consumption
- Better protection of the socially endangered groups.

The electricity price and the social aspects

The process of liberalization of the energy sector, and in this context the electricity energy sub-sector, has the main goal and task to increase the competitiveness between the economic entities in the production and supply with electricity, to contribute to creation of favorable investment climate i.e. attract new investors (local and international) in the sector, to establish real market price of this significantly important fuel, to stimulate rational use of the electricity, to contribute towards the increase of the energy efficiency in the Macedonian economy, etc. The long-term existence of low (distorted) price of electricity, i.e. treatment of electricity as a welfare category, in the previous social-economic system, but also long term afterwards (practically till this very day) aimed at protecting the standard of the residential sector, i.e. the citizens. However, it is now obvious that by 2015 Macedonia will have to introduce market price of the electricity also for the residential sector. It is also obvious that in the meantime the electricity price for the residential sector will increase the will gradually close the gap between the real market price and the regulated price of electricity. The fact that some of

[119] The World Bank Report No. 48983-MK, FYR of Macedonia Energy Policy Note (Draft), june 2009

the residential sector, due to the low income, will not be able to bear the burden of the increased price of electricity imposes the need to introduce relevant mechanisms for protection of the socially threatened categories of the population.

In reality two models are known (mechanisms) for social support of the vulnerable consumers of electricity: block tariff structure and targeted subsidies [120].

The mechanism of the *block tariff structure* assumes low prices of electricity (below the real costs) for socially threatened families that would be compensated with higher prices of electricity for other categories of consumers. The good side of this system is that it does not require additional funds, i.e. additional budget subsidies. The weakness of this system can be seen in the fact that it can cause significant marginal (additional) tariffs, i.e. prices of electricity for other categories of consumers.

The mechanism of *targeted subsidies* is about a certain type of vouchers for payment of electricity by the socially vulnerable groups of people. Its strengths are that it is directly focused towards supporting the poor people and does not cause distortion of the electricity price (different prices for different categories of the population). The weakness is that this mechanism requires additional budget funds that could be problematic from the aspect of budget constraints.

The common disadvantage of these two mechanisms is the problems in the objective identification of the socially vulnerable categories of people.

Macedonia should use the second model. In this regard, no voucher should be issued for the consumers that are socially vulnerable but their bills should be paid directly, with budget funds, for specifically defined amount of consumed electricity for each of the social assistance beneficiaries separately. In order to reduce these costs, the state should finance the improvement of the energy efficiency of the households of the socially vulnerable cases and offer acceptable options for substitution of electricity with natural gas.

Macedonia signed the Memorandum of Understanding on the Social Issues in the context of the Energy Community[121], and it undertook obligation to monitor the effects and undertake measures to reduce the negative social effects related to implementation of the Agreement for establishment of the Energy Community.

Of course, the social aspects related to the electricity price and the price of other fuels is under the responsibility of the Ministry of Labor and Social Policy which needs to resolve these issues in cooperation with the Ministry of Economy, the Ministry of Finance and the Energy Regulatory Commission. The Government of the Republic of Macedonia has adopted ***Social Action Plans***[122] which describe the activities in this sphere in greater details.

The price of other important fuels

Subject to regulation, beside the price of electricity, are also the prices of petroleum products, natural gas, the heat and the geothermal energy.

When regulating the prices and services of other fuels (the prices of production of energy for tariff consumers, supply services for the tariff consumers, as well as the prices of distribution and transmission of energy), the main principle should be the *coverage of the total costs, including reasonable rate for return on the capital.* If there is no compliance to this principle we will have an economic inefficiency and no cost effectiveness. The economic inefficiency can be seen in the fact that the energy

[120] World Bank, July 23, 2004, p. 22

[121] Memorandum of Understanding on Social Issues in the context of the Energy Community, Vienna, 18 October 2007.

[122] Social Action Plans, Government of RM, September 2009

consumers are not motivated to save the energy. The lack of cost efficiency is caused by depressed prices – these create losses for the economic entities in the energy sector which, if we are talking about state owned enterprises, will have to be covered from the state Budget with all the negative consequences that will arise from that – reallocation of the revenues, distortion of the market mechanisms, etc. The Republic of Macedonia already had such experiences. In addition to electricity, this was the case with the petroleum products, which in the 1990s they had depressed price. The assumption was that Macedonia being a small and open economy is subject to strong external shocks, including petroleum products and, therefore, the regulated price of the petroleum products should not be subject to changes. In such situation, the Skopje Oil Refinery was unable to cover the operational costs, was late when paying the excise taxes, etc. On the other side, the depressed prices of energy, as a result of improper regulation, de-stimulate the entry of the private capital (both local and international) in the sector. Therefore, the practice of depressed prices in the energy sector should be thing of the past for Macedonia, i.e. must not repeat in the future. The Law on Energy (Article 20) now obliges the regulators: "...when establishing the prices of specific types of energy and regulated services... to provide the carriers of the licenses with covering of the costs for performing the energy activity and relevant return on the capital".

Article 100 from the Law on Energy explicitly requests, when establishing the prices of the ***petroleum products***, to provide coverage of all costs as well as regulated yield on the capital, paying attention also to the tendencies on the world market of crude oil and petroleum products. Therefore, today in the Republic of Macedonia *the price of petroleum products* is established on a market basis, depending on the price tendencies of these fuels on the international market. The harmonization of the prices on the domestic market, according to the present methodology, is done every two weeks. From environmental aspect, it would good to make significant differentiation of the prices of petroleum products, in the sense of reduction of the fuel prices for cars that pollute less. This can be realized if the Government gives up from one portion of the excise revenues for environmentally cleaner fuels for motor vehicles – in order to reduce the costs which the society is incurring as a result of the increased pollution of the environment.

The Regulatory Commission, when establishing the price of the natural gas, takes into account the following elements: the procurement price of natural gas, the price for trading and supplying the tariff consumers that are directly connected to the system, the price for transmission and management with the system as well as the VAT tax. The Regulator also takes into account the changes in the price of heavy fuel oil and the diesel on the world market and the exchange rate of the denar against the US dollar. The Athens Memorandum requires the establishing of a special regulatory body for the gas. Different solutions are present in the EU countries – somewhere there is special regulatory body and somewhere this is in the hands of the regulatory institutions in charge for the prices of other fuels. Starting from the fact that the Republic of Macedonia is small country, therefore faced with dis-economies from creating numerous regulatory institutions (large costs related to the functioning of the regulators in a situation of relatively small scope of work), we think that it is proper that the regulation of the gas price to remain in the frames of the Energy Regulatory Commission. In this sense, clear distinction between the supply, transmission and distribution, as well as diversity in supply with natural gas from different sources and form different directions are prerequisites for realization of the obligations undertaken with the Agreement for Establishment of the Energy Community, for deregulation and liberalization of the market of natural gas. In these circumstances, only the transmission and distribution will remain as natural monopolies subject to regulation.

For liberalization of the thermal energy market, beside the regulated producers, it is also necessary to have independent producers of heat, distributors of heat, suppliers, beneficiaries (plants) and heat consumers (individual entities in the frames of the plant). The measurement of the heat energy consumed should be on the level of building (plant) connected to the central heating system while the allocation of the total costs for heating of the building should be done on the level of individual consumer in the building by using measurement devices for allocation. The realization of the said pre-requisites for liberalization of the heat market will ensure competitiveness in two key segments – production and supply. The regulated producer will be under competition by independent producer and the suppliers will compete with each other where any building will be able to be supplied with heating energy by any licensed supplier. This creates conditions for improvement in the quality of production, distribution and supply of heat.

The Price of Transmission and Distribution

The transmission and distribution pricing policy for certain types of energy through the measures which are natural monopoly should enable uninterrupted functioning, maintenance and development of these grids, especially of the grids which will be identified as critical infrastructure.

9. OWNERSHIP STRUCTURE OF THE ENERGY SECTOR

In the energy sector there are large production facilities which feature, very often, characteristics of a natural monopoly. In the highly developed countries, the natural monopolies owned by the state were the main practice in Western Europe in the late 1980s, mainly in three sectors: *energy (*electricity, natural gas, water); *telecommunications* and *transportation*[123]. Before the start of the process of privatization of the natural monopolies (in England after 1984 and in other western European countries by the end of the 1980s and during the 1990s) in many western European countries the energy sector was mainly owned by the state. Namely, in the area of electricity and natural gas the state ownership was present with more than 75% in UK, Austria, France and Switzerland and with over 50% in Sweden, Italy and Germany. In the USA the cases of companies with elements of natural monopoly owned by the state are rare (for example, in some cities, including here Los Angeles) there are public enterprises for electricity)[124]. In Japan there are no state companies in the area of energy. In Australia, before the privatization, the state ownership in the energy sector participated with more than 75%. The situation was similar in many other developing countries: Brazil, India, Mexico, etc.

Today, with the opening of intensive processes of deregulation and privatization, the state owned enterprises in the energy sector in the Western Europe are much less present.

In the energy sector of the EU member states there is a ***mixed type of ownership*** whereby the state ownership is more present in the new EU members states (advanced countries in transition) and less present in the EU - 15 member states.

In ***Slovenia,*** for example, the State (directly or indirectly), is dominant owner of all companies producing electricity, except of the nuclear power plant in Krshko where it owns 50% - the remaining 50% belong to the Croatian Government[125].

The case with the **Czech Republic** is especially interesting. In 1992 CzEZ was established – company for production and operating in the area of electricity, with dominant state capital. Soon afterwards there was a separation of the production and the distribution (and 8 distribution companies were established in the process). In the period before 1995 privatization processes in the distribution sector start happening, with the entry of strategic investors. However, the Government adopted special Resolution which stopped the privatization process. The Government also buys back the management package of shares from the owners of the distribution companies in 1999. This also happened in the area of gas. Today, CzeZ is among the five largest companies in Central and Eastern Europe worth around 25 billion USD and present in the distribution in Bulgaria, Romania and Poland[126].

In **the Baltic countries (Estonia, Latvia and Lithuania)**, the energy sector is also predominantly owned by the state – in Estonia it is completely owned by the state. In Latvia the privatization is limited by law and in Lithuania the distribution is privatized.

According to the information from Southeastern Europe Energy Data Statistics, the privatization processes of the energy sector in **Bulgaria** were intensified in the last couple of years – in the area of distribution of electricity there was a penetration of

[123] Dieter Bos 1994, p. 8 – 9
[124] Krugman and Wells 2005, p. 349.
[125] Report on the Energy Sector in Slovenia 2005, Javna agencija Republike Slovenije za energijo, juli 2006, p. 40 -42.
[126] World Energy Council, Energy Sector in the Czech Republic, 2004

Austrian, Czech and German capital and currently ongoing is the privatization of plants and capacities for production of electricity (in Varna, etc.)

