GOVERNMENT OF THE REPUBLIC OF MACEDONIA
MINISTRY OF ECONOMY

STRATEGY FOR UTILISATION OF RENEWABLE ENERGY SOURCES IN THE REPUBLIC OF MACEDONIA BY 2020

SKOPJE, August 2010

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ABBREVIATIONS

WPP	Wind Power Plant
HV	High Voltage
TEC	Total Energy Consumption
VAT	Value Added Tax
E	Electricity
ES	Electricity System
ELEM	Macedonian Power Plants
ESM	Electricity Company of Macedonia
EU	European Union
IRENA	International Renewable Energy Agency
RCEIM - MASA	Research Centre for Energy, Informatics and Materials – Macedonian Academy of Sciences and Arts
PE	Public Enterprise
PPP	Public-Private Partnership
CGPP	Co-Generation Gas Power Plant
MEPSO	Macedonian Electricity Transmission System Operator
AL	Aerial Lines
LV	Low Voltage
ESO	Electric power System Operator
RES	Renewable Energy Sources
EMO	Electricity Market Operator
EMESO	Electricity Market and Electricity System Operator
PSHPP	Pumped Storage Hydro Power Plant
FEC	Final Energy Consumption
RO	Referent Option
MV	Medium Voltage
TPP	Thermal Power Plant
TPP-HP	Thermal Power Plant – Heat Plant
PS	Power Substation
PVPP	Photovoltaic Power Plant
FS	Fiscal Support
HPP	Hydro Power Plant
HS	Hydro System
RES TARGET	Target Share for Total RES Energy
RES-E TRAGET	Target Share for Total RES Electricity
CDM	Clean Development Mechanism
CF	Capacity Factor – annual operation factor of the power plant's installed capacity

IEA	International Energy Agency
OECD	Organization for Economic Cooperation and Development
SCADA	Supervisory Control and Data Acquisition
TF	Time Factor – power plant's annual operation
WPD	Wind Power Density

In accordance with Article 123 of the Energy Law ("Official Gazette of the Republic of Macedonia" No. 63/2006, 36/2007 and 106/2008), the Government of the Republic of Macedonia at the session held on 07.09.2010, adopted

STRATEGY
ON USE OF RENEWABLE ENERGY SOURCES IN THE REPUBLIC OF MACEDONIA BY 2020

EXECUTIVE SUMMARY

INTRODUCTION

The global commitment to environmental protection and in particular to reduction of greenhouse gas emissions, Macedonia's dependence on energy imports, as well as the need to secure greater variety and thereby reliability of energy supply undoubtedly impose increased share of renewable energy sources in the final energy consumption. However, in parallel with activities and measures targeting increased share of renewable energy sources, measures and activities to increase energy efficiency of final energy consumption should be pursued. Thus, the target share of renewable energy sources in final consumption will be achieved much easily and faster, but the economy's competitiveness will also be improved due to reduced energy costs.

In preparation to transpose and implement the EU legislation *(acquis communautaire)* on renewable energy sources into the national legislation, the main objective of the present Strategy is to provide information on the potential and possible exploitation of renewable energy sources (hereinafter: RES) in the Republic of Macedonia. Quantification of such knowledge shall be made by determining the following:

- ***Target share in total energy (RES target),*** which is share of energy generated from RES in the total energy consumption;
- ***Target share of electricity (RES electricity target),*** which is share of electricity generated from RES in the total electricity consumption;
- ***Manner and dynamics of attaining RES target and RES electricity target*** by addressing the following issues:
    - relevant types of RES in the Republic of Macedonia and their availability;
    - primary and secondary legislation and institutional set-up ;
    - financial implications from the establishment of mechanisms to support use of RES (feed-in tariffs);
    - Environmental aspects, by means of analysis on possible greenhouse gas emission reduction.

Furthermore, in the light of secondary legislation on RES, the present Strategy undertakes relevant analyses aimed to determine:

- ***installed capacity per plant*** required to obtain the status of preferential electricity producer from RES, for all RES types;

– ***total installed capacity eligible for application of feed-in tariffs*** to be used for purchase of electricity from RES, for all RES types;
– ***financing mechanisms for feed-in tariffs.***

The Strategy also considers the possibilities to promote the use of ***biofuels for transport*** in pure and processed form, having in mind the potentials for securing sufficient quantity of biomass of domestic origin and from import.

Environmental aspects have been addressed mainly by means of RES environmental impact assessment by determining total greenhouse gas emissions (expressed in kt CO_2-equivalents) that can be reduced with the use of RES.

Finally, findings from all previous analyses will provide the basis elements of the Five-Year Program on Use of RES, including pilot-projects, overview of beneficiaries and private sector's participation, particularly the participation of small and medium-sized enterprises, as well as public awareness activities.

OVERVIEW OF RES RELEVANT FOR THE REPUBLIC OF MACEDONIA

Hydro energy. Hydro energy potential in Macedonia is primarily used by the constructed seven big hydro power plants (hereinafter: HPP). HPPs Vrben, Vrutok and Raven comprise the Mavrovo Hydro Energy System with significant regulation capacity. HPP Globocica and HPP Spilje, together with the Ohrid Lake, used as a reservoir, comprise the cascade energy complex of Crn Drim. Third significant hydro energy complex includes HPP Kozjak, HPP St. Petka (under construction) and HPP Matka[1], and is located on the river Treska.

Candidates for construction, selected under the tender procedure using the public-private partnership include HPP Galiste and HPP Cebren. Another important hydro energy project is the reservoir system Lukovo Pole with the downstream HPP Crn Kamen, which will increase the energy generation of Mavrovo power plants by additional 163 GWh. Plans are in place to start construction of HPP Boskov Most. HPPs Veles and Gradec on the river Vardar are facilities that require higher investments and additional construction works, such as re-allocation of the railway track, and should be constructed as an integral part of the Vardar Valley complex together with other 10 SHPPs on the river Vardar.

At the moment, 13 SHPPs (up to 10 MW) are in operation in Macedonia. The Ministry of Economy has implemented 4 tender procedures, under which it offered 117 SHPPs with total installed capacity of 90 MW. In the previous period 3 tender procedure for which 35 Agreements for concession was signed for total install capacity from 21 MW, was finished

Table 1 provides an overview of existing and planned hydro energy potential in Macedonia.

Table 1. Overview of existing and planned hydro potential

HPP	EXISTING		PLANNED		TOTAL	
	P_{inst} (MW)	W_{year} (GWh)	P_{inst} (MW)	W_{year} (GWh)	P_{inst} (MW)	W_{year} (GWh)
Large	552	1392	960	2280	1512	3672
Small	27	76	97	258	124	334
Total	**579**	**1468**	**1057**	**2538**	**1636**	**4006**

[1] HPP Matka is classified as LHPP, as it includes a reservoir lake and its installed capacity is approximately 10 MW.

Biomass. With consumption of 166 ktoe (1930 GWh; 6950 TJ)[2], biomass has a significant share in the energy balance of the Republic of Macedonia.

Biomass is mainly used by households and fulfils 30 – 33% of total energy needs. Around 430,000 households (76%) use biomass for heating purposes.

Wood and wooden coal account for 80% of total biomass used for energy purposes. Use of vine sprouts, rice chaff and fruit tree branches for energy purposes is also common in the Republic of Macedonia, but major portion of straw is mainly used for fertilizers, animal feed and production of cellulose. Therefore it is not available for energy purposes.

Several studies have been made to assess waste biomass in the Republic of Macedonia, including comprehensive and quality studies, but they do not suffice in terms of providing reliable data to assess the economic. There is also insufficient experience in terms of construction of such plants.

Biofuels. The first factory for biodiesel fuel in the Republic of Macedonia was opened in 2007. The Refinery is owned by the private company “Makpetrol” and has a capacity of 30 thousands tons per year. Non-refined rape seed oil is used for production of biodiesel fuel. At this stage, non-refined oil is supplied from import.

Geothermal energy. Macedonia has a long-standing experience in terms of use of geothermal energy. Nevertheless, the last 20 years for Macedonia have been a period of standstill as concerns the development of geothermal energy. As a result thereof, the use of geothermal energy use has significantly declined in the last several years: from 21 ktoe annually in 2001 to 9 ktoe (around 400 TJ; 110 GWh) in 2006. In the total consumption of primary energy, geothermal energy accounts for around 0.4%, while its share in the final energy consumption accounts for 0.5%.

Use of this potential for energy purposes pertains to local government competences. Having in mind the relatively low temperature (highest temperature recorded is 78ºC in the Kocani region), it is mainly used to meet heating needs. Its basic (dominant) use was noted in regard to heating greenhouse complexes.

Solar energy. Symbolic level of solar energy use is noted in regard to hot water preparation in households. Macedonia's geographic position and climate, however, offer a much better perspective on the use of solar energy. It is expected that the introduction of market electricity price (from 2015) and the expected increase of electricity prices in the region (due to the price paid by TPPs on the account of greenhouse gas emission) will make the solar systems more attractive.

In Macedonia, there is great interest in construction of photovoltaic systems for electricity generation (considering the favourable feed-in tariffs). One such system was already constructed, but improvements in the legislation are expected to facilitate greater construction of such systems. In the period following 2020, plans are made for a construction of a solar power plant with thermal technology.