The situation is similar in **Romania,** where there was penetration of Czech and German capital. The participation of private companies in the gas sub-sector (Romania is the biggest producer of gas in the South-Eastern Europe) reached 70% compared to the average of around 90% in Central Europe.

In some of the more developed EU member states (**France and Austria),** the state owns significant parts of the energy sector. For example, EDF (Electricite de France) is one of the most reputable energy groups in Europe (absolute leader in France with also a Group with good standing in UK, Germany and Italy) with around 159,000 employees and with almost 60 billion Euros in sales per year – it is dominant ownership of the state – 84.8% of the shares are owned by the state, 13.3% by the general public and 1.9% of the employees in the company[127]. According to the Constitution of **Austria,** the energy company Verbund remains in the ownership of the state with 51%. In order improve the influence by the Government in the work of the Verbund, the Law foresees additional restrictions in the voting rights, related to the 5% of shares with voting rights. The Verbund company in Austria even today is company number one in the area of distribution and, together with six other energy companies they make the Energy Alliance of Austria[128].

The ownership structure in the EE sub-sector in the countries of the immediate economic environment is mainly state owned. In **Serbia,** the State is 100% owner of Elektroprivreda Srbije. In **Montenegro,** the Law on Privatization imposes the obligation that the state retains 55% of the ownership of the Elektroprivreda Crne Gore. In **Croatia,** the Law on Privatization also imposes obligation to retain 51% ownership of the Hrvatska Elektroprivreda and the rest will be privatized after Croatia joins the EU, with a special law on privatization.

9.1. PROFILING THE OWNERSHIP STRUCTURE OF THE ENERGY SECTOR IN THE REPUBLIC OF MACEDONIA

The Republic of Macedonia, de facto, accepted a model of **mixed ownership** in the energy sector, such as the case in many other countries in the world. EVN Macedonia AD company is mainly privately owned, soon in Macedonia a private gas power plant will be built, the private sector is involved in the distribution and production of the heat, in the transmission of natural gas, construction of natural gas distribution networks, and, furthermore, the deregulation enables participation of the private capital in the construction of new energy facilities, etc.

When making a decision about the profiling of the future ownership structure in the energy sector in the Republic of Macedonia, we need to especially take into account the strengths and weaknesses of the state and private ownership.

The strongest argument against the existence of the state enterprises (including those in the energy sector) is their lower economic efficiency compared to the private companies. The following are the most important reasons and sources of inefficiency in the state enterprises[129]:

- the lack of motive for profit and the existence of the phenomena of the soft budget limitation;
- misuse of the public procurements and the relevant wastage;

[127] EDF website
[128] http:// iflr.com/Article/2027046, 2008
[129] Stiglitz 2005, str. 202 -208; Bos 1994, p. 5 -6; Boyes and Melvin 2005, p.651

- staff limitations; budget constraints, bureaucratic procedures and risk aversion;
- the state (the government) controls these enterprises directly or indirectly, setting the prices of their products or services at a low level thus creating losses which must be covered thus causing inefficient resource allocations;
- cost-benefit analysis – this analysis in large infrastructural facilities often shows economic efficiency but their construction takes long time and is connected to occurrence of unexpected, hidden costs;
- the state enterprises are less profitable since they create over-employment and are focused towards assisting the local population and the citizens, etc.

The arguments in favor of existence of the state enterprises are commonly the following:

- the state enterprises with elements of natural monopoly make products which are of vital importance for the national economy (such is the case with the energy);
- if the Government (the relevant Ministry) appoints capable managers and obliges them to do efficient work with clear management contracts which include both penalties and awards, this can make efficient the state enterprises;
- deregulation and privatization which, in fact, means transfer of the natural monopoly from state into private hands, if it is not accompanied with good regulation, i.e. re-regulation, can cause significant negative repercussions – incredibly high prices, bad quality of goods and service, non-compliance to other standards (environmental, security, etc.).

On the other hand, the maintenance, the modernization and development of the energy system requires large capital investments (the costs for electricity production in the last 3-4 years all over the world have increased from 30 to 60%, depending on the used fuel and technologies) and therefore the attraction of the foreign capital in the **energy sector is a must for a small country with limited resources** (natural, material, financial). On top of this, the foreign investments in the energy sector have also a lot of advantages:

- it eases the gap between the power of the national accumulation and the desired investments rate, not only in the energy sector but also in the overall economy, through non-credit sources of financing;
- if the country establishes good and fair regulation, including concessions, efficient protection of the property rights and if the Euro-Atlantic processes are de-blocked, and in a situation of evident energy deficiency in the region, the flow of the foreign capital in the energy sector in Macedonia can be significant. It will contribute to a stable and sustainable development for the Macedonian economy;
- in general, the private companies are more efficient and the foreign capital can also contribute towards transfer of the new knowledge in the country (from the aspect of production, energy efficiency, management, etc.);
- the foreign capital will also contribute towards increase in the competition and it will be an incentive for better work of the state owned enterprises.

The above mentioned experiences regarding the ownership structure in the area of energy (especially electricity), in different countries, confirm several things: **firstly,** the state owned enterprises in the energy sector can be also profitable and efficient (the case of France, Austria, Czech Republic); **secondly,** the privatization in the energy sector,

especially in the area of electricity in the transitional countries that have become EU members is either lacking (Estonia, Czech Republic) or it is slow and cautious (Slovenia, Latvia and Lithuania); **thirdly,** more intensive processes of privatization in the energy were opened once the countries have become EU member states (Bulgaria and Romania); **fourth,** the Croatia experience (which is an EU candidate country and negotiates with the EU for membership) confirms that it prolongs the privatization of the HEP for the period after becoming EU member. In this sense, important are the following

Recommendations:

First, The privatization is not, and it must not be, a purpose for itself. The privatization has *raison d'etre* only if the energy facilities are unable to work with profitability and efficiently, if they cannot secure sufficient funds for maintenance, modernization and expansion of the facilities.

Second, The Republic of Macedonia should be active in attracting foreign capital in the energy sector. The increase of the competitive pressure in the energy sector and increase of its economic efficiency necessarily presuppose an increased activity for attraction of foreign capital in the sector. On one hand, this is an imperative for a small country with limited resources - due to the fact that the maintenance, modernization and development of the energy system require large capital investments. On the other hand, the reliance on the foreign capital brings many advantages for the economy which was emphasized in the text above. In the meantime, the entry of the private capital (both local and international) in construction of new production capacities, new coal thermal power plants and coal mines, natural gas fired combined heat and power plants, small hydropower plants, wind power plants, etc., need to be supported and stimulated also with the measures of the economic policy (especially when it is about the use of renewable energy sources).

Third, Macedonia will objectively be forced to use all possible sources of financing in the energy sector: ownership financing, indebtedness, state grants, further capitalization, concessions, public-private partnership and other innovative approaches. ***The selection of the specific form of financing will depend on the characteristics of the actual project and the implemented analysis of the strengths and weaknesses.***

Fourth, the final result from implementation of these recommendations will enable: **(a)** involvement of the private sector in the energy market in Macedonia will increase which will, in turn, develop the individual-private initiative and the entrepreneurship in the sector, its further liberalization and de-monopolization, etc.; **(b)** increased involvement of private capital (both local and international) in the energy sector will be a factor contributing towards the economic development of the country.

10. VISION FOR DEVELOPMENT OF THE ENERGY SECTOR BY 2030

10.1. THE DEMAND FOR FINAL ENERGY IN THE PERIOD 2020-2030

10.1.1. The demand for final energy in the period 2020-2030, per sectors

Basline scenario

The total consumption of the final energy by 2030 (Table 10.1.1.1 and Figure 10.1.1.1) will be increase at an average annual rate of 2.48% and will be 3346 ktoe in 2030. The total increase is 27.8%, i.e. the demand will increase by 728 ktoe in reference to 2020. The greatest increase can be again seen in the transport sector and in the agriculture and forestry.

Table 10.1.1.1. Final energy demand by 2030, according to the baseline scenario (ktoe)

	ktoe											%	
	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	P1	P2
Industry	794	822	848	869	892	913	933	951	969	983	996	2,30	25,5
Residential	760	773	787	800	813	826	839	852	865	878	891	1,60	17,2
Comm. and service	313	322	330	339	348	357	365	374	382	389	397	2,40	26,8
Transport	663	694	725	756	787	816	844	871	897	922	945	3,61	42,6
Agr and Forestry	59	65	69	72	74	77	79	82	84	86	88	4,00	48,0
Non-energy use	29	29	29	29	29	29	29	29	29	29	29		
TOTAL	2618	2705	2788	2866	2943	3018	3089	3159	3225	3287	3346	2,48	27,8

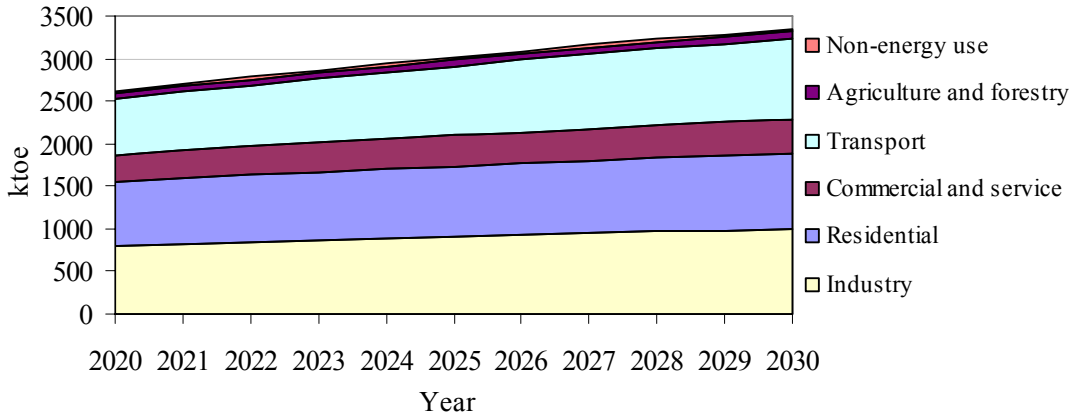

Figure 10.1.1.1. Needs for total final energy by 2030 according to the baseline scenario (ktoe)

In the period 2020 - 2030 there won't be significant change in the relative participation of the sectors in the energy consumption. The relative participation of the industry will decrease from 30.3% to 29.8%, of the residential sector from 29% to 26.6%, commercial and service sector from 12% to 11.9% and the non-energy consumption from 1.1% to 0.9%. The transportation sector in the same period will increase its participation in the consumption from 25.3% to 28.2% and the agriculture and forestry from 2.3% to 2.6%.

Scenario with strengthened measures for energy efficiency

According to the scenario with strengthened energy efficiency measures, the final energy demand will increase at an average annual rate of 2.3%, and in 2030 they will reach 3101 ktoe (Figure 10.1.1.2 and Table 10.1.1.2) which is 245 ktoe (7.3%) less than the consumption foreseen by the baseline scenario.