Wind energy. Up to this moment, several studies were developed for Macedonia in the light of screening the most favourable sites for construction of wind power plants (WPP), as well to assess wind energy on relevant sites. According to the study developed on the basis of satellite images from AWSTruewind[3], the wind

[2] 2006 data; Source: © OECD/IEA, [2008], IEA Online Database: Energy Balances of Non-OECD and OECD Countries and Energy Statistics of Non-OECD and OECD Countries

[3] Wind Energy Resource Atlas and Site Screening of the Republic of Macedonia, AWSTruewind, June 2005

energy potential atlas was designed for Macedonia. Based on the Atlas, selection was made of the most favourable sites for further research of wind energy. As of 2006, wind speed, direction, and other meteorological parameters were continuously measured on the four sites selected[4]. In 2009, additional four metering systems were installed on one of the sites and its surrounding. Preparations for metering of additional five sites are underway. Average wind speed at metered sites in Macedonia ranges from 6.7 m/s to 8.5 m/s, while experiences show that they are suitable for WPP construction. The site selection will certainly depend on other conditions, including: terrain configuration, site tenure matters, infrastructure and access to roads (for transport of equipment), distance from high voltage or medium voltage grid, and the cost-effectiveness as precondition for attracting investors, etc.

ANALYSIS OF RES IMPACT ON THE ELECTRICITY SYSTEM

Electricity systems (hereinafter: ES) are designed, constructed and operate based on the economic logic of large systems, i.e., generation facilities are of relatively high installed capacity and constructed in the vicinity of primary energy sources, while transmission grids serve the purpose of electricity transport for large distances. Most power plants are directly connected to the transmission grid in the ES, while the number of power plants connected to the distribution systems is lower.

With the exception of large hydro power plants, renewable sources, by rule, are not concentrated and can be used for electricity generation by small generation units dispersed on a large area and located much closer to consumers.

Dispersion of generation facilities and their connection to distribution grids and availability to consumers reduce electricity grid losses and improve reliability of supply. On the other hand, this concept creates additional problems in the system operation from technical and economic terms. Technical problems are primarily due to the fact that dispersion of most generation facilities and their connection to distribution grids significantly complicate the equipment operation and protection in transmission and distribution systems. Additional economic problems arise from the relatively big uncertainty or irregularity of renewable sources availability, which imposes the need of additional (reserve) "conventional" generation facilities.

The above indicated problems can be solved, but would require time and additional costs, which, in turn, increase the electricity price for end consumers. On the other hand, the price paid by end consumers is higher when the share of electricity generated from renewable sources is bigger, which is a result of the higher specific investment costs for renewable energy sources.

Global commitment to reduce greenhouse gas emissions and protect the environment will undoubtedly increase the share of renewable resources in final consumption. Nevertheless, the high price of electricity from renewable sources renders them uncompetitive on the electricity markets, so the states undertake measures to stimulate the construction and use of these sources. Measures can range from fiscal (direct subsidies, reduced taxes and like), incentives by means of higher electricity purchase prices, trade in green certificates (CO_2 emissions) or environmental charges, i.e., limiting greenhouse gas emissions from power plants using fossil fuels, and thereby resulting in higher generation price compared to conventional power plants. Regardless of the stimulation measure applied, energy

[4] Pilot-project – Wind Farm, ELEM, Skopje 2008

costs in the country's economy will be higher, and the difference in price raises the question whether the increased costs will be predominantly financed by taxpayers or energy end consumers.

Key element of any country policy is to achieve an optimal share of renewable sources in end consumption, and to ensure that increased costs (taxes or end prices for consumers) do not cause negative effects on the country's economic development.

The Republic of Macedonia accepted the system on stimulating electricity generation from renewable sources by means of feed-in tariffs and issuance of guarantees of origin for the electricity generated. In addition, on two occasions in the last several years, the Government of the Republic of Macedonia provided direct budget subsidies aimed to stimulate installation of solar collectors for hot water.

Guarantees of origin for electricity generated from renewable sources and high efficient cogeneration plants are issued by the Energy Agency of the Republic of Macedonia, while the generators can use them when marketing the electricity they generated.

Feed-in tariffs are stipulated by the Energy Regulatory Commission and currently in effect are tariffs applicable for SHPPs, WPPs, PVPP, power plants using biogas from biomass and power plants using biomass. It is expected that tariffs for (cogeneration) power plants using biomass will be adopted in near future. Depending on the technology, feed-in tariffs range from 45 to 120 EUR/MWh for SHPPs, 89 EUR/MWh for WPPs, 130 to 150 EUR/MWh for power plants using biogas from biomass and 260 to 300 EUR/MWh for PVPPs and 90 to 110 EUR/MWh for power plants using biomass.

According to legislation in effect, the Electricity Market Operator shall purchase the electricity from preferential generators, while the costs incurred on the basis of the difference between the regulated electricity price and feed-in tariffs shall be incorporated in the transmission charge levied to all consumers. In this manner, increased costs of the electricity system incurred from the inclusion of these generators are equitably disbursed to all electricity consumers.

Feed-in tariffs are set by including the possibility for investors to recover their fund invested within a period shorter than the period of tariff application. As concerns the eligibility for application of feed-in tariffs for small hydro power plants, the installed capacity is limited to 10 MW. This is in compliance with European practices, and is applied because small hydro power plants require higher specific investments per unit of installed capacity while large hydro power plants (most of which dispose with reservoir) can optimize their generation and be competitive on electricity markets.

Analysis of incentives provided by the European countries showed that feed-in tariffs are the most frequent incentive used; therefore the tariffs in effect in the Republic of Macedonia are in compliance with European practices.

In order to set the relevant share of renewable sources in electricity generation and thereby prevent any distortions to the operation of the electricity system of the Republic of Macedonia and creation of additional costs, the Strategy includes calculations on the effects of feed-in tariffs and their application on end prices for consumers.

Analyses of different scenarios were made in order to assess the effect of feed-in tariffs on end prices for consumers. Based on analyses results and technical limitations and economic effects on the operation of the electricity system, the Strategy proposes limitations in regard to application of feed-in tariffs.

The feed-in tariffs proposed for WPPs assume a total installed capacity of the system in the amount of 150 MW and WPPs with installed capacity of up to 50 MW. Such limits are proposed due to the relatively small installed capacity of power plants in the electricity system of the Republic of Macedonia and due to the structure of generation facilities, where dominant are Thermal Power Plants (hereinafter: TPPs) .

As for cogeneration plants' using biogas and biomass, the limit of the total installed capacity in the system is set at 10 MW, which is primarily due to the relatively small potential of these renewable sources. In addition, limits are also proposed in regard to plant's installed capacity eligible for application of feed-in tariffs due to the fact that large cogeneration TPPs can operate with profits under market prices and without subsidies.

As for PVPPs, it is proposed to limit the total installed capacity of the system at 10 MW, where the total installed capacity of large plants (up to 1 MW) is limited to 8 MW in order to enable mass construction of small photovoltaic plants. The main reason for the limitation of PVPPs is the high feed-in tariff applied for their generation.

As for SHPPs, no limit is imposed in regard to the system's total installed capacity from the simple reason that their operation does not cause serious problems in the system in terms of predictability of sources, feed-in tariffs applicable for SHPPs are relatively low and are of insignificant economic effect, but also because sources are distributed throughout a large area and do not create additional problems in the generation and consumption balance.

Based on applicable feed-in tariff and due consideration of previously listed limitations, the effect of feed-in tariffs on end prices for consumers is assessed for a potential construction by the year 2015 and forecasted final consumption of electricity of approximately 10500 GWh. Since additional costs (included in the transmission tariff) are covered by all consumers, they will result in increase of end prices for consumers. Depending on the relevant market price, the resulting price increase for distribution consumers will range from 1.2% to 2.8% under market prices of 80 and 60 EUR/MWh, respectively. As for consumers connected to the transmission grid (for which the transmission tariff accounts for larger share in the end price, as they do not pay the distribution tariff), the resulting price increase will range from 1.6% to 3.8%, respectively.

It is estimated that such increase of end electricity prices is acceptable, while electricity generation from renewable sources can be stimulated with relevant subsidies and together with the use of other renewable sources by 2020 will account for 21% share of renewable sources in the total final energy consumption in the Republic of Macedonia.

Based on analyses, estimations and recommendations contained in the Strategy, the Government of the Republic of Macedonia adopted a decision stipulating the types of power plants using renewable sources that are eligible for the application of feed-in tariffs.

In order to achieve the target share of renewable sources in meeting the consumption demand, it is recommended for the Energy Regulatory Commission and the Government of the Republic of Macedonia to regularly monitor the situation and depending on the construction extent and construction prospects for new plants using renewable sources to adequately amend feed-in tariffs and terms and conditions for their application. Also, the present Strategy recommends the future amendments to the Energy Law, as well as to the Electricity Market Code (that is to stipulate in detail the manner of electricity purchase from preferential generators) to anticipate adequate solutions that will simplify the procedure on obtaining the status of preferential generator and will address the shortcomings in the existing legislation.

SETTING RES TARGET AND RES ELECTRICITY TARGET

In 2005, the share of 13.8% for renewable energy sources in the final energy consumption listed Macedonia among countries with relatively high use of renewable energy sources.

In 2005, the use of RES in Macedonia accounted for 3016 GWh. In that, biomass was used as final energy in the amount of 1767 GWh and participated with 59% in the total use of RES in Macedonia (Figure 4.2). The contribution of hydro energy in 2005 accounted for 1144 GWh, which represents a relative share of 38%. Generation from LHPPs and SHPPs in 2005 accounted for 94% and 6%, respectively. In 2005, geothermal energy accounted for 105 GWh or 3%. In the same year modest use of solar energy was noted (around 0.2% in the total use of RES), but the same was not registered in statistical terms.

Obligations assumed by the EU Member States are calculated based on the 2005 RES share for the country in question plus 5.5% for each Member State and plus a particular percentage calculated in proportion to the country's GDP per capita. Correspondingly, the target for Macedonia is set at 21% (Table 4.2.1).

The planned share of 21% for RES can be achieved by various combinations of use of RES and final energy consumption within the given limits. Four possible scenarios were analysed. Scenarios S2 and S3 are deemed to be most likely. Table 2 shows the RES share and final energy consumption (hereinafter: FEC) for the lower limit (LL), the upper limit (UL) and values anticipated pursuant to scenarios C2 and C3 that are to contribute to the attainment of the target share of 21%.