Table 10.1.1.2 The demand for total final energy by 2030 according to the scenario with strengthened energy efficiency measures (ktoe)

	ktoe											%	
	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	P1	P2
Industry	758	776	796	815	833	851	868	883	897	910	920	1,96	21,4
Residential	745	756	768	780	791	803	815	826	838	849	860	1,45	15,5
Comm. and service	292	298	305	311	317	324	330	336	342	347	353	1,90	20,7
Transport	575	604	633	662	691	719	746	772	797	821	844	3,91	46,8
Agr and Forestry	67	72	76	79	82	85	87	89	91	93	95	3,60	42,4
Non-energy use	29	29	29	29	29	29	29	29	29	29	29		
TOTAL	2466	2536	2607	2676	2743	2811	2874	2936	2994	3050	3101	2,32	25,8

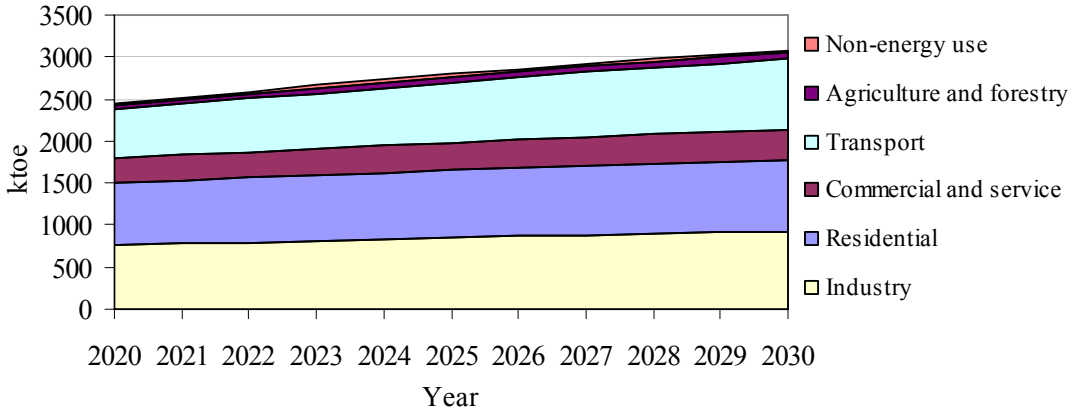

Figure 10.1.1.2. The demand for total final energy by 2030 according to the scenario with strengthened energy efficiency measures

10.1.2. The demand for final energy in the period 2020-2030, by fuels

Baseline scenario

The final energy demand by fuels, by 2030, according to the baseline scenario, is shown on Figure 10.1.2.1 and Table 10.1.2.1.

The largest growth rate can be seen in the natural gas of 9.8%, followed by the geothermal energy 3.5%, solar energy with 3.3% and petroleum products 2.75%. The electricity and coal have growth rates of 2.1% и 2.0%, respectively. The heat consumption will remain on almost the same level and in the biomass there is a slight reduction with a rate of 0.8%.

The consumption of electricity shall increase by more than 2300 GWh (200 ktoe) – from almost 10050 GWh (864 ktoe) in 2020 to around 12370 GWh (1064 ktoe) in 2030.

Table 10.1.2.1. Final energy demand by 2030 according to the baseline scenario (ktoe)

	ktoe											%	
	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	P1	P2
Electricity	864	892	918	941	961	980	999	1017	1036	1050	1064	2,11	23,2
Heat	140	141	142	142	142	143	143	143	144	144	144	0,27	2,8
Petroleum prod. and biof.	1093	1132	1170	1208	1245	1281	1314	1346	1377	1407	1435	2,75	31,2
Natural gas	98	109	121	135	151	168	185	202	218	234	250	9,80	154,7
Coal	147	152	155	158	162	165	168	171	174	176	179	2,00	21,9
Biomass for comb.	236	236	235	234	232	230	228	226	224	221	218	-0,76	-7,3
Geothermal	34	39	41	43	43	44	45	46	47	48	49	3,50	41,0
Solar	5,2	5,6	5,9	6,2	6,4	6,6	6,8	6,9	7,0	7,0	7,1	3,27	37,9
TOTAL	**2618**	**2705**	**2788**	**2866**	**2943**	**3018**	**3089**	**3159**	**3225**	**3287**	**3346**	**2,48**	**27,8**

By 2030 the petroleum products together with the biofuels will increase the participation in the total consumption of the final energy compared to 2020 from 41.8% to 42.9%. In the same period, the participation will mainly increase for the natural gas – from 3.7% to 7.5%. The participation of the geothermal energy will increase from 1.3% to 1.5% and solar energy will remain on the same level with a rate of 0.2%. The electricity will reduce its share from 33% to 31.8%, heating will drop from 5.3% to 4.3%, biomass for combustion from 9% to 6.5% and the coal from 5.6% in 2020 to 5.4% in 2030.

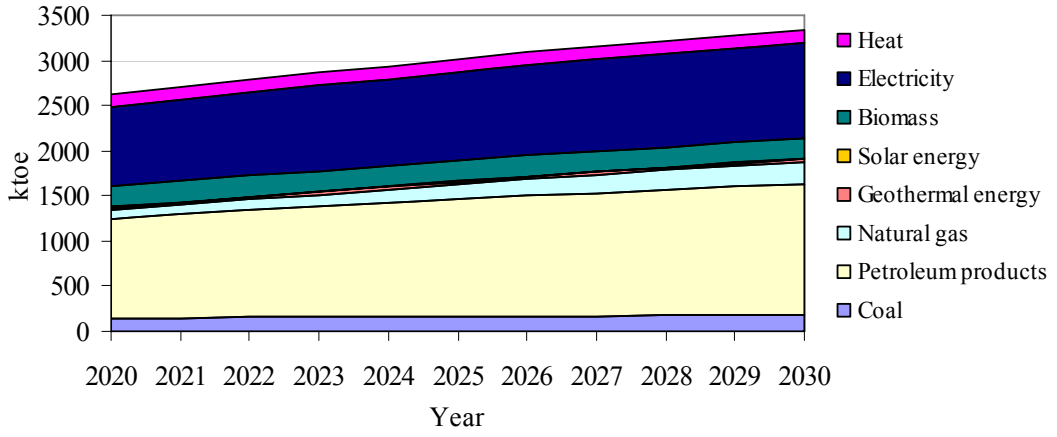

Figure 10.1.2.1. Final energy demand by 2030 according to the baseline scenario

Scenario with strengthened energy efficiency measures

According to this Scenario (Table 10.1.2.2), the electricity consumption in 2030 will be 12% less than the consumption foreseen in the baseline scenario. The electricity consumption in 2030 will reduce its participation in the total final energy consumption by additional 1.3% in relation to the baseline scenario and petroleum products by 1%. The percentage participation of the heat, coal and geothermal energy in 2030 will remain almost the same as in the baseline scenario. The percentage share of natural gas in 2030 will increase in relation to the baseline scenario by additional 1% and the solar energy by

additional 0.2%. The participation of the biomass for combustion will be reduced less than compared to the baseline scenario – in 2030 it will be 7.3%.

Table 10.1.2.2. Final energy demand by 2020 according to the scenario with strengthened energy efficiency measures (ktoe)

	ktoe											%	
	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	P1	P2
Electricity	807	823	839	853	867	880	893	904	916	927	937	1,50	16,1
Heat	137	137	137	138	138	138	138	138	138	139	139	0,14	1,4
Petroleum prod. and biof.	971	1008	1044	1079	1114	1149	1181	1213	1244	1274	1300	2,97	33,9
Natural gas	130	141	154	167	182	196	211	225	238	251	263	7,28	101,8
Coal	141	143	146	150	153	156	159	162	164	165	166	1,64	17,7
Biomass for comb.	227	227	227	227	226	226	226	226	226	226	226	-0,05	-0,5
Geothermal	45	48	50	51	53	54	54	55	55	56	56	2,38	26,6
Solar	7,7	9,0	10,0	10,8	11,5	12,1	12,4	12,7	13,0	13,2	13,3	5,70	74,0
TOTAL	**2466**	**2536**	**2607**	**2676**	**2743**	**2811**	**2874**	**2936**	**2994**	**3050**	**3101**	**2,32**	**25,8**

10.2. POSSIBILITIES FOR MEETING THE ELECTRICITY AND HEAT NEEDS IN THE PERIOD 2020-2030

10.2.1. Electricity

Possible production plants that could be put into operation in the period 2020 – 2030, that were subject to analysis, were two lignite thermal power plants (TPP Mariovo and TPP Negotino) of 300 MW each, a nuclear power plant of 1000 MW and the hydro power plant Veles, whose basic characteristics are shown in the Tables 6.1.1.1 to 6.1.1.6. The thermal power plants will be supplied with lignite from the planned mines with pit exploitation in Mariovo and in Negotino.

The small hydro power plants, the solar power plants, and CHP for production of electricity and heat by biomass for combustion are taken integrally, with development dynamics of 50 MW each and with production of 140 GWh (12 ktoe) per year, every 5 years (2025, 2030). This dynamics of development of these RES means that, in 2030 their total power will be 200 MW and their production will be 560 GWh (48 ktoe) per year. In addition, the plan is to install 180 – 360 MW wind power plants by 2030 with annual generation of 360 – 720 GWh. Because of the necessary reserve power for them, this generation will contribute mainly for fuel savings in the thermal power plants and only partly in the energy balance when used in combination with storage hydropower plants.

For all development scenarios, the import of electricity is considered as plant with power of 500 MW which is available to use for coverage of the demand for electricity in the EPS of Macedonia.

The following three scenarios are analyzed for the reporting period:

- Scenario 1 (S1): Increase in the consumption by 2.5% and construction of lignite thermal power plant
- Scenario 2 (S2): Increase in the consumption by 3.0% and construction of lignite thermal power plant
- Scenario 3 (S3): Increase in the consumption by 3.0% and with nuclear option.

According to these three scenarios, in 2021 the Veles hydro power plant will be put into operation (Table 10.2.1.3).

In the first scenario the plan is to put into operation the coal thermal power plants in Mariovo in 2022 and in Negotino in 2024. Both of these thermal power plants have maximum power of 300 MW each and with maximum annual production each of around 2000 GWh (172 ktoe).

The second scenario differs from the first one only in the fact that the Mavrovo thermal power plant will be put into operation one year earlier.

The third scenario plans to build nuclear power plant of 1000 MW and maximum production of around 7500 GWh (645 ktoe) that will be put into operation in 2026.

Table 10.2.1.3. Timeframe for construction of the new production plants in Macedonia for all three scenarios

	SCENARIO 1	SCENARIO 2	SCENARIO 3
	Consumption 2.5%	Consumption 3.0%	Consumption 3.0%
	Strategy LIGNITE	Strategy LIGNITE	Strategy NPP+LIGNITE
2021	HPP Veles	HPP Veles, TPP Mariovo	HPP Veles
2022	TPP Mariovo		
2024	TPP Negotino	TPP Negotino	
2026			NPP 1000

The period after 2020 is featured with replacement of the existing thermal power plants with new base electricity plants for production of base energy. The current lignite thermal power plants (Bitola 1, 2, 3 and Oslomej), as well as the heavy crude oil TPP Negotino are about to enter their final period of their life cycle (around 40 years). In this period the expectations are that these plants will drop out from production, except Bitola 3 which was the one that entered the last in the EPS of Macedonia (1988). The working expectations for Bitola 3 is by 2030 and the schedule for going offline of the existing thermal power plants is as follows:

- Scenario 1 and Scenario 2: Negotino in 2021, Oslomej in 2023, Bitola 1 in 2024 and Bitola 2 in 2026.
- Scenario 3: Negotino, Oslomej, Bitola 1 and Bitola 2 in 2026.

The production of electricity, at average hydrology for all three scenarios, is shown in the Tables 10.2.1.4, 10.2.1.5 and 10.2.1.6.

Table 10.2.1.4. Production for average hydrology, in GWh of specific plants for the Scenario 1

	GWh										
	Bitola	Oslomej	Heavy fuel oil	Gas SK.+ KOGEL	Gas Energetika	Bitola 4	Negotino	Mariovo	Import	Hydro	Total
2020	3700	502	160	1546	1253	1690	0	0	2	2989	11842
2021	3758	486	0	1564	1251	1667	0	0	3	3287	12016
2022	3689	404	0	1158	772	1579	0	1427	0	3287	12316
2023	3564	0	0	1354	1150	1697	0	1574	3	3287	12629
2024	2504	0	0	1336	1081	1679	1438	1619	0	3287	12944
2025	2610	0	0	1321	1217	1728	1492	1615	2	3427	13412
2026	1358	0	0	1696	1559	2073	1785	1842	9	3427	13749
2027	1363	0	0	1744	1651	2096	1839	1972	2	3427	14094
2028	1365	0	0	1805	1766	2114	1919	2039	9	3427	14444
2029	1368	0	0	1828	1884	2123	2006	2094	75	3427	14805
2030	1368	0	0	1857	1965	2130	2047	2107	135	3567	15176

Table 10.2.1.5. Production for average hydrology, in GWh of specific plants for the Scenario 2

	GWh										
	Bitola	Oslomej	Heavy fuel oil	Gas SK.+ KOGEL	Gas Energetika	Bitola 4	Negotino	Mariovo	Import	Hydro	Total
2020	3758	563	366	1657	1471	1802	0	0	10	2989	12616
2021	3821	442	0	1249	939	1675	0	1451	0	3287	12864
2022	3809	452	0	1329	1046	1721	0	1596	8	3287	13248
2023	3858	0	0	1562	1374	1848	0	1702	20	3287	13651
2024	2647	0	0	1558	1330	1884	1609	1731	14	3287	14060
2025	2640	0	0	1592	1435	1996	1699	1847	5	3427	14641
2026	1368	0	0	1853	1956	2130	2041	2105	199	3427	15079
2027	1384	0	0	1902	2040	2136	2084	2119	440	3427	15532
2028	1432	0	0	1934	2093	2137	2108	2131	734	3427	15996
2029	1432	0	0	1980	2148	2170	2120	2137	1054	3427	16468
2030	1432	0	0	1984	2197	2210	2132	2137	1284	3567	16943

Table 10.2.1.6. Production for average hydrology, in GWh of specific plants for the Scenario 3

	GWh									
	Bitola	Oslomej	Heavy fuel oil	Gas SK + KOGEL	Gas Energetika	Bitola 4	NPP	Import	Hydro	Total
2020	3758	563	366	1657	1471	1802	0	10	2989	12616
2021	3826	461	364	1653	1460	1795	0	17	3287	12863
2022	3919	475	424	1696	1592	1823	0	32	3287	13249
2023	3915	603	491	1742	1708	1882	0	23	3287	13650
2024	4086	614	505	1781	1810	1956	0	21	3287	14060
2025	4142	634	612	1853	1896	2041	0	30	3427	14635
2026	1060	0	0	1294	1177	1468	6654	3	3427	15083
2027	1074	0	0	1309	1208	1485	7022	8	3427	15533
2028	1168	0	0	1340	1333	1659	7066	7	3427	16000
2029	1186	0	0	1480	1436	1759	7190	2	3427	16480
2030	1193	0	0	1580	1547	1846	7236	5	3567	16974

As we can see from the tables, with the realization of the Scenario 1, with average rate of increase in the consumption of 2.5%, the production capacities will satisfy the demand for electricity with average hydrology with a small net import that will grow to around 3% by 2030. In the case of dry hydrology, the net import by 2030 will reach up to around 1500 GWh, (129 ktoe) i.e. around 10% from the total electricity consumption.

If the consumption of electricity in the period 2020 - 2030 takes place in accordance with the analysis in the baseline scenario with average annual growth rate of 2.11%, then the consumption of electricity in 2030 will be almost 500 GWh (43 ktoe) lower and in the case of average hydrology would be equal to the production.

According to the scenario with strengthened energy efficiency measures, the consumption of electricity in 2030 would be less by an additional 1500 GWh (129 ktoe). In that case the production of electricity would meet the demand even in the case of dry hydrology. If this scenario of electricity consumption happens, than the construction of one of the coal thermal power plants could be moved to several years later.

In the realization of the second scenario, where we analyze the increase in the consumption of electricity by 3% and construction of coal thermal power plants, the import of electricity after 2026 will increase also in the case of average hydrology, reaching an amount of over 1300 GWh (112 ktoe) in 2030. In the case of dry hydrology

the import of electricity in 2030 would be around 2700 GWh, (232 ktoe) i.e. around 16% from the total consumption.

If the scenario with construction of the nuclear power plant is realized, the demand for electricity at average hydrology would be met also in the case of increase of consumption with an annual rate of 3%.

The nuclear option is a realistic possibility for development of the electric and power system of Macedonia after 2025. Potential location for construction of the nuclear power plant is Mariovo. The Mariovo location is proper from the aspect of water supply for cooling from the planned hydro-power complex Chebren and Galishte. The hydro-nuclear energy production center Mariovo would have an advantage that it will consume part of the electricity produced to pump the water when the electricity is cheap and would produce in the reversible power plant when it is more expensive.

According to the calculations included in the section 6.1.1, the price of the electricity produced is around 5.3 c€/kWh for the nuclear power plant and 4 c€/kWh for the thermal power plants. However, we need to take into account that in the option which includes lignite thermal power plants, significant import of electricity will be required the price of which is not expected to be below 7 c€/kWh.

The nuclear option will have even greater advantage in relation to the coal thermal power plants, if the price that will be paid for the emission of greenhouse gasses reaches high values and if the technologies for production of electricity by using coal without emissions of greenhouse gases are not commercially available at competitive prices by that period.

The nuclear option will provide greater diversity as well as reliability in the supply of electricity. Around 40% of the electricity could be produced from the nuclear power plant, 23% from the renewable energy sources, 22% from the combined power plants running on natural gas and 15% from the lignite thermal power plants.

Certainly, detailed analyses have to be performed in order to consider the different aspects (environmental, safety, public opinion etc.), before making the decision whether Macedonia will construct a nuclear power plant and where. In that context, it is necessary to form a body that would prepare all the studies required to make the decision, as soon as possible. Having in mind the relatively long construction period for a nuclear power plant, it is recommended that this decision (positive or negative) is made by 2012.

10.2.2. Heat

According to the baseline scenario, the consumption of heat in the period 2020-2030 will be increased in total by less than 3%, from 1628 GWh (140 ktoe, 5861TJ) in 2020 to 1673 GWh (144 ktoe, 6023 TJ) in 2030. According to the scenario with strengthened energy efficiency measures, the total increase in the reporting period is 1.4% in 2030, and the total heat consumption will be 1612 GWh (139 ktoe, 5803 TJ).

Since, by that period the obsolete coal boilers will be replaced with new combined plants running of biomass and natural gas, and in the considered period the natural gas will be introduced and replace some of the petroleum products, the total coefficient of energy efficiency will increase, so the primary energy consumption for production of heat will remain on almost the same level or around 2135 GWh (184 ktoe, 7686 TJ).

10.3. THE DEMAND FOR PRIMARY ENERGY IN THE PERIOD 2020-2030 AND THE POSSIBILITY FOR MEETING THIS ENERGY NEEDS

The demand for primary energy are obtained by collecting the necessary primary energy for production of electricity and heat, and the primary energy required for the fuels which are consumed in the same form as final energy.

The Table 10.3.1 shows the demand for primary energy in the considered period (2020-2030) according to the **baseline scenario**. The average annual rate of increase of the primary energy will be 2.1% (P1).

Table 10.3.1. Needs for primary energy by 2030 according to the baseline scenario (ktoe)

	ktoe											%	
	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	P1	P2
Coal	1645	1666	1924	1841	1870	1936	1787	1820	1835	1853	1869	1,28	13,6
Oil and petrol.prod.	1333	1273	1310	1344	1383	1421	1458	1488	1520	1547	1572	1,66	17,9
Natural gas	674	750	810	870	920	960	995	1027	1043	1063	1082	4,85	60,5
Biomass for combust..	249	267	266	265	264	263	262	261	260	259	258	0,37	3,7
Hydro	251	277	277	277	277	286	286	286	286	286	295	1,62	17,4
Geothermal	38	43	45	47	48	49	50	51	52	52	53	3,50	41,0
Solar	7	8	9	10	11	12	13	14	16	18	20	11,07	185,7
Wind	15	16	17	18	20	22	24	26	28	30	31	7,53	106,7
Electricity	0	0	0	0	0	0	1	0	1	6	12		
TOTAL	**4211**	**4299**	**4657**	**4672**	**4793**	**4948**	**4876**	**4973**	**5040**	**5114**	**5192**	2,11	23,3

We can notice that the use of renewable energy sources is increasing. There is greatest growth rate in the use of solar energy – 11% and in 2030 it will increase to 20 ktoe. The use of wind energy will grow at a rate of around 7.5% thus reaching the value of 31 ktoe in 2030. The use of the geothermal energy will also increase at the average rate of 3.5%, i.e. by 41% in total. Slight increase can be seen in the use of hydro power which is used for production of electricity. The biomass for combustion will continue to be used at almost the same level.

The consumption of primary energy, according to the **scenario with strengthened energy efficiency measures**, relevant to the final energy demand in this scenario, in 2030 will be less by 2.8% (143 ktoe) from the consumption in the baseline scenario – it will be 5049 ktoe.