Table 2. Shares of renewable energy sources in the final energy consumption (GWh)

	2020 LL	**2020 UL**	**2020 C2**	**2020 C3**
Electricity from RES	**2539**	**3482**	**3039**	**2679**
HPPs	2300	3000	2710	2350
LHPPs	2000	2600	2350	2000
SHPPs	300	400	360	350
WPPs	180	360	270	270
PV Systems	14	42	14	14
Biomass	25	50	25	25
Biogas	20	30	20	20
Heat from RES	**3100**	**3350**	**3200**	**3240**
Biomass	2640	2740	2740	2740
Solar energy	60	90	60	60
Geothermal energy	400	520	400	440
Biofuels	**560**	**655**	**655**	**560**
TOTAL RES	**6199**	**7487**	**6894**	**6479**
FEC	**32873**	**30825**	**32873**	**30825**
RES share (%)	**18.9**	**24.3**	**21.0**	**21.0**

The low share of RES (LL) in the final energy consumption was obtained based on the lowest planned shares for each RES in the final energy consumption pursuant to the basic scenario from the Strategy on Energy Development in Macedonia.

The high share of RES (UL) in the final energy consumption was obtained based on the highest planned shares for each RES in the final energy consumption pursuant to the scenario with strong energy efficiency measures from the Strategy on Energy Development in Macedonia.

Scenario S3 is based on the final energy consumption anticipated under the scenario with strong energy efficiency measures from the Strategy on Energy Development in Macedonia and therefore it is considered target option.

Scenario S2 anticipates a final energy consumption pursuant to the basic scenario from the Strategy.

Both scenarios anticipate reduction of electricity and heat losses in transmission and distribution pursuant to acceptable European levels.

Scenario S2. The target setting under this scenario anticipates a particular delay in the construction of LHPPs compared to the basic scenario from the Strategy on Energy Development in Macedonia as follows: the construction of HPP St. Petka to be delayed by one year, HPP Boskov Most by two years, Lukovo Pole with HPP Crn Kamen and HPP Galiste by two years, HPP Cebren by one year and HPP Gradec by more than three years. This would imply that the construction of HPP Gradec will be initiated after 2020. The difference up to the target share of 21 % for RES will be covered by increasing consumption of biomass for combustion from 2640 to 2740 GWh pursuant to scenario S1. Planned use of biomass for combustion in 2020 is set at the upper limit, which is by less than 10% higher compared to the 2006 consumption level, including both recorded and non-recorded consumption[5]. Such use of biomass can be achieved in reality by small increase of wood potential and by improving forest cutting and processing technology, which will reduce the unused waste biomass.

Scenario S3. This scenario is based on the final energy consumption as anticipated under the scenario with strong energy efficiency measures from the Strategy on Energy Development in Macedonia.

The dynamics of LHPPs construction has been additionally postponed for one year, and thereby the construction of HPP Cebren is anticipated in the period after 2020. The difference up to the target share of 21% of RES will be covered with the additional construction of SHPPs with total capacity of 23 MW and generation of 60 GWh compared to scenario S1 and with use of biomass for combustion in the amount of 2700 GWh. The share of other RES is at the projected lower limit.

Implementation of S2 and S3. The implementation of scenarios S2 or S3 or any other option between them, by 2020 will necessitate the use of:

- hydro energy from LHPPs in the amount of 2000 - 2350 GWh (construction of HPP St. Petka, HPP Boskov Most, Lukovo Pole with HPP Crn Kamen and HPP Galiste from the scenario S3, plus HPP Cebren from the scenario S2);
- hydro energy from SHPPs in the amount of 350 – 360 Gwh;
- wind energy in the amount of 270 Gwh;
- solar energy for electricity generation in the amount of 14 Gwh;

[5] The Strategy on Energy Development in the Republic of Macedonia until 2030, Macedonian Academy for Sciences and Arts, 2010

- waste biomass from TPP-HP for electricity generation in the amount of 25 Gwh;
- biogas for electricity generation in the amount of 20 Gwh;
- biomass for combustion for heat generation in the amount of 2740 Gwh;
- solar energy for heat generation in the amount of 60 Gwh;
- geothermal energy in the amount of 400 – 440 Gwh; and
- biofuels in the amount of 560 – 655 GWh.

Electricity generation from RES. Under electricity generation growth rate of of 3%, 2% and 2.5%, and electricity generation from RES pursuant to LL (2539 GWh, Table 4.4.1), UL (3482 GWh), S2 (3039 GWh) and S3 (2679 GWh), the share of RES in electricity generation by 2020 will account for 20.1%, 31.5%, 25.7% and 24.2%, respectively. According to previous analyses, the share of electricity from RES by 2020 can be expected at around 25%.

Table 3. Share of electricity from renewable energy sources in 2020

Electricity from RES	2020 LL	2020 UL	2020 S2	2020 S3
GWh	**2539**	**3482**	**3039**	**2679**
Total electricity generation under a growth rate of	3%	2%	2.50%	2%
GWh	**12616**	**11060**	**11842**	**11060**
RES share (%)	**20.1**	**31.5**	**25.7**	**24.2**

POSSIBILITIES FOR REDUCTION OF GREENHOUSE GAS EMISSIONS WITH USE OF RES

Environmental effects of RES-based technologies are assessed by setting the total greenhouse gas emissions on annual level (expressed in kt CO_2-equivalents), which by 2020 can be reduced by means of use of RES. Calculations were made based on possible energy generation from RES anticipated under scenarios S2 and S3 from Chapter 4. Calculations are based on the following assumptions:

– reduction of greenhouse gas emissions by 2020 is calculated based on the coal scenario, i.e., the so called black scenario, which is defined as the basic scenario in the Second National Climate Change Report. In addition to TPPs using coal, the black scenario also includes LHPPs, and therefore relevant emission reductions are not calculated in the total reduction achieved by use of RES;

– the network factor from the black scenario is accounted as the emission factor for electricity, and under certain electricity fuel composition, TPPs using coal and their revolving reserve will be replaced with RES;

– considering the fact that households to large extent use electricity for heating and hot water, it is assumed that the increased penetration of biomass and solar collectors will primarily contribute to electricity savings;

– biofuels shall replace petrol and diesel fuels for transport;

– emission factors of all fuels are taken from the National Inventory on Greenhouse Gases developed as part of the Second National Climate Change Report, which uses the methodology on greenhouse gas inventory developed by the Intergovernmental Panel on Climate Change.

Total annual reduction of greenhouse gas emissions that can be achieved by use of RES by 2020 accounts for around 1700 kt CO_2-equivalents under both scenarios, S2 and S3. Under the coal scenario, total reduction of emissions by use of RES accounts for around 8%. In addition to increased use of RES, the scenario S3 also anticipates stronger EE measures (lower energy consumption) that would provide additional (higher) emission reductions.

It should be noted that RES-based projects, despite relevant reduction of greenhouse gas emissions can also be related to other sustainable development benefits. As such, these projects are eligible for carbon funding through the Clean Development Mechanism, and thereby improve the project's cost-effectiveness and accordingly increase investors' interest, in particular the interest of foreign investors.

As regards the cost-effectiveness of RES-based technologies, in general, it is lower compared to the cost-effectiveness of EE measures. Namely, the cost to reduce 1 t CO_2 by using RES-based technologies is higher due to the country's relatively high energy intensity and due to the relatively high investment costs for RES. Anyway, additional study is needed to determine the costs of greenhouse gas emission reductions with the use of different technologies and measures, as well as to determine appropriate priorities that would take into consideration the economic, environmental and social aspects.

ELEMENTS OF THE PROGRAM ON RENEWABLE ENERGY SOURCES

Increasing the share of renewable energy sources is not possible without adequate (incentive-providing) ***primary and secondary legislation***. The legislation (primary and secondary) is to provide a framework that would enable simplified construction of generation facilities, incentives (financial measures) and implementation thereof. Therefore, the existing primary legislation should be improved and the necessary secondary legislation should be adopted.

The major problem, in particular affecting construction of facilities with lower installed capacity, is the complex procedure on obtaining construction permits, the right to land use and obtaining the status of preferential generator.

Also, it is recommended for future amendments to the Energy Law, as well as to the Electricity Market Code (that are to stipulate in detail the manner of electricity purchase from preferential generators), to stipulate adequate solutions that would simplify procedures on obtaining the status of preferential generator and would address certain shortcomings contained in the existing legislation.

In addition to the existence of quality legislation, a key precondition to increase the share of RES in the final consumption is the enforcement of the existing regulation. This is particularly important in order to increase investors' trust and thereby reduce their perceptions on investment risks.

According to the analyses presented under Chapter 4, from the pool of renewable energy sources in Macedonia predominant is the share and non-utilized potential of hydro energy and biomass for combustion. Accordingly, the Program and its implementation should pay due attention to the rational use of existing and planned hydro energy and biomass potential.

Construction of ***HPP Galiste*** and ***HPP Cebren*** should be pursued by means of public-private partnership. SHPPs can be constructed by AD ELEM. Namely, it is recommended to develop an action plan for the construction of the reservoir ***Lukovo***

Pole with ***HPP Crn Kamen*** and ***HPP Boskov Most*** by AD ELEM and with state support as part of the Public Investment Program.