The ratio between the consumption of the final energy and the consumption of the primary energy, according to the baseline scenario, will gradually increase with the inclusion of the new thermal and hydro power plants with high efficiency rate and from 62% in 2020 it will reach 64% in 2030.

The demand for **coal** mainly depends from the scenarios for production of electricity. The table 10.3.1 shows the demand for coal if the scenarios for construction of coal thermal power plants are realized. These will be secured with coal from the closest mines with pit exploitation. The analyses show that, similar to the Zhivojno mine, the production price of the coal in these mines is around 14 - 16 Euros per ton[130] and is quite lower compared to the price of imported coal of same quality.

If the scenario for construction of the nuclear power plant is realized, in the period after 2026, only Bitola 3 and Bitola 4 will remain from the coal thermal power plants.

[130] Зоран Деспотов и др., Подземна експлоатација на јаглените во Пелагонискиот регион со примена на современи технологии, Зборник на трудови, Тркалеста маса: РЕК Bitola потреби и можности за континуирано обезбедување со јаглен, Bitola, 2008.

Around 600 - 700 ktoe of coal is needed for their operation. These will be secured from the surface mines and from the Zhivojno mine with pit exploitation.

The consumption of the coal used as final energy in the sector will be in the range of 147 ktoe to 180 ktoe. These will be secured from our lignite mines for wide consumption and from imports.

The necessary quantity of **petroleum products** in the amount from 1340 ktoe to 1570 ktoe is in the frames of the capacity of the OKTA refinery and the existing oil pipeline. What will be the level of import of oil or petroleum products will depend on the competitive ability of OKTA.

It is estimated that 20% from the total consumption of petrol and diesel fuels will be replaced with biofuels to 2030.

The demand for **natural gas** will increase up to 1350 million Nm^3 in (1083 ktoe) 2030. This consumption does not take into account the two planned gas power plants – heating plants of Toplifikacija AD, Skopje Sever AD, with total consumption of the natural gas of 390 million Nm^3 (313 ktoe) per year as well as some number of small plants that are planned. Since up to that period the regional connection will be implemented with a new gas pipeline, we cannot neglect the construction of the said plants that are planned, which will increase the consumption of natural gas by 2030 which will be around 1800 million Nm^3 (1445 ktoe) per year.

10.3.1 Renewable Energy Sources

Hydropower

The Strategy plans for the construction of 7 new large hydropower plants in the period to 2030 (HPP Sv. Petka, HPP Boshkov Most, Lukovo Pole with HPP Crn Kamen and HPP Galishte, HPP Gradec, HPP Chebren and HPP Veles) regardless on the scenario realized on the period until 2020. With these, the electricity generation from large hydropower plants would be around 2920 GWh (251 ktoe).

Until 2030 it is realistic to expect construction of a total of 160 MW of small hydropower plants with annual generation of 420 GWh (36 ktoe). The optimistic scenario envisages construction of 240 MW of small hydropower plants with generation of 620 GWh (53 ktoe) per year which is close to the total potential of the possible 400 locations. If we include the existing generation of small HPP, the total generation of small HPP in 2030, in average hydrology conditions would be 510 – 710 GWh (44-61 ktoe) per year.

Besides the above mentioned, it is realistic to expect construction of some of the remaining 10 HPP in the Vardar valley (except HPP Veles and HPP Gradec) with possible annual generation of around 780 GWh (67 ktoe).

According to above, until 2030 it is planned to use the hydropower in amount of 3430 – 4410 GWh (295-379 ktoe) per year which is 62 – 80% from the available technical potential[131].

Wind energy

Based on the past investigations we can reasonably expect construction of 180 – 360 MW of wind power plants until 2030 with annual generation of 360 – 720 GWh (31-62 ktoe). The planned wind power plants would not exceed 10% of the planned capacity for electricity generation in Macedonia by 2030.

[131] Study of Electrotek and MASA on the energy potential of Macedonia.

Photovoltaic Solar Energy

The Strategy envisages construction of a total of 20 – 40 MW of photovoltaics by 2030 with annual generation of 28 – 56 GWh (2.4-4.8 ktoe).

Waste biomass for combined heat and power generation

According to our estimates it is possible to construct a total of 10 – 14 MW to 2030 with an annual production of 50 – 70 GWh (4.3-6 ktoe).

Biogas

The potential for electricity generation from biogas has also not been sufficiently investigated. The Strategy envisages that these facilities will have a total power of 10 – 15 MW to 2030 with an annual generation of 30 – 45 GWh (2.6 – 3.9 ktoe).

Biomass for combustion

The planned utilization of biomass for combustion will not change significantly compared to 2020.

According to the baseline scenario, the consumption of biomass for combustion, which will be used as heat, in 2030, will be 218 ktoe (2540 GWh) which is approximately equal to the available potential.

The scenario with strengthened energy efficiency measures envisages consumption of biomass for combustion with the above mentioned purpose to be 226 ktoe (2630 GWh) in 2030.

If the waste biomass for combined heat and power production, which is planned to 26 – 40 ktoe, is taken into account, then the consumption of biomass for combustion in 2030 will be 252– 258 ktoe (2930 – 3000 GWh).

Solar Energy as Heat

The strategy envisages utilization of solar power as heat primarily in the residential sector. Until 2030, 80000 - 150000 installations in the residential sector are planed and the total utilization of solar power (together with the commercial sector and industry) would be 83 – 155 GWh (7.1 - 13.3 ktoe) per year.

Geothermal energy

Geothermal energy as final energy is planned at the level of 560 – 660 GWh (48 – 57 ktoe, 2016 – 2376 TJ) until 2030. Geothermal energy will participate in the primary energy consumption in 2030 with 620 – 730 GWh (53 – 53 ktoe, 2232 – 2628 TJ).

Biofuels

The share of biofuels in 2030 is assessed to the amount of at least 20% of the total petrol and diesel fuel consumption in the traffic. The share of these fuels should be 1700 - 1900 GWh (145 – 163 ktoe).

10.3.2. Share of the Renewable Energy Sources in Final Energy Consumption and Electricity Generation

Table 10.3.2.1 presents the share of RES and the final energy consumption (FEC) for the lowest limits (LL), the highest limits (UL) and the planned values (PV). The percentage share of RES in Macedonia, in 2030 will be between 21.1% and 27.7% with average value (realistically achievable) of nearly 25%.

Table 10.3.2.1. Share of the renewable energy sources in the final energy consumption (GWh)

	2030 LL	2030 UL
Electricity from RES	**3898**	**5301**
Hydro power plants	3430	4410
Large hydro power plants	2920	3700
Small hydro power plants	510	710
Wind power plants	360	720
Photovoltaics	28	56
Biomass	50	70
Biogas	30	45
Heat from RES	**3183**	**3445**
Biomass	2540	2630
Solar energy	83	155
Geothermal energy	560	660
Biofuels	**1700**	**1900**
TOTAL RES	**8781**	**10646**
Final energy consumption	**41710**	**38560**
RES share (%)	**21,1**	**27,6**

There are no real potentials for more significant increase of the hydropower compared to the upper limit shown. The wind potential of Macedonia will hardly exceed the value of 360 MW. That would mean construction of wind power plants of 50 MW each on seven locations. The photovoltaics, considering their price, are already planned very optimistically. Even in case of increase of the utilization of the waste biomass, biogas and solar energy as heat in amount double than the optimistic value, which is hardly achievable, the RES share in the final energy consumption would increase by only 0.6 percentage points.

If Macedonia is imposed a goal to increase the share of RES to more than 27.6%, additional efforts will have to be made mainly for reduction of the final energy consumption and greater utilization of the biomass and geothermal energy. For every percentage point of increase of RES it is necessary to have additional 400 GWh of energy from them or saved in the final consumption.

Considering an electricity generation growth with an average annual rate of 3%, 2% and 2.5% and electricity generation from RES according to the LL (3898 GWh, table 10.3.2.2) UL (5301 GWh) and their average value (4600 GWh) the percentage share of RES in the electricity generation in 2030 would be 23.0%, 39.3% and 30.3% respectively.

Table 10.3.2.2. Share of the renewable energy sources in the electricity generation

Electricity from RES	2020 LL	2020 UL	2020 PV
GWh	**3898**	**5301**	**4600**
Total electricity generation with growth rate	3%	2%	2,5%
GWh	**16955**	**13482**	**15159**
RES share (%)	**23,0**	**39,3**	**30,3**

11. FINANCIAL SUPPORT REQUIRED FOR REALIZATION OF THE ACTIVITIES PLANNED

The funds necessary for implementation of the activities foreseen by the Strategy are provided in the Table 11.1.

Table 11.1. Funds necessary for realization of the strategy

Activity	Funds (million euros)	Comment
Extend the life of the existing HPP and TPP	**417**	
1.Opening of the new surface mining in Brod Gneotino and activation of the underlying seam of Suvodol.	**90**[132] ELEM 2009 - 2011[133]	38 for Brod-Gneotino and 52 for the ground series; No funds are foreseen for opening of the surface mine Popovjani near Oslomej thermal power plant
2. Revitalization of the equipment in the TPP Bitola, TPP Oslomej and TPP Negotino	**260** **ELEM (250)** **a) 2010 - 2012** **c) 2014 - 2017** **TPP Negotino (10)** **b) 2010 - 2012**	a) 50 for TPP Bitola, 50 for TPP Oslomej , (assessment by ELEM); b) 10 for TPP Negotino c) For realization of the requirements from the EU Directive on integrated prevention and control of pollution, and the EU Directive on the Large Combustion Plants, the estimated value of the TPP Bitola, TPP Oslomej is 150 million euros
3. Revitalization of the existing HPP	**67** ELEM 2012 - 2015	Assessment by ELEM
Construction of new production plants	**2701**	**Option 1**
4. HPP candidates	**1041** a) PPP[134] participation of ELEM with HPP Tikvesh 2011 - 2019 b) ELEM or DBOT[135] 2012 - 2016 c)ELEM 2010 - 2014 d) concession 2011 - 2021	a) Chebren 319 and Galishte 200, b) Boshkov Most 70, c)Lukovo Pole with Crn Kamen 45, d) Veles 251 and Gradec 156

[132] "Feasibility Study for the start of opening and exploitation of the surface mine Brod-Gneotino, during 2004-2005.", MI Skopje, 2004.
"Master Design for opening and exploitation of Brod-Gneotino", MI Skopje, 2006
"Main concept of the Master Mine Project for opening and exploitation of the coal from surface series", Rudproekt, Skopje, 2008

[133] The investment period include the first and the last specified year

[134] PPP - Public Private Partnership in whoch ELEM will participate with HPP Tikvesh in the complex of three power plants on the river Crna Reka.