As for the project Vardar Valley, the first step implies the announcement of a tender on the development of an innovative study for the Vardar Valley that would provide precise answers as regards the railway track (temporary re-allocation or reallocation to an already defined new track or construction of a new contemporary railway track) and the leading champions (whether the idea on Vardar's navigation by ships is abandoned and thereby pursue the optimal energy utilization thereof)

Pivotal in terms of support for SHPPs is the simplification of procedures on water concessions, which are to include a requirement for previously settled issue of land use. The Energy Agency should be authorized to closely monitor all stages from the preparation and construction of the first ten SHPPs and to provide assistance in overcoming administrative and legislative burdens aimed at faster implementation of the projects in question. Moreover, based on the experiences gained the Energy Agency should develop guidelines with clearly defined procedure on SHPP construction to be used by future investors. Considering the lack of trust and incomplete data available on the hydro energy potential, it is necessary to develop and implement the project to update data on hydro energy potential and other relevant parameters (possibly as a design idea) for all pre-determined sites prior to the announcement of future tenders for SHPP construction.

It is recommended for the first WPP in the Republic of Macedonia to be constructed by AD ELEM as a "pilot" project that would also serve the purpose of identifying all possible legal and administrative barriers, but will also build the capacity of state administration and domestic companies involved in the project implementation (contractors, equipment suppliers, etc.). Other possible WPPs could be constructed by private investors or by means of public-private partnership with AD ELEM's participation.

The promotion of ***solar thermal systems*** should include incentives both for consumers and generators. It is recommended to introduce a mechanism on regular subsidies (Fund that will support solar thermal systems) and proper taxation credits aimed to facilitate mass purchase and installation of these systems.

It is necessary to eliminate legal barriers for construction of ***photovoltaic power plants*** that would provide investment safety.

Promotion activities for ***biomass for combustion*** are mainly targeted at:

- Incentive programs for small and medium industries to manufacture high-efficiency devices for biomass combustion;
- Subsidies to replace old and purchase new high-efficiency combustion devices, especially targeting vulnerable population groups;
- Measures to reduce losses in forest cutting;
- Measures to reduce the non-registered consumption;
- Technical support and assistance in finding creditors and investors for the first pilot TPP-HP fuelled by waste biomass and the first pilot TPP-HP as part of wood processing and wood products companies.

As regards the use of ***biofuels***, it is necessary to develop the Rulebook on the manner of securing relevant share of biofuels in the total energy consumption in transport. It is our recommendation this to be achieved by putting the blends into market circulation under a clearly defined dynamics aimed to increase share of biofuels, initially with diesel fuels, and later with petrol fuels as well. For that purpose, measures are needed by which the State will promote the use of blends with buofuels without significant increase of fuel prices (by reducing the excise on biofuels and by introducing increased excise for oil derivatives not used in transport). Also, as part of the program on agricultural development, it is necessary to stimulate the production of domestic raw materials for biofuels by supporting producers of biofuels to invest in agricultural production of raw materials, guaranteed purchase, favourable crediting lines, etc.

Promotion of the use of ***geothermal energy*** should be pursued by stimulating development and use of heat pumps as part of the Energy Efficiency Program.

Geothermal water sources (steam) require coordinated activities by local governments and state institutions. The potential to use geothermal energy for heating greenhouse plantations should be correlated with agricultural development. In order to achieve this objective, apart from already undertaken measures to use existing sources and identify new, additional actions are also needed by the local governments and the Government. Additional funds should be allocated to support research of geothermal potentials.

Total investments for the **implementation of the Program on Development of RES** in the period up to 2020 are estimated at around 1.5 billion EUR.

Anticipated investments in the revitalization of existing and construction of new generation facilities can be achieved by means of investments made by AD ELEM in the amount of 260 million EUR (own funds and credits), by means of public-private partnerships in the amount of 670 million EUR, and by concession holders, who are to secure 480 million EUR and from private investors in the construction of plants using waste biomass and biogas, in the amount of 30 million EUR.

Funds from the budget should be allocated in the amount of around 20 million EUR to support research of geothermal potentials.

Investments in the installation of solar systems for hot water will be made by households and private companies in the amount of 50 million EUR and will be supported by the budget in the amount of around 10 million EUR.

1. INTRODUCTION

The global commitment to environmental protection and in particular to reduction of greenhouse gas emissions, Macedonia's dependence on energy imports, as well as the need to secure greater variety and thereby reliability of energy supply undoubtedly impose increased share of renewable energy sources in the final energy consumption. However, in parallel with activities and measures targeting increased share of renewable energy sources, measures and activities to increase energy efficiency of final consumption should be pursued. Thus, the target share of renewable energy sources in final consumption will be achieved much easily and faster, but the economy's competitiveness will also be improved due to reduced energy costs.

1.1. STRATEGY OBJECTIVES

According to the Directive 2009/28/EC on the promotion of the use of energy from renewable sources (as well as its precedent – Directive 2001/77/EC on the promotion of electricity produced from renewable energy sources on the internal electricity market), renewable energy sources include: wind, solar energy, geothermal energy, wave energy, tide energy, hydro energy, biomass, landfill gas, gas obtained from waste water treatment plants and biogases.

The main objective of the present Strategy is to provide information on the potential and possible exploitation of renewable energy sources in the Republic of Macedonia. Quantification of such knowledge shall be made by determining the following:

- ***target share in total energy (RES target),*** which is share of energy generated from RES in the total energy consumption;
- ***target share of electricity (RES electricity target),*** which is share of electricity generated from RES in the total electricity consumption;
- ***manner and dynamics of attaining RES target and RES electricity target*** by addressing the following issues:
    - relevant types of RES in the Republic of Macedonia and their availability;
    - primary and secondary legislation and institutional set-up;
    - financial implications from the establishment of mechanisms to support use of RES (feed-in tariffs);
    - Environmental aspects, by means of analysis on possible greenhouse gas emission reduction.

The development of the present Strategy used previous analyses, studies and relevant materials related to use of RES in the Republic of Macedonia and experimental research performed by the team of RCEIM-MASA[6] and other entities,

[6] RCEIM-MASA projects in the field of RES:
- Renewable Energy Strategy (USAID, 1999-2000)
- Optimization of Building-integrated and Grid-Support Photovoltaic Solar Systems in Macedonian Conditions (US-Macedonian Fund, 1997-2000)

as well as world-wide experiences in the relevant field. Special use was made of experiences from developed and neighbouring countries. The Strategy's commissioning party provided the available relevant documents (studies, analyses, legislation, etc.), which served as input data for the anticipated analyses and activities.

Setting the RES TARGET and RES ELECTRICITY TARGET was based on numerous assumptions, including, *inter alia*, future costs of RES-based technologies, the harmful effects related to local pollution, future prices of reduced CO2 emissions and replacement of conventional technologies and fuels with RES-based generators.

Weighted costs of energy generation (including capital costs, generation costs and maintenance costs, etc.) for most RES projects are higher compared to the costs of conventional generation, in the absence of costs related to external factors (i.e., pollution taxes and charges). When costs of external factors are included in the calculation, large number of RES projects may become economically justifiable.

Furthermore, as regards RES electricity, the generation price thereof should include a portion related to grid connection costs. Connection costs include an energy connection between the generation unit and the closest point in the transmission or distribution system, as well as the relevant equipment required to construct the connection in question. Also, when determining the recovery of total costs one must take into consideration the fact that most RES-based technologies are operational only under certain weather conditions (i.e., sufficient wind speed, sufficient water flow, etc.). Therefore, investors are faced with significant risks, which increase the total costs, especially if they are required to sign contracts that guarantee certain capacity during particular time periods. On the other side, the System Operator might be able to reduce portion of these costs by enabling access to different RES-based projects. Special analysis will be made of possibilities to use different RES in order to minimise risks assumed by relevant investors, and thereby promote cost-effective projects. RES have special effect on the electricity system's operation and performance. Therefore, in the light of use of RES, it is necessary to research the electricity system's protection, control and reliability.

Further on, in the light of secondary legislation on RES (Rulebook on renewable energy sources for electricity generation, Rulebook on issuing guarantees of origin for electricity generated from renewable energy sources and Rulebook on obtaining the status of preferential electricity producer from renewable energy sources), the present Strategy undertakes relevant analyses aimed to determine:

- ***installed capacity per plant*** required to obtain the status of preferential electricity producer from RES, for all RES types;
- ***total installed capacity eligible for application of feed-in tariffs*** to be used for purchase of electricity from RES, for all RES types;
- ***financing mechanisms for feed-in tariffs.***

Another issue that will be addressed concerns the recommendations for the promotion of the use of ***biofuels for transport*** in pure and processed form (pursuant

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- Renewables for Isolated Systems – Energy Supply and Waste Water Treatment (RISE), Specific Target Research Project – STREP (EU FP6, 2004-2007)
- Solar Thermal Program, (Austrian Government, 2005-2008)
- More Microgrids, Specific Target Research Project – STREP (EU FP6, 2007-2009)

to the Directive 2009/28/EC and it precedent - Directive 2003/30/EC), having in mind the potentials for securing sufficient quantity of biomass of domestic origin and from import.

Environmental aspects have been addressed mainly by means of RES environmental impact assessment by determining total greenhouse gas emissions (expressed in kt CO_2-equivalents) that can be reduced with the use of RES.

Finally, findings from all previous analyses will provide the basic elements of the Fire-Year Program on Use of RES, including pilot-projects, overview of beneficiaries and private sector's participation, particularly the participation of small and medium-sized enterprises, as well as public awareness activities.

1.2. RES-RELATED EU LEGISLATION

The existing EU legislation (*acquis communautaire*) on renewable energy sources is comprised of the following Directives:

- Directive 2001/77/EC (OJ L 283, 27.10.2001) of the European Parliament and of the Council on the promotion of electricity produced from renewable energy sources in the internal electricity market;
- Directive 2003/30/EC (OJ L 123, 17.5.2003) of the European Parliament and of the Council on the promotion of the use of biofuels or other renewable fuels for transport; and
- Directive 2009/28/EC (OJ L 140, 5.6.2009) of the European Parliament and of the Council on the promotion of the use of energy from renewable sources.