[135] DBOT - Design, Build, Operate and Transfer

5. CHP using natural gas	**250** PPP 2010 - 2014	Funds are foreseen only for CHP Energetika. The foreseen funds do not include the investments for CHP Skopje and CHP KOGEL which are in the final funds so it is deemed that the funds for them are already secured
6. TPP Bitola 4, TPP Mariovo and TPP Negotino, lignite fired	**1120** a) PPP 2014 - 2018 b) PPP 2020 - 2024	a) 760 for Bitola 4 with 600 MW (or Bitola 4 and Mariovo with 300 MW each) b) 360 for TPP Negotino 2
7. Opening of three new mines with pit exploitation (Zhivojno, Mariovo, Negotino)	**290** a) PPP 2013 - 2018 b) PPP 2018 - 2022 c) PPP 2020 - 2024	a) 100 for Zhivojno, b) 110 for Mariovo and c) 80 for Negotino
Construction of new production plants	**3751**	**Option 2**
4. HPP candidates	**1041** a) PPP participation of ELEM with HPP Tikvesh 2011 - 2019 b) ELEM or DBOT 2012 - 2016 c)ELEM 2010 - 2014 d) concession 2011 - 2021	a) Chebren 319 and Galishte 200, b) Boshkov Most 70, c) Lukovo Pole with Crn Kamen 45, d) Veles 251 and Gradec 156
5. CHP using natural gas	**250** PPP 2010 - 2014	Funds are foreseen only for CHP Energetika
6. TPP Bitola 4	**360** PPP 2014 - 2018	Bitola 4 with 300 MW
7. Opening of new mine with pit exploitation	**100** PPP 2013 - 2018	a) Zhivojno
8. Nuclear power plant	**2000** PPP 2019 - 2026	Single unit of 1000 MW
Development of the transmission grid	**109.3** **AD MEPSO**	
Short-term activities	**19**	Section / Project: – Double system over head power line SS Bitola 3 – SS Bitola 4 – HPP Матка -SS Skopje 3 – Macedonia – Serbia, Shtip – Nish
Four substations 400/110 kV	**6.25**	Skopje 1, Skopje 4, Bitola 2 and Dubrovo
Reconstruction of the existing 110 kV power line SS Skopje 1 – SS Tetovo 1	**7.18**	
Reconstruction of 110 kV power line SS Skopje 1 – SS Kumanovo 1	**6.4**	Due to overload by connecting the SS Bunarjik to the electricity transmission grid

Reconstruction of 110 kV power line and the Vrutok – Tetovo section	**27**	Construction of double - system power line, construction of SS Petrovec and the connecting 110 kV power line for SS Petrovec, including construction of multiple 110 kV power line fields
Construction of new and reconstruction and revitalization of the existing power lines and substations	**15.8**	Construction of new 2 × 110 kV power line SS Bitola 3 – SS Bitola 4, revitalization and upgrade of the SS 110/x kV (revitalization of the HV equipment, management, protection, etc.)
400 kV inter-connection power line Macedonia - Albania	**16.7**	
400 kV inter-connection power line Macedonia – Kosovo A	**6.4**	
110 kV power line for connecting the HPP Boshkov Most to the transmission grid	**4.65**	
Activities in the heating infrastructure	**56.3** **AD Toplifikacija**	
Revitalization and modernization of the equipment	**35**	AD Toplifikacija foresees investments for increasing the energy efficiency and reduction of the energy losses, increase of the reliability of the operations. Finances are foreseen to be provided from the depreciation and part of the profit
Construction of new production plants		The CHP plants were considered in the electricity sector
Reconstruction of the grid	**21.3**	Toplifikacija AD
Gasification	**240**	
Construction of thetranssmision network	**160** AD GAMA	Gas ring around Skopje (4 mil. EUR); Maine gas pipeline Klechovce - Gevgelija (65); Shtip - Bitola - Struga (50); Skopje - Tetovo - Gostivar - Kichevo - Debar (30); Sv. Nikole -Veles (6); Other small places (5)
Gasification of the cities - Development of distribution networks	**80** Concession	80 - 1000 thousands conections till 2030
Renewable energy sources	**618**	
Small hydro power plants	**180** Concession	180 for 120 MW
Geothermal energy	**60** Local self-government	
Windmills	**150** a) ELEM b) PPP	150 MW a) 50 MW b) 2× 50 MW
Photovoltaic systems	**120** Concession	20 MW
Solar systems for hot water	**108** Private investment 86 and State budget 22	135000 households
TOTAL Option 1	**4142**	
TOTAL Option 2	**5192**	

The total investments in the energy sector in the period until 2030 are estimated to a little bit more than 4 billion Euros for the option with coal thermal power plants, and over 5 billion Euros for the option with construction of a nuclear power plant.

The fact that the investments lacked in this sector for a long period of time, led to a situation that on one hand, a serious investment cycle should start, and on other, mechanisms and methods to find funds have to be found.

In general, there are several possible methods to find these significant funds, such as:

- Through significant investments from the regular activities of the energy companies,
- Through additional indebting of the energy companies in the international financial institutions or local and foreign commercial banks,
- Through direct investments from the state budget or indirectly through state guarantees for the credits of the energy companies in dominant state ownership,
- Through investments in the energy field by local or international investors by granting concessions to use public goods (land, water or coal) or through purely independent energy generators.

In any case, these investments have to be guaranteed i.e. the return of the investment has to be guaranteed through appropriate defining of the product price – in this case the produced energy. Due to that, we cannot talk about serious investments in the energy field without ***appropriate definition of the pricing policy*** which will realistically enable realization of these investments. It is fact that the energy is good of public interest and the needs for energy has enormous significance for the development of a country's entire economy.

The maintenance, modernization and development of the energy sector requires significant capital investments and therefore it is needed ***to increase the involvement of the private sector and attract foreign capital*** to the energy market of Macedonia which, on one hand, is a necessity for a small country with limited financial resources and, on the other hand, this will increase the investment activity of the country and intensify the total economic development.

Besides this method of investing, with special Government decision, other methods of financing of the energy sector may be realized, such as:

- Sale of the minority share packages of the state energy companies on the capital market to the interested local legal entities and individuals and use the acquired funds for additional investments in the sector.
- Identification of energy companies for whose construction, the companies (or the state) would issue shares (project investment) and these new structure would be partially state owned and partially owned by other investors – principle of public – private partnership.
- Financing of new energy projects with budget funds collected from concessions for other energy (or non-energy) facilities etc.

Regarding domestic sources of financing for realization of the goals of the Strategy, it is essential that the regulated electricity price is established according to the cost plus regulation principle i.e. the price to cover the total average costs including a reasonable rate of return on investments. Macedonia has an obligation to introduce market price of the electricity for the residential sector by 2015 (obligation from the Energy Community Treaty). On other hand it is evident that the gap between the market price and the regulated price of electricity for the residential sector will be gradually closed and that the process ill be accompanied with social package for the vulnerable

groups of households. Meanwhile, in order the cover the lack of investment funds, the Government should: (1) continue the practice of mobilizing loans from the international financial institutions for construction of capital structures in the energy field i.e. indebting of the public enterprises with guarantees from the Budget of the Republic of Macedonia. This approach will be limited with the degree of indebtness of the public enterprises (which is monitored by the creditors), (2) invest fixed amount of budget funds as share in the financing of the construction of energy structures. These funds should be placed to the public enterprise in a transparent way: the public enterprises would issue additional emissions of securities through the stock exchange which would be available to all potential investors (local and international).

The investments envisaged in option 1 for revitalization of the existing and construction of new generation capacities can be realized by ELEM with 500 million Euros (form own funds and loans), public private partnership with 2040 million Euros and the concessioners should provide 480 million Euros.

For the option 2 it is necessary to provide additional 1000 million Euros with public private partnership

AD MEPSO can realize the envisaged investments in amount of 109 million Euros for development of the transmission grid from own funds and loans.

The investments of 56 million Euros for heat infrastructure will be provided by AD Toplifikacija.

The investments of 160 million Euros for development of the gasification system should be provided by AD GAMA through the Budget of the Republic of Macedonia (the state share includes the funds for settlement of the Russian clearing debt), loans and other investors. The investments in development of natural gas distribution networks in the cities should be provided through concessions.

The investments in small hydropower plants, geothermal energy, wind power plants and photovoltaics will be provided by concessioners. The budget should provide certain amount of around 20 million Euros for support of the investigation of the geothermal potentials.

The investments in the realization of the hot water solar systems will be realized by the households and private companies with support by the Budget in amount of around 20 million Euros.

The Budget should also invest around 15 - 20 million Euros for realization of the energy social program. The additional budget investments for realization of the complete energy program would be around 50 million Euros for support of the gasification, investigation of the geothermal potential and support of the introduction of hot water solar systems. The Budget should also support the development of the natural gas distribution systems in the first phase in order to encourage the private investors.

We need to emphasize that the realization of the projects for production of electricity from renewable energy sources require additional finances to cover the feed-in tariffs for electricity produced by small hydropower plants, windmills and photovoltaics. These funds will be obtained with the increase of the electricity price.

If we assume that the existing feed-in tariffs will be used (100 Euro/MWh for small hydropower plants, 89 Euro/MWh for windmills and 420 Euro/MWh for photovoltaics and averagely 106 Euro/MWh for biogas power plants and assumed tariff of 120 Euro/MWh for waste biomass fired combined heat and power plants), in case of their implementation for generation of electricity in small hydropower plants in amount of 216 GWh, from windmills 300 GWh, photovoltaics 20 GWh, CHP on biomass 25 GWh and biogas 25 GWh (that would provide electricity generation of nearly 600 GWh), the funds necessary to cover the feed-in tariffs would increase the electricity price for the distribution consumers by 1.4% - 3.1% and for the direct consumers by

1.9% - 4.2% (the absolute value of the increase of the electricity price is the same for both categories) in case of market electricity price of 80 Euro/MWh and 60 Euro/MWh respectively.

This Strategy will be published in the “Official Gazette of the Republic of Macedonia”.

ANNEX 1

SWAT ANALYSIS OF THE ENERGY SECTOR IN MACEDONIA AND BASIC RECOMMENDATIONS

SWOT ANALYSIS

The Strategy for Development of the Energy Sector in Macedonia is largely based on the conclusions from the analysis of the situation in the energy sector of Macedonia (SWOT – strengths, weaknesses, opportunities and threats) as well as the comparative (benchmark) analysis[136,137], which served as starting bases in the strategic planning processes. This annex presents excerpts from the SWOT analyses used as concept bases for the Strategy as well as conclusions derived from the additional analyses implemented during the preparation of the Strategy.

STRENGTHS

- ***Strategic geographic location***

  Macedonia is located in the center of southeastern Europe.

- ***Unutilized potential of renewable energy sources***

  Considering the participation of the renewable energy sources of 13.8% in the final energy consumption in 2005, Macedonia belongs among the countries with a relatively high utilization of the renewable energy sources.

  In spite of that, the unutilized potential of RES enables further significant growth of the share of RES. The unutilized potential of RES that can be realistically used by 2030 is as follows:

  Electricity generation from RES

  Large hydropower plants: 2260 GWh/year
  Small hydropower plants: 620 GWh/year
  Wind power plants: 720 GWh/year
  Photovoltaic: 80 GWh/year
  Biogas from biomass: 45 GWh/year
  Waste biomass and other waste: 70 GWh/year
  Total electricity from RES: 3795 GWh/year

  Heat production from RES

  Biomass: 860 GWh/year
  Heat from solar power: 155 GWh/year
  Geothermal energy: 550 GWh/year
  Total heat from RES: 1565 GWh/year

  Biofuels in traffic

  Total biofuels in traffic: 1900 GWh/year

The total unused potential from RES that can be used by 2030 is 7260 GWh/year. This RES potential enables an increase of the share of RES in the final energy consumption up to 21% in 2020 and 27.6% in 2030.

The percentage share of RES in the electricity generation can increase from 20% in the past period, to about 25% in 2020 and to about 30% in 2030.

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[136] Round table, 07. 11.2008, MASA

[137] Markovska N., Taseska V, Pop-Jordanov J.: SWOT Analyses of the National Energy Sector for Sustainable Energy Development, *Energy 34* (2009) 752–756 (based on the implemented SWOT analysis for the purposes of the National Strategy for Sustainable Development)

In addition to the above mentioned values, one may expect an increase in the utilization of the insufficiently researched geothermal energy potential for production of heat and electricity, as well as the additional increase of the potential of biomass for energy purposes.

➢ ***New legislation and bodies in accordance with the European regulation and the Athens memorandum***

The Republic of Macedonia signed and ratified the Energy Charter Agreement, the Energy Community Treaty, the United Nations Framework Convention on Climate Change and the Kyoto Protocol.

In accordance with the Energy Community Treaty, Macedonia is harmonizing its legislation with the existing legal regulations of the European Union (acquis communautaire) on energy, environment, competition and renewable energy sources. The strategic commitments of the Republic of Macedonia in the energy sector, one of which is the commitment for harmonization with the acquis communautaire, have been incorporated in the Law on Energy (*Official Gazette of the Republic of Macedonia no. 63/2006, 36/07, 106/08)*. Appropriate secondary legislation has been adopted in order to effectuate the provisions of the Law on Energy.

The Energy Agency was formed in order to provide support to the Government in implementing its energy policy *(Official Gazette of the Republic of Macedonia no.65/05)*.

The Energy Regulatory Commission (ERC) was formed for the purposes of regulating specific issues related to the performance of the energy activities specified with the Law on Energy, as an independent body which has the status of a legal entity.

All of these activities, as a necessary prerequisite, facilitate the development of the energy sector in Macedonia as part of the European Energy Community.

➢ ***Strengthened activities in the areas of energy efficiency and renewable energy sources***

The activities for accelerated and more significant penetration of RES and accelerated and more significant improvement of energy efficiency can be summarized as follows:

- Introduction of feed-in tariffs for the utilization of RES and adoption of relevant rulebooks for application of RES,
- Published tenders for the construction of small hydropower plants,
- Searching for possibilities to construct the large hydropower plants,
- Construction of a natural gas fired CHP with high level of efficiency,
- Preparation of the first National Energy Efficiency Action Plan and appropriate rulebooks in this area,
- Financial subsidies and financial support for utilization of solar energy as heat,
- Preparatory activities (analyses, measurements) for construction of wind power plants,
- The ongoing activities for greater utilization of the geothermal energy, waste biomass and biogas,
- Activities related to greater and clearly defined participation of biofuels,
- Increased interest of donors and credit lines.

WEAKNESSES

The weaknesses of the energy sector in Macedonia are numerous and are elaborated in more details in the previous section of the Strategy. In order to provide better clarity we will not repeat the details here.

- ***Long term lack of strategic planning***

From the time of independence until today, i.e. the period from 1991 to 2008, several energy strategies have been prepared, with support of foreign sources, however, none of these strategies were adopted nor realized by the Government. The lack of vision and the absence of a long term strategy for development and operation of the energy sector have led to a strong stagnation in the development and promotion of this sector.

- ***Weak economic power of the state for investments in the energy sector***

The Republic of Macedonia, with a Gross Domestic Product (GDP) of 2060 US$2000/capita for 2006, or 7000 US$2000/capita when calculated according to purchasing power parity is among the countries with low GDP and weak power for investments. In 2006, Macedonia reached the value of GDP it had in 1990 and significantly lagged behind the developed European countries as well as the less developed European countries. With an average growth of 3.5% per year during the period from 2003-2006, Macedonia belongs to the group of countries with lowest economic growth in the region of Europe and Central Asia. With 3460 US$/capita in 2007, Macedonia is of the 111 place in the world.

In 2007, Macedonia achieved a growth rate of GDP of 5%, but the global financial crisis by the end of 2008 had and still has a strong negative influence both on the economic growth and the economic power of the state to invest, as well as on the readiness of the foreign companies to invest in the Macedonian energy sector.

- ***Weak geopolitical location***

Primarily due to the weak economic power and the small energy market, Macedonia cannot influence the decisions about the strategic directions of the energy transmission on European or regional level.

- ***The country is poor with domestic energy resources and largely depends on energy imports***

Macedonia features an emphasized energy deficiency. ***It imports its total demand for oil, natural gas and good quality coals,*** and since 2000, a part of its electricity demand. The energy import has grown in the past period, and in the last few years the electricity imports have grown particularly.

- ***Unfavorable combination of energy sources***

The utilization of natural gas in Macedonia is poor. Only 10% of the total capacity of the gas pipeline is being used, and gas has not yet penetrated the residential sector. About 80% of the total electricity production is based on domestic, low quality lignite which is the least favorable fuel from an environmental point of view.

- ***Insufficient and obsolete electricity generation capacities***

The Republic of Macedonia today is left, practically, with the same power facilities as before 1990, and these facilities are now two decades older and are insufficient to fulfill the present demand. The thermal power plants, in addition to the low level of efficiency, and therefore the relatively high level of greenhouse gasses emissions, also feature high emissions of sulfur dioxide.

- ***Low energy efficiency in the generation, transmission, distribution and utilization of energy***

One of the core features of the energy sector in Macedonia is the high consumption of energy per unit of GDP, in spite of the low energy consumption per capita. The low energy efficiency is a result of the long term lack of investments and obsolete equipment for generation, distribution and utilization of energy, lack of incentives to save energy and lack of motives to save energy due to the depressed electricity price, the unfavorable infrastructure that imposes high energy intensity, high electricity losses in the distribution system, as well as the insufficient awareness for the significance of the energy, its cost and the need to use it rationally.

- ***Incomplete secondary legislation for energy efficiency and RES***

The secondary legislation related to the efficient use of energy is still not complete to a level where it can be practically applied. In the area of RES, in addition to completion of the secondary legislation, it is also necessary to remove the administrative barriers that hinder the realization of the projects to such an extent that they become unfeasible. There is no legislation which will define the national RES and energy savings objectives, as well as programs and action plans with regulatory and economic measures, specific roles of institutions, time schedules and financing.

- ***High electricity consumption in the residential sector***

The fact the electricity price has been depressed for a long time has lead to a relatively high share of electricity in the total energy consumption in the residential sector (with a continuous growth, and more than twice the amount in comparison to the European countries).

- ***Insufficient capacities***

The capacities of the Ministry of Economy, - the energy sector the Energy Regulatory Commission, the Energy Agency and the units of the local self government are not sufficient to provide for efficient implementation of the new legal framework of the energy sector which imposes numerous new obligations. In addition, the capacities for research, development and introduction of new technologies in the energy sector are also not sufficient.

OPPORTUNITIES

- ***Energy community***

The membership in the Energy Community enables Macedonia to closely cooperate with all of the other members and, by creating a stable regulatory and market framework, to attract investments in transit and transmission infrastructure for gas and electricity and for electricity generation capacities. All of this leads to a stable and continuous supply with electricity and natural gas. The creation of a unique regulatory framework in the region of southeastern Europe provides for possibilities to connect this region to the Caspian, North African and middle eastern reserves of natural gas and for exploitation of the domestic reserves of natural gas, coal and the hydropower potential. The membership in the Energy Community also enables development of competition and liquidity and utilization of the economies of scale.

The Energy Community Treaty pays special attention to caring for the environment and its improvement with respect to natural gas and electricity by improving the energy efficiency and utilization of the renewable sources.

- ***Firm link between the energy and the climate change***

Macedonia is a country that does not have obligations to reduce the greenhouse gas emissions in accordance to the Kyoto Protocol (does not belong to the Annex 1

countries). Therefore it can participate in the activities for greenhouse gas emissions reduction and to create carbon credits through the Clean Development Mechanism (CDM). Considering that it creates additional revenues from the reduced greenhouse gas emissions, the Clean Development Mechanism is seen as an opportunity to improve the economic feasibility of the sustainable energy projects, and thus, as an opportunity to increase their potential to attract foreign investments.

- ***Additional employments in the energy sector and additional engagement of other domestic companies***

The construction of large energy plants leads to hiring the larger domestic companies in the realization of specific segments (generation, civil and installation works etc.), while the activities in the area of energy efficiency, the renewable energy courses and introduction of natural gas in the residential sector will facilitate a higher level of involvement of the small and medium enterprises.

The transfer and the dissemination of sustainable energy technologies facilitates the development of specialized national private companies that will undertake the financing and the realization of the technological penetration. This also applies to the Energy Service Companies (ESCOs).

THREATS

- ***Price volatility of imported fuels and production capacities***

A considerable growth of prices of fuels and imported equipment is a great threat for Macedonia because it is a great importer of energy and energy equipment. On the other hand, the higher reduction of the electricity price in the region has an adverse impact on the competitive abilities of some of our generation capacities on the free regional market.

A higher variation of the prices ratio of certain fuels is also a threat to Macedonia that has an unsatisfactory diversity regarding the use of these fuels.

- ***Reduced economic development due to the lack of electricity and natural gas in the region due to the absence of competitive external supplies and transmission lines***

The lack of electricity and natural gas in the region due to the absence of competitive external suppliers and transmission lines is a threat for the economic development of Macedonia primarily due to the energy intensive industry.

- ***Uncertainties with the exchanges of steel and other metals***

The prices of steel and other metals have great impacts on the scope of their production in Macedonia, and in turn on the energy consumption.

- ***Uncertainty about the period after Kyoto***

Macedonia belongs among the countries which according to the Kyoto Protocol are not Annex 1 countries, and at the same time Macedonia is an EU member candidate country, and therefore the future status of the obligations of the country with respect to climate change are still not clear. In particular, the uncertainty regarding the obligations arising from the Kyoto Protocol after 2012, creates additional risk for the potential CDM projects and the monetary value of the relevant emission reductions.