Directive 2001/77/EC (OJ L 283, 27.10.2001) of the European Parliament and of the Council on the promotion of electricity produced from renewable sources in the internal electricity market:

The Directive sets forth the indicative share of electricity produced from renewable sources at 21% in the total electricity consumption in the Community by the year 2010. It defines national indicative targets for all EU Member-States, promotes the use of national support schemes, elimination of administrative barriers and integration in the grid system, and also stipulates the obligation on issuing guarantees of origin for electricity generators from renewable sources, on their request. Under current policies and efforts/achievements made, it can be expected that by 2010 a share of 19% will be achieved instead of the initial target set at 21%.

Directive 2003/30/EC (OJ L 123, 17.5.2003) of the European Parliament and of the Council on the promotion of the use of biofuels and other renewable fuels for transport:

The Directive sets forth the target of 5.75% share of biofuels in all petrol and diesel fuels for transport, which shall be put into circulation on the market from 31 December 2010. Member States are required to set indicative targets for 2005, taking into consideration the reference value of 2%. This intermediate indicative target was not achieved. In 2005, biofuels reached a share of 1% in fuels for transport. The Commission's conclusion, based on the progress evaluation, was that the target set for 2010 will probably not be achieved as it is expected for the relevant share to account for around 4.2%.

Provisions from previous Directives 2001/77/EC and 2003/30/EC that overlap with provisions from new Directives will be repelled with the entry into force of the latter, while those concerning the targets and reports for 2010 remain in force by 31 December 2011.

Directive 2009/28/EC (OJ L 140, 5.6.2009) of the European Parliament and of the Council on the promotion of the use of energy from renewable sources and amending and subsequently repealing Directives 2001/77/EC and 2003/30/EC:

The Directive sets forth the principles according to which Member-States are to ensure the share of energy from renewable sources in the final energy consumption in the EU so as to achieve a share of at least 20% by 2020 and at the same time sets forth the national targets for all EU Member States. Also, by 2020 Member-States are to achieve at least 10% share of energy from renewable sources (primarily biofuels) in transport.

For the purposes of this Directive, the following definitions are used (Article 2, L140/27):

- (a) „energy from renewable sources“ means energy from renewable non-fossil sources, namely wind, solar, geothermal, wave energy, tidal energy, hydropower[7], biomass, landfill gas, sewage treatment plant gas and biogases;
- (b) „biomass“ means the biodegradable fraction of products, waste and residues from agriculture (including vegetal and animal substances), forestry and related industries, as well as biodegradable fraction of industrial and municipal waste;
- (c) „final consumption of energy“ means the energy commodities delivered for energy purpose to manufacturing industry, transport, households, services, agriculture, forestry and fisheries, including the consumption of electricity and heat by the energy branch for electricity and heat production and including losses of electricity and heat in transmission;
- (d) „district heating or cooling“ means the distribution of thermal energy in the form of steam, hot water or chilled liquids, from a central source of production through a network to multiple buildings or sites, for the use of space or process heating or cooling;
- (e) „biofuels“ means liquid or gaseous fuel for transport produced from biomass;
- (f) „guarantee of origin“ means an electronic document which has the function of providing proof to a final customer that a given quantity of energy was produced from renewable sources.

Three sectors are addressed with renewable energy: electricity, central heating and cooling and transport. The general approach is for Member States to kept their freedom of choice as concerns the combination of these sectors in order to achieve their respective national targets. The starting status, renewable energy potential and energy mix are different for different Member States. Therefore, it is necessary for

[7] Distinction is not made between small and large hydro power plants. Energy obtained from HPPs is considered renewable energy, disregarding the fact whether it originates from small or large HPP.

the ***total 20% to be reflected in the individual targets of all Member States (national targets),*** having in mind the fair and adequate allocation and taking into consideration different national starting positions and potentials (current level of renewable energy in the energy mix). Thus, the national targets for 2020 (Annex_1) are set in the following manner: the share of renewable sources in 2005 for all countries is increased by 5.5% and then each country increases that share in the amount calculated pursuant to national specifics, primarily the gross domestic product.

In order to provide safe attainment of EU target for 20% share of RES, Member States shall work according to the ***indicative trajectory*** that paves the road to the attainment of their respective national targets. Member States shall develop national action plants, including targets by sectors, in order for their indicative trajectory to include the following shares of energy from renewable sources:

$S_{2005} + 0.25 (S_{2020} – S_{2005})$, as an average for the two-year period 2011 to 2012;
$S_{2005} + 0.35 (S_{2020} – S_{2005})$, as an average for the two-year period 2013 to 2014;
$S_{2005} + 0.45 (S_{2020} – S_{2005})$, as an average for the two-year period 2015 to 2016;
$S_{2005} + 0.65 (S_{2020} – S_{2005})$, as an average for the two year period 2017 to 2018.

Biofuels

Contrary to different individual obligations of Member States to secure the share of renewable energy sources, by 2020 each ***Member State is required to achieve at least 10 %*** of energy from renewable sources (primarily biofuels) in transport. This was established from the following reasons: (1) the transport sector was marked by an increased growth of greenhouse gas emissions compared to all economy sectors; (2) biofuels also relate to the issue of their oil dependence in transport, which is one of the most serious problems of non-reliable energy supply affecting the EU; (3) at the moment, biofuels are more expensive than other renewable energy forms, which can mean that they would not be further developed if there is no specific demand.

In particular, as regards biofuels and other bioliquids, the Directives establish a system that would guarantee policy sustainability in terms of environmental protection by providing, *inter alia*, that efforts should be made to achieve relevant targets for biofuels along with the attainment of maximum level of greenhouse gas savings.

As fuels for transport are easily traded, Member States with low share of in-country resources will easily be able to secure renewable fuels for transport from import. Although it is technically possible for the Community to achieve its target for biofuels only from domestic production, it is likely, as well as desirable that the targets will be achieved by combination of domestic production and import. The Commission will monitor the supply side with biofuels on the Community market and shall propose, where appropriate, relevant measures aimed at achieving a balanced approach to domestic production and import, having in mind the development of multilateral and bilateral trade negotiations, as well as environmental protection, costs, energy security and other relevant issues.

1.3. LEGAL AND INSTITUTIONAL FRAMEWORK ON RES IN THE REPUBLIC OF MACEDONIA

From the aspect of legal and institutional frameworks, the basic elements related to RES are stipulated under the Energy Law (Official Gazette of the Republic of Macedonia no. 63/2006, 36/2007, 106/2008) which - *inter alia* - promotes the use of RES.

The said law stipulates that the Energy Agency of the Republic of Macedonia shall issue guarantees on the origin of electricity from RES and high-efficiency cogeneration plants and shall keep and maintain the Registry of Guarantees of Origin. The guarantee of origin for electricity generated from RES shall specify the energy source used to generate electricity, as well as the generation date and place. Guarantees shall enable electricity generators to obtain the status of preferential generators for the electricity quantity generated from RES.

The Energy Regulatory Commission of the Republic of Macedonia adopts Rulebooks and Decisions on feed-in tariffs for purchase (buy-out) of electricity generated by preferential electricity producers, as well as generated at high-efficiency cogeneration plants. Insofar, the following Rulebooks have been adopted :

- Rulebook on the manner and procedure for setting and approving application of feed-in tariffs to purchase electricity generated by SHPPs (Official Gazette of the Republic of Macedonia no. 16/2007)
- Rulebook on the manner and procedure for setting and approving the application of feed-in tariffs to purchase electricity generated by WPPs (Official Gazette of the Republic of Macedonia no. 61/2007)
- Rulebook on the manner and procedure for setting and approving application of feed-in tariffs to purchase electricity generated by electricity facilities using biogas obtained from biomass (Official Gazette of the Republic of Macedonia no. 142/2007) and Rulebook for amendments of the Rulebook on the manner and procedure for setting and approving application of feed-in tariffs to purchase electricity generated by electricity facilities using biogas obtained from biomass(Official Gazette of the Republic of Macedonia no. 44/2010)
- Rulebook on the manner and procedure for setting and approving application of feed-in tariffs to purchase electricity generated by photovoltaic systems (Official Gazette of the Republic of Macedonia no. 112/2008) and Rulebook for amendments of the Rulebook on the manner and procedure for setting and approving application of feed-in tariffs to purchase electricity generated by photovoltaic systems (Official Gazette of the Republic of Macedonia no. 44/2010)
- Rulebook on the manner and procedure for setting and approving application of feed-in tariffs to purchase electricity generated by electricity facilities using biomass (Official Gazette of the Republic of Macedonia no. 44/2010)

Pursuant to the Rulebooks, the Energy Regulatory Commission adopted Decisions on the amount of feed-in tariffs applicable for the purchase of electricity generated and delivered by SHPPs, WPPs, and energy facilities using biogas obtained from biomass and by photovoltaic systems.

The Market Operator is obliged to purchase the total electricity generated by preferential electricity producers. Costs incurred with the said electricity purchase shall be invoiced to the Market Operator in compliance with relevant feed-in tariffs. Preferential electricity producers are obliged to submit the Energy Regulatory Commission a document issued by the Energy Agency and confirming the use of RES or application of high-efficiency cogeneration process in order to qualify for the application of feed-in tariffs to their generation. These issues have already been stipulated under relevant Rulebooks:

- Rulebook on renewable energy sources for electricity generation (Official Gazette of the Republic of Macedonia no. 127/2008);
- Rulebook on issuing guarantees of origin for electricity generated from renewable energy sources (Official Gazette of the Republic of Macedonia no. 127/2008);
- Rulebook on obtaining the status of preferential electricity producer from renewable energy sources (Official Gazette of the Republic of Macedonia no. 29/2009).

In order to provide enforcement of these Rulebook and based on the present Strategy a Decision was taken on the upper limit of installed capacity (Official Gazette of the Republic of Macedonia no. 123/09) to determine the installed capacity of individual plants required to qualify for obtaining the status of preferential electricity producer from RES, for all RES types; total installed capacity for application of feed-in tariffs to purchase electricity generated from RES, for all RES types; as well as financing mechanisms for feed-in tariffs. All these elements are subject to analysis under the present Strategy.

In order to promote use of solar systems for hot water, on several occasions the Government provided subsidies for the first 500 households that have installed solar thermal collector systems in the amount of 30% from the total investment, but not exceeding 300 EUR per household. For the same purpose, the Law on Amending the Law on Value Added Tax (Official Gazette of the Republic of Macedonia no. 114/2007) was adopted and provided preferential tax rate of 5% for thermal solar systems and their components (Decision on amending the Decision to determine the products liable to preferential VAT rate, Official Gazette of the Republic of Macedonia no.116/2007)

1.4. REPUBLIC OF MACEDONIA IN THE INTERNATIONAL AGREEMENTS AND RES RELATED INITIATIVES

Republic of Macedonia is a signatory to the ***Energy Community Treaty***[8]. According to the Energy Community Treaty, signatory countries shall harmonize their national legislation in line with the existing EU legislation (*acquis communautaire*) on energy, environment, competition and renewable energy sources (Chapter 12). The Energy Community Treaty puts special emphasis on environmental protection, in particular related to natural gas and electricity, by

[8] Along Macedonia, countries signatories to the Energy Community Treaty also include Albania, Bulgaria, Bosnia and Herzegovina, Croatia, Montenegro, Romania, Serbia, Kosovo and the European Community. In 2006, Macedonia ratified the Treaty by means of a law.

means of improving energy efficiency and use of renewable energy sources. The organization of the Energy Community Secretariat is developing the Study on the implementation of the new Directive on the promotion of the use of RES[9], which in addition to the Strategy will provide guidelines for national RES targets.

Republic of Macedonia ratified the ***United Nation Framework Convention on Climate Change*** in 1997 and ratified the ***Kyoto Protocol*** in 2004. Republic of Macedonia is included among countries exempted from Annex I, i.e., countries without quantified obligations anticipated under referred international documents. As such, Republic of Macedonia can use the Clean Development Mechanism (CDM) to attract foreign investments for projects aimed to reduce greenhouse gas emissions, including projects in the field of renewable energy sources.

Republic of Macedonia signed the Statute of IRENA (International Renewable Energy Agency – IRENA) which included it among countries founders of this international organization (75 in number at the moment). It is planned that by 2010 the agency will become fully operational. Republic of Macedonia is to take active part in the preparatory activities for the establishment of IRENA and to get involved in on-going activities upon its initiation of operation. The Agency is established with the aim to become a leading actor in the promotion of fast transfer and sustainable use of renewable energy sources. For that purpose, IRENA will provide exchange of experience and knowledge and facilitation of new technology transfers among its members. IRENA will also facilitate access to relevant information related to the use of renewable energy sources.

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[9] IPA Energy + Water Economics & EPU-NTUA Study on the Implementation of the New EU Renewable Directive in the EC, Draft, December 2009

2. OVERVIEW OF RES RELEVANT FOR THE REPUBLIC OF MACEDONIA

2.1. HYDRO ENERGY

HPPs as electricity generating facilities fall under the group of environmentally clean technologies. Use of water as energy resource for electricity generation classifies HPPs in the group of renewable energy sources.

Table 2.1.1 shows the hydro energy potential[10] of river basins in Macedonia, classified according to official documents and developed studies. The best sites for construction of HPPs are found in the western part of the country, i.e., along the right-side bank of river Vardar. That is why most HPPs have already been constructed and new HPPs are to be constructed in this part of the country.

Table 2.1.1. Hydro potential along the river basins of Vardar and Crn Drim

River	Theoretical	Technical	Construction	Const./ Tech.	Planned	Plan./ Tech.	Total	Total/ Tech.
	GWh	GWh	GWh	%	GWh	%	GWh	%
Vardar above the confluence of Treska	1202	1084	488	45.02	140	12.92	628	57.93
Treska	377	347	190	54.76	60		250	72.05
Kadina river and Markova river	97	87						
Pcinja	265	201						
Topolka and Babuna	46	35						
Bregalnica	270	205	17	8.29			17	8.29
Crna	1098	944	184	19.49	604	63.98	788	83.47
Bosava	38	33						
Main flow of Vardar	1454	1336			1336	100.00	1336	100.00
Vardar	**4847**	**4272**	**879**	20.58	**2140**	50.09	3019	70.67
Radika	438	338			134	39.64	134	39.64
Crn Drim	710	548	513	93.61			513	93.61
Total for Crn Drim	**1148**	**886**	**513**	57.90	**134**	15.12	647	73.02
Total for Vardar and Crn Drim	5995	5158	1392	26.99	2274	44.09	3666	71.07
SHPPs	671*	440**	76	17.27	197	44.77	273	62.05
TOTAL	**6666**	**5598**	**1468**	26.22	**2471**	44.14	3939	70.36

**All 400 SHPPs (total capacity 255.5 MW and CF[11] = 0.3)*
***SHPPs > 1 MW, (total capacity 168.5 MW and CF = 0.3) according to the Study on 400 SHPPs in the Republic of Macedonia*

According to waters used and river basins, hydro facilities in Macedonia can be divided into power plants located on the river Crn Drim, which further flows into the

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[10] Energy Sector Development Strategy for Macedonia - Final Report, Ministry of Economy, Research Centre for Energy Informatics and Materials of the Macedonian Academy of Sciences and Arts and Electrotek Concepts Inc., July 2000

[11] CF is the annual operation factor of the plant's installed capacity; CF=W/(8760·P) where W is the annual electricity generation and P is plant's installed capacity.

Adriatic Sea, as well as basins of major confluences to the river Vardar, those being Treska and Crna. Mavrovo HPPs comprise a separate group and use the water flows in the mountain Sar Planina, which belong to the Vardar river basin and flow into the Aegean Sea. The estimated technical energy potential is mostly attributed to the river basin of Vardar with approximately 4270 GWh, followed by the river basin of Crn Drim with around 880 GWh, where the two river basins account for a potential of around 5150 Gwh, excluding the small confluences. Small confluences have an additional technical potential of around 440 GWh, and thereby the total hydro energy potential in Macedonia is assessed at around 5600 GWh. From the total energy potential, the already constructed hydro facilities use around 1470 GWh for average hydrology or 26% of the technical potential. According to the number of candidates for HPPs, the construction of hydro facilities with potential of around 2500 GWh or additional 44 % can be expected in the forthcoming period, which will provide a total use of the potentials at around 3900 GWh or around 70% of the technical potential in the country.

According to their installed capacity, distinction is made between small and large HPPs. This distinction is not rigidly defined, as under the existing circumstances in the country LHPPs are considered those with installed capacity above 10 MW, with the exception of HPP Matka, which is classified as large having in mind that its capacity is approximately 10 MW and it disposes with a reservoir lake.

Existing LHPPs in Macedonia are owned by the state company on electricity generation AD ELEM – Skopje (Power Plants of Macedonia) and two LHPPs are owned by the private company EVN Macedonia AD, company for distribution, distribution system operation and electricity supply for captive consumers connected to the distribution grid it owns on the territory of Macedonia. Majority of SHPPs are owned by EVN Macedonia, but there are also SHPPs owned by water economy undertakings (PEs)

2.1.1. LHPPs

LHPPs are generation units included in the electricity system of Macedonia and are used to cover variable energy. Depending on their reservoir size, installation and head fall, HPPs can be of multi-season, season, weekly or daily regulation potential.

2.1.1.1. Existing LHPPs

With the exception of Kozjak and Sv. Petka, most LHPPs in Macedonia have been constructed in the 60s and 70s of the last century, and were revitalized after almost 40 years of operation. The revitalization project replaced most of mechanical and technical equipment, and thereby increased their lifespan, but also improved the performance of turbines and increased their capacity. Table 2.1.1.1.1 provides the basic technical features of existing LHPPs in Macedonia.

Table 2.1.1.1.1. Basic features of existing LHPPs in the Republic of Macedonia

HPP	Basin	No. of aggregates	Q_{inst} / aggre.	H_{gross}	Vol	P_{inst}	W_{year}	Entry in the electricity system
			(m^3/s)	(m)	($10^6 m^3$)	(MW)	GWh	(year)
Vrben	Mavrovo	2	4.6	193	0	12.8	45	1957 / 1973
Vrutok	Mavrovio	4	9	574	277	172.0	390	1959 / 1973
Raven	Mavrovo	3	10.6	66	0	21.6	53	1959
Tikves	Crna river	4	36	100	272	116.0	184	1966 / 1981
Kalimanci	Bregalnica	2	9			13.8	17	2006
Globocica	Crn Drim	2	27	110.9	228	42.0	213	1965
Spilje	Crn Drim	3	36	95	212	84.0	300	1969
Kozjak *	Treska	2	50	100	260	80.0	150	2004
Matka**	Treska	2	20	28	1.1	9.6	40	2009
ВКУПНО						**551.8**	**1392**	

** Kozjak, under extremely high water level has the possibility to operate under H_{gross}=108 m and with capacity of 88 MW.*
***Matka is considered to be LHPP having in mind that its capacity is approximately 10 MW and it disposes with a reservoir lake.*

HPPs Vrben, Vrutok and Raven comprise the Mavrovo hydro-energy system with a significant regulation capability. HPP Globocica and Spilje together with Ohrid Lake as a reservoir comprise the cascade energy system on Crn Drim. The third important hydro-energy complex is located on the river Treska and includes HPP Kozjak, HPP St. Petka and HPP Matka. HPP St. Petka is under construction and it is expected to start operation by 2011, while HPP Matka was revitalized in the early 2009 whereby its flow was increased by double and was incapacitated to regulate the out-flow of the hydro-system into the river Vardar. Total installed capacity of existing LHPPs is around 550 MW, with average annual generation under average hydrology of around 1400 GWh.

2.1.1.2. Candidates for construction of LHPPs

Candidates for construction of LHPPs in Macedonia considered under the present Strategy are the facilities with relevant technical documents and hydro maps. Table 2.1.1.2.1 shows the basic technical features of candidates for construction of LHPPs in Macedonia[12]. Some of them are under construction, while for others tender documents are being developed and the tender procedure was completed for the third group of LHPPs. However, there are also hydro-energy facilities that have been under research for a longer period of time and their procedure on initiating construction has not started yet.

[12] According to ELEM documents.

Table 2.1.1.2.1. Basic features of candidates for construction of LHPPs in Macedonia

	Basin	$P_{inst.}$	W_{year}	Investment	Time of construction
		MW	GWh	mil €	year
St. Petka *	Treska	36	60		
Boskov Most	Radika	68.2	117	70	4
Lukovo pole and HPP Crn Kamen**	Mavrovo	5	163	45	4
Galiste	Crna river	193.5	264	200	7
Cebren***	Crna river	333	340/840	319	7
Gradec	Vardar	54.6	252	157	7
Veles	Vardar	93.0	300	251	7
10 HPPs in the Vardar valley	Vardar	176.8	784	486	7
TOTAL		**960**	**2280/2780**	1528	

**St. Petka is under construction and it is expect to start operation by 2011.*
***HPP Crn Kamen is a new HPP with capacity of 5 MW, while 163 GWh is the additional generation of all Mavrovo HPPs.*
****Cebren is HPP/Pumped-Storage HPP with annual generation of 340/840 GWh.*

The construction of HPPs along the Vardar Valley is conditioned with the reallocation of the railway track Skopje-Gevgelija with additional funds, where the new railway track will be constructed under a contemporary solution for two-way traffic and accelerated speeds. Railway reallocation activities have not been initiated, and its completion cannot be expected before 2020.

From the pool of HPP candidates, tender procedures for construction under public-private partnership were announced for HPP Galiste and HPP Cebren. HPP Cebren and HPP Galiste are power plants, which together with the down-flow located HPP Tikves comprise the hydro-energy complex on the river Crna. Due to the small water flow and high installed capacity, it is anticipated for HPP Cebren to constructed as pumped storage HPP and thereby to increase the operation of the entire electricity system. This will also result in a more efficient variable potential with positive financial outcomes.

Another important hydro-energy project is the reservoir system Lukovo Pole together with the down-flow HPP Crn Kamen. This will increase the generation output of the entire hydro-energy complex Mavrovo by additional 163 GWh.

The start of the construction of HPP Boskov Most is also planned.

HPPs Veles and Gradec on the river Vardar are facilities that require higher investments and additional construction ventures such as the reallocation of the railway track. These two HPPs should be constructed as integral part of the Vardar Valley project, together with the remaining SHPPs along the flow of river Vardar.

Total installed capacity of LHPP candidates accounts for around 960 MW, with average annual generation under average hydrology of around 2290 Gwh, i.e., around 2790 GWh when the calculation includes the generation from the pumped water at the Pumped-Storage HPP Cebren. Total electricity generation by LHPP candidates can vary depending on the hydrology, but also depending on the technical realization of HPP Cebren and Galiste as pumped-storage or conventional HPPs. Investments for the construction of these plants are estimated in the amount of around 1,530 million EUR.

2.1.1.2.1. Candidates for 10 Unified HPPs on Vardar

The project design and the Study[13] on the integral construction of the Vardar Valley anticipates 12 HPPs with cascade positions as given in Figure 2.1.1.2.1.1.

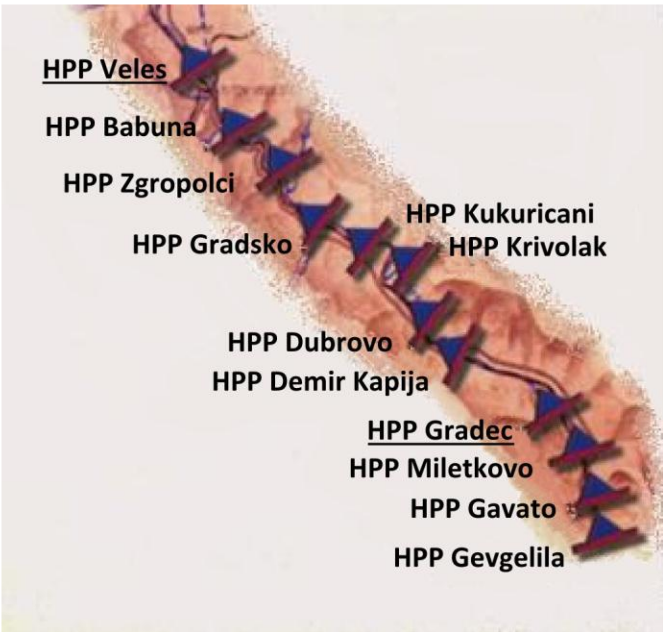

Figure 2.1.1.2.1.1. Location of HPPs on river Vardar

Two of these HPPs, notably Veles and Gradec, necessitate special treatment because of their installed capacity and generation output. Table 2.1.1.2.1.1 shows the remaining 10 HPPs anticipated as integral part of Vardar Valley project. All of them have been planned for construction with installed capacity in the range of 17 MW to 24 MW.

Total installed capacity of these 10 unified HPPs under same water flow accounts for around 177 MW and average annual generation of around 784 GWh. Total anticipated investments for their construction, when factoring in the railway track reallocation, amounts to approximately 486 million €.

Table 2.1.1.2.1.1. Candidates for 10 unified HPPs on river Vardar

HPP	Q_{inst}	H_n	P_{inst}	W_{year}	Investment
	(m^3/sec)	(m)	(MW)	(GWh)	(mil. €)
Babuna	240	8.5	17	56.9	36.65
Zgropolci	240	8.5	17	55.5	39.80
Gradsko	240	8.3	17	66.6	44.34
Kukuricani	240	8.3	17	79.5	43.88
Krivolak	240	8.3	17	80.0	43.88
Dubrovo	240	8.3	17	80.2	52.50
Demir Kapija	240	12	24	116.4	61.90
Miletkovo	240	8.2	17	80.3	53.89
Gavato	240	8.2	17	83.2	60.66
Gevgelija	240	8.3	17	85.1	48.50
TOTAL			**177**	**783.7**	486.01

[13] ELEM, Sector on Development and Investments, September 2008

2.1.2. SHPPs

SHPPs are with generation units with capacity of up to 10 MW.

2.1.2.1. Existing SHPPs

Table 2.1.2.1.1 shows the basic features of existing SHPPs in Macedonia. Majority of them are owned by EVN Macedonia, while a small number is owned by water economy undertakings.

Table 2.1.2.1.1. Basic features of existing SHPPs in the Republic of Macedonia

	Q_{inst}	P_{inst}	W_{year}	CF*
	(m^3/s)	(MW)	GWh	
Pena	2 × 2	3.3	9.43	0.33
Zrnovci	3 × 0.4	1.4	4.19	0.34
Pesocani	2 × 0.6	2.7	10.29	0.43
Sapuncica	2 × 0.4	2.9	9.96	0.39
Dosnica	3 × 0.7	4.1	15.02	0.42
Turija	2 × 2.3	2.2	5.20	0.27
Modric	1 × 0.4	0.2	0.43	0.20
Babuna	3 × 1.24	0.7	2.70	0.43
Belica	1 × 1	0.3	1.00	0.46
Glaznja	/	2.1	/	
Popova Sapka	4 × 0.6	4.8	18.00	0.43
Strezevo 1	/	2.4	/	
Strezevo 2	/	0.1	/	
TOTAL		**27.2**	**76.2**	**0.32**

* *CF is the annual operation factor of plant's installed capacity;*
CF=W/(8760·P) where W is the annual electricity generation and P is plant's installed capacity.

Total installed capacity of existing SHPPs accounts for around 27 MW with average annual generation of approximately 80 GWh.

2.1.2.2. Candidates for construction of SHPPs

Candidates for construction of SHPPs can be divided into two groups, the first one includes SHPPs offered for construction under the tender procedure announced by the Ministry of Economy, while the second group is comprised of other potential SHPPs owned by water economy undertakings and other hydro systems.

2.1.2.2.1. Candidates for SHPPs offered under tender procedure:

According to the Study[14] on SHPPs, Macedonia has 400 potential sites for construction of SHPPs with total installed capacity of 255 MW and estimated annual generation of around 1100 GWh. However, pursuant to the average generation of existing SHPPs, the annual generation output provided by the additional 255 MW will account for 670 GWh. In the meantime, certain sites were additionally covered with relevant studies and project designs and the Ministry of Economy is gradually

[14] Study on hydro power potential of SHPPs, 1980.

announcing construction tenders for the best and most perspective sites. Insofar, 4 tender procedures have been implemented for a total of 117 SHPPs with total installed capacity of 90 MW (see Annex_2). Estimated annual generation of these 117 SHPPs under CF=0.3 (2630 hours) accounts for around 236 GWh. In the previous period 3 tender procedures for which 35 concession agreements was signed was finished for total install capacity from 21MW

2.1.2.2.2. Candidates for SHPPs in other hydro systems

In addition to SHPPs covered with the tender procedures announced by the Ministry of Economy, plans are in place to construct SHPPs within other hydro-systems, as well as water supply or irrigation systems. Example thereof is the 3 SHPPs anticipated for constriction as part of the hydro system and shown in Table 2.1.2.2.2.1.

Table 2.1.2.2.2.1. Candidates for SHPPs as part of the the hydro-system Zletovica

	Q_{inst}	H_{gross}	P_{inst}	W_{year}
HPP	(m^3/s)	(m)	(MW)	(GWh)
Zletovica 1	3.2	235	3.1	8.96
Zletovica 2	3.2	163	2.5	7.23
Zletovica 3	3.5	133	1.9	5.49
Total			**7.5**	21.68

The hydro system Zletovica is under construction, and the first stage includes the construction of the dam and the drinking water supply system intended to service the eastern part of the country, together with the irrigation system. Construction of HPPs is planned for the second stage in the implementation of the HS Zletovica. All HPPs will be equipped with two generators. Total installed capacity of all three HPPs accounts for 7.5 MW and has average annual generation of up to 22 GWh. Table 2.1.2.2.2.2 shows the installed capacity and average annual generation of candidates for SHPP construction in Macedonia included in the tenders announced by the Ministry of Economy and the HPPs to be constructed as part of HS Zletovica

Table 2.1.2.2.2.2. Candidates for planned SHPPs

	P_{inst}	W_{year}
Planned SHPPs	(MW)	(GWh)
MoE tender	90	236
HS Zletovica	7.5	22.6
Total	**97.5**	**258**

In addition to the listed HPPs, several other SHPPs have also been anticipated for construction as part of water utility systems such as: HS Studencica, HS Lisice, HS Bosava and others, but they are not yet covered with technical data.

2.1.3. Comparison of existing and planned hydro facilities

The last section on hydro energy provides an overview of existing constructed and planned hydro-energy facilities in Macedonia. Table 2.1.3.1 gives an overview of existing and planned hydro-energy facilities in Macedonia. Figure 2.1.3.1 and

Figure 2.1.3.2 provide graphical overview of installed capacity and relevant generation of existing, planned and total HPPs in Macedonia, respectively.

Table 2.1.3.1. Overview of existing and planned hydro facilities

HPPs	EXISTING P_{inst} (MW)	EXISTING W_{year} (GWh)	PLANNED P_{inst} (MW)	PLANNED W_{year} (GWh)	TOTAL P_{inst} (MW)	TOTAL W_{year} (GWh)
BHPPs	552	1392	960	2280	1512	3672
SHPPs	27	76	97	258	124	334
Total	**579**	**1468**	**1057**	**2538**	**1636**	**4006**

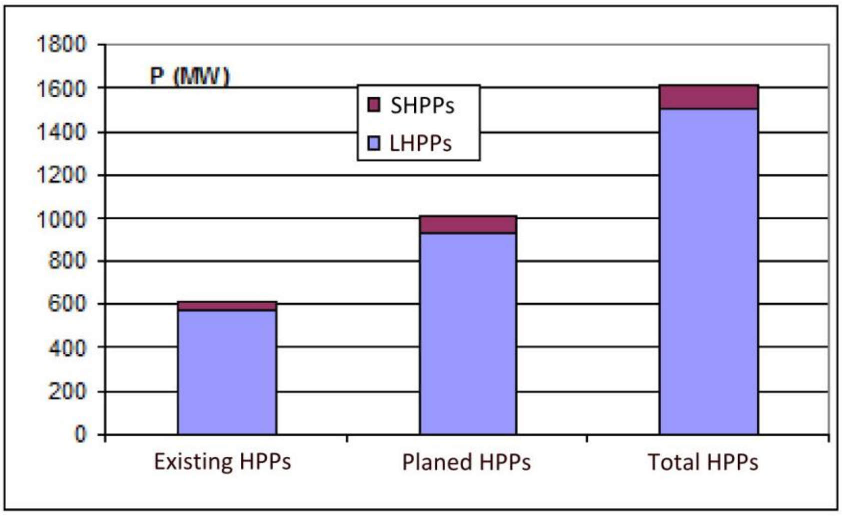

Figure 2.1.3.1. Installed capacity of existing, planned and total HPPs

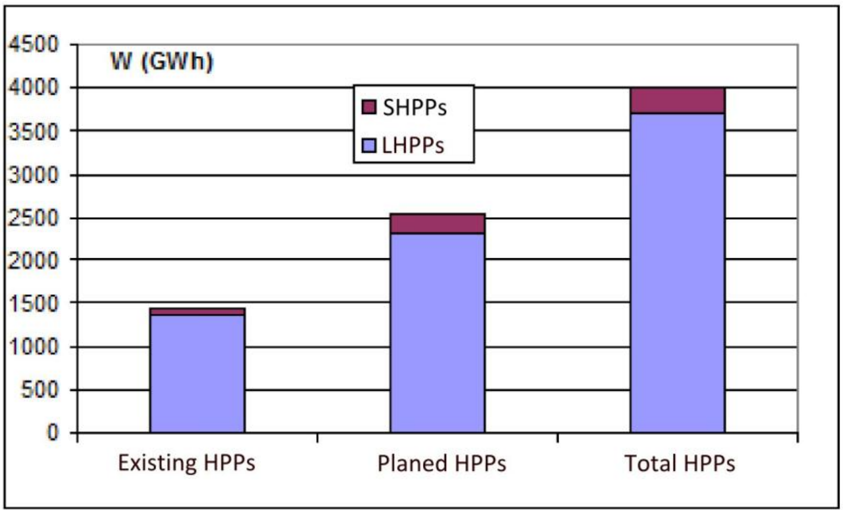

Figure 2.1.3.2. Average annual generation of existing, planned and total HPPs

HPPs planned for construction in the forthcoming period in Macedonia account for a total installed capacity of around 1060 MW, 960 MW of which belong to large hydro-energy facilities, while 100 MW to SHPPs. Accordingly, the total average annual production accounts for around 2540 GWh, where 2280 GWh is generated by

LHPPs and around 260 GWh by SHPPs. With the announced concession-awarding procedures for additional site intended for SHPP construction, it is expected that by 2020 the contribution of new SHPPs will reach installed capacity in the range of 80 to 120 MW and annual generation of 210 to 310 GWh. The construction of the remaining SHPPs is expected in the period 2020-2030. The revitalization of existing HPPs can result in additional electricity generation.

Under the current perspectives considering the hydro facilities, in the period until 2030 Macedonia is to increase its hydro potential to a total installed capacity of around 1700 MW and average annual generation of around 4400 GWh.

2.2. BIOMASS

Biomass has a significant contribution in the energy balance of the Republic of Macedonia. It participates with 166 ktoe (1930 GWh; 6950 TJ), which accounts for 11.5% of the total energy generated in the Republic of Macedonia (2006 data)[15], i.e., 6% of total primary energy consumed and 9.5% of total final energy consumed. Biomass for combustion accounts for 59% in the use of RES in Macedonia (Figure 4.2).

Biomass is particularly present with households, and meets 30 – 33% of total energy needs. Around 430,000 households (76%) use biomass for heating purposes.

It is estimated that the non-registered consumption of biomass for combustion accounts for 25 – 35% of the registered consumption.

Types and regional disbursement of biomass sources in Macedonia depend on the specifics of separate regions. Biomass is most commonly present in agricultural and forest regions throughout the country. From the total biomass used for energy purposes, wood and wooden coal account for 80%. In the Republic of Macedonia, portion of art of vine sprouts, rice chaff and fruit tree branches is used for energy purposes, while large portion of straw is used for fertilizers, livestock feed and production of cellulose. Therefore, it is not available for energy purposes.

Forest land in the Republic of Macedonia covers an area of around 11600 km^2 (1.16 million ha), where the total area under forests accounts for nearly 960 thousand hectares (status as recorded on 31 December 2006) (Table 2.2.1 and Figure 2.2.1). Total wood mass accounts for around 74 million m^3 (Table 2.2.2), while total annual growth accounts for 1.85 million m^3 with average annual growth of 2.02 m^3 per hectare.

Forests in state ownership account for 90.14% from the total areas, while total share in wood stock accounts for 92.2%. Private forests account for 9.86% (104 thousand hectares) from the total area under forests and contribute with 7.8% in the total wood stock. Private forests are of relatively small size, sometimes smaller than 1 ha, and are scattered as individual or grouped parcels representing enclaves within the state-owned forests.

8% of the total area under forests and forest land are not classified (no economy purpose).

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

Table 2.2.1 Forest stock per tree type in the Republic of Macedonia[16]

Forest stock (in hectares)	31.12.2005	Forest ownership (31.12.2006)		
	Total 2005	**Total 2006**	**State owned**	**Privately owned**
Total	**955228**	**959259**	**854799**	**104460**
Clean deciduous plantations	**555495**	**560389**	**486431**	**73958**
Beech	232644	235311	216918	18393
Oak (all)	284253	284587	237668	46919
Other hardwood deciduous trees	34224	35971	27867	8104
Poplar	457	480	201	279
Other softwood deciduous trees	3917	4040	3777	263
Clean needleleaf plantations	**83665**	**87569**	**76909**	**10660**
Picea	1419	1466	1427	39
Fir	3148	3278	3202	76
Black Pine	61795	64971	55755	9216
White Pine	10019	10259	8987	1272
Other needleleaf trees	7284	7595	7538	57
Mixed deciduous plantations	**251006**	**248439**	**231338**	**17101**
Beech- Oak – other deciduous trees	31768	31406	27610	3796
Beech – other deciduous trees	23677	22009	19310	2699
Oak – other deciduous trees	168339	169123	161076	8047
Other deciduous trees	27222	25901	23342	2559
Mixed needleleaf plantations	**5161**	**6383**	**5068**	**1315**
Picea – Fir	295	242	242	-
Black-White Pine	1316	2654	1339	1315
Other needleleaf trees	3550	3487	3487	-
Mixed deciduous and needleleaf plantations	**59901**	**56479**	**55053**	**1426**
Beech-Picea-Fir	10682	10693	10693	-
Black Pine, White Pine and other needleleaf trees