Recommendations

The following core recommendations arise from the previously presented analysis of the situation in the energy sector of Macedonia (SWOT):

1. Preparation of a Program for the realization of the Strategy. The development of the energy sector should be a function of an accelerated economic development through securing sufficient energy quantities as well as the investment activities in the energy sector.

2. Strengthening of the energy savings measures and the energy efficiency improvement measures in the residential setoc, the commercial and service sector, industry and traffic (preparation and realization of an Action Plan for Energy Efficiency, completion of the secondary legislation of energy efficiency).

3. Macedonia should devote special attention to the electricity generation, in particular the following:

- Construction of the second large CHP running on natural gas in Skopje, as soon as possible;
- Revitalization of the existing thermal power plants;
- Opening and exploitation of the lignite mines in accordance with the set time schedule for uninterrupted work of the thermal power plants;
- Start the activities to construct Lukovo Pole with HPP Crn Kamen and HPP Boshkov Most;
- Improvement of the tender documentation and strengthened measures for finding strategic partners to construct HPP Chebren and HPP Galishte;
- Removal of all the administrative barriers impeding the more intensive construction of the small hydropower plants;
- Start the construction of wind and photovoltaic power plants and combined plants using waste biomass;
- Start a nuclear program by preparing all of the studies necessary to make the decision to construct or delay the construction of a nuclear power plant;
- Start the preparatory activities for pit excavation of lignite;
- Gradual replacement of the existing thermal power plants with new ones, with high level of efficiency and, in turn, reduce the greenhouse gas emissions and fulfill the strictest environmental standards (prepare a special action plan for this purpose);
- Realization of the second stage of the revitalization of the hydropower plants;
- Construction of small natural gas fired CHPs where they are economically justified.

4. Market price of electricity for all except the residential sector with adopted programs for protection of the competitive ability of the economy and gradual move toward market price for the residential sector until 2015, with a program for protection of the socially vulnerable groups, as a prerequisite for the following:

- Introduction of natural gas in the residential, commercial and service sectors
- Massive use of solar energy and thermal pumps for heat generation;
- More intensive investment activity in the energy sector;
- Reduction of electricity consumption;
- Better protection of the socially vulnerable groups.

5. Strengthening of the measures for maximizing the use of the renewable energy sources as a domestic resource and a resource that will improve the energy diversity (completion of the secondary legislation for RES, removal of the administrative barriers, greater utilization of the geothermal energy and the waste biomass).

6. Maximal utilization of the capacity of the existing gas pipeline through intensification of the activities for complete construction of the transmission and distribution grid in all of Republic of Macedonia as well as connection of the national gas pipeline system with the regional gas pipelines.

7. Reduction of the losses in the electricity distribution.

8. Clear delineation of the generation, transmission, distribution and supply.

9. Strengthening of the capacities of the Ministry of Economy – energy sector, the Energy Regulatory Commission, the Energy Agency and the units of the local self government.

10. Open an office for coordinated auctions of cross0border capacities and open a regional electricity exchange.

11. Further connection with the neighboring countries through 400 kV power lines.

12. Involvement in the activities for construction of a regional gas ring and/or connection to other gas pipeline.

13. Gradual restructuring of the industry and fostering of energy extensive industry branches.

14. Construction of a new modern railroad from Tabanovce to Gevgelija, as a prerequisite to utilizing the Vardar valley for hydropower plants.

ANNEX 2

DIRECTIVES IN THE AREA OF ENERGY, ENVIRONMENT, COMPETITIVENESS, RENEWABLE ENERGY SOURCES, ENERGY EFFICIENCY AND OIL RESERVES

Pursuant to the Treaty for Establishment of the Energy Community, the state-parties need to harmonize their legislation with the following EU acts:

Acquis communautaire on energy: Directive 2003/54/EC of the European Parliament and the Council of 26.06.2003 concerning the rules on the common market of electricity, Directive 2003/55/EC of the European Parliament and the Council of 26.06.2003 concerning the general rules on the common market of natural gas, the Directive 2005/89/EC of the European Parliament and og the Council of 18.01.2006 on measures for securing of the reliability of the electricity supply and infrastructure investments, the Directive 2004/67/EC of the Council of 26.04.2004 on measures for securing of the reliability of natural gas supply, the European Community Regulation 1228/2003/EC of the European Parliament and of the Council of 26 June 2003 on conditions for access to the network for cross-border electricity exchanges and the Regulation 1775/2005/EC of the European Parliament and Council of 28.09.2005 on the conditions for access to the natural gas grids.

Acquis communautaire on environment: Council Directive 96/61/EC of 24.09.1996 concerning integrated pollution prevention and control, Council Directive 85/337/EEC of 27.06.1985 on the assessment of the impact from particular public and private projects on the environment, replaced by the Council Directive 97/11/EC of 03.03.1997 and the Directive 2003/35/EC of the European Parliament and the Council of 26.05.2003, Directive 2003/87/EC of the European Parliament and the Council introducing a scheme for trade with greenhouse gases emission of 13.10.2003, Council Directive 1999/32/EC of 26.04.1999 on the reduction of the sulfur content in particular liquid fuels and the Directive for amendment of the 93/12/EEC, Directive 2001/80/EC of the European Parliament and the Council of 23.10.2001 on the limitation of emissions of certain pollutants into the air from large combustion plants and Article 4 (2) of the Directive 79/409/EEC of the Council of 02.04.1979 on preservation of the wild birds.

Acquis communautaire on competition: Article 81, 82 and 87 of the European Community Treaty

Acquis communautaire on renewable energies: Directive 2001/77/EC of the European Parliament and the Council of 27.09.2001 on the promotion of electricity produced from renewable energy sources in the internal electricity market and the Directive 2003/30/EC of the European Parliament and the Council of 08.05.2003 on the promotion of the use of biofuels or other renewable fuels for transport and Directive 2009/28/EC of the European Parliament and Council of 5.6.2009 on promotion of the use of energy from renewable sources and amendment and cancellation of the Directives 2001/77/EC and 2003/30/EC.

Acquis communautaire on energy efficiency: Directive 2006/32/EC of the European Parliament and the Council of 05.04.2006 on the end user energy efficiency

and energy services, the Directive 2002/91/EC of the European Parliament and the Council of 06.12.2002 on the energy construction of buildings.

Acquis communautaire on oil reserves: Directive 98/93/EC of the Council of 14.12.1998 for amendments of the Directive 68/414/EEC that imposes obligation of the EEC member states to maintain minimum reserves of crude oil and/or oil products, Directive 2003/17/EEC of the European Parliament and Council of 03.03.2003 for amendments of the Directive 98/70/EC regarding quality of oil and diesel fuels and Directive 2006/67/EC of the Council of 24.07.2006 that imposes obligation to the member states to maintain minimum reserves of crude oil and/or oil products.

ABBREVIATIONS

BAT	Best Available Technologies
CDM	Clean Development Mechanism
CHP	Thermal power plant – heating plant
CHP	Combined heat and power plant
DNA	Designated National Authority
EIA	Environmental Impact Assessment
ELEM	Macedonian Power Plants
ETS	Emission Trading Scheme
EU-27	The 27 European Union member states
FDI	Foreign direct investments
GDP	Gross Domestic Product
GEF	Global Environmental Facility
HPP	Hydro power plant
HV	High voltage
IEA	International Energy Agency
IPPC	Integrated Pollution Prevention and Control
KOGEL	Combined gas power plant
LNG	Liquid natural bas
LPG	Liquid petrol gas
MCS	Main coal seam
MEPSO	Macedonian operator of the electricity transmission system
MESP	Ministry of Environment and Spatial Planning
MI	Mining Institute
NATO	North Atlantic Treaty Organication (NATO)
NEAP	National Environmental Action Plan
NEEAP	National Energy Efficiency Action Plan
NFMI	Non-ferrous metals industry
Non-OECD Europe	European countries which are not members of the Organizationa on Economic Cooperation and Development
OI	Other industry
PAHE	Pump-storage hydropower plant
PEP	Primary energy production
PL (DV)	Power lines
PPP	Public private partnership
REK	Mining and energy plant
RES	Renewable energy sources
RKE (ERC)	Energy Regulatory Commission of the Republic of Macedonia
ROT	Program for rehabilitation, operation and transfer of the small hydro power plants
SFI	Steel and ferroalloys industry

SM	Surface mine
TFEC	Total final energy consumption
TPEC	Total consumption of primary energy
TPP	Thermal power plant
TS	Transformer station (substation)
UCS	Underlying coal seam
UNDP	United Nation Development Programme
UNFCCC	United Nation Framework Convention on Climate Change
VAT	Value Added Tax
WASP	Wien Automatic System Planning
ESM	Electric Power Supply Company of Macedonia
EES	Electrical energy system
OECD	Organisation for Economic Co-operation and Development (OECD)
OECD Europa	European countries – members of the Organization for Economic Cooperation and Development

Chemical symbols:

CO	Carbon monoxide
CO_2	Carbon dioxide
CO_2-eq..	Carbon dioxide equivalent
CH_4	Methane
N_2O	Natrium dioxide
NO_X	Natrium oxides
SO_2	Sulfur dioxide

State designations[138]:

AL	Albania
AT	Austria
BG	Bulgaria
CZ	Czech Republic
GR	Greece
HR	Croatia
HU	Hungary
MK	Republic of Macedonia
SK	Slovakia
SI	Slovenia

Other:

N_{gross}	Gross altitude and fall at the hydro power plant
$P_{inst.}$	Installed power of an electrical power plant
ppm	parts per million
$Q_{inst.}$	Installed flow of the hydro power plant
c.o.e.	coefficient of efficiency
Comb.	Combustion

[138] Designations according to ISO 3166 Country Codes

MEASURING UNITS

	MJ	kWh	koe	Mcal	Nm^3
1 MJ	1	0,278	0,024	0,239	0,029
1 kWh	3,6	1	0,086	0,86	0,107
1 koe	41,87	11,63	1	10,01	1,25
1 Mcal	4,187	1,163	0,1	1	0,125
1 Nm^3	33,50	9,306	0,80	8,00	1

	MJ	kWh	koe	Mcal	Nm^3
1 MJ	1	0.278	0.024	0.239	0.029
1 kWh	3.6	1	0.086	0.86	0.107
1 koe	41.87	11.63	1	10.01	1.25
1 Mcal	4.187	1.163	0.1	1	0.125
1 Nm^3	33.50	9.306	0.80	8.00	1

da	deca	10
h	hecto	10^2
k	kilo	10^3
M	mega	10^6
G	giga	10^9
T	tera	10^{12}
P	peta	10^{15}
E	exa	10^{18}

CURRENCY EXCHANGE RATE

1 US$ = 47.5 MKD
1 € (Euro) = 61.5 MKD

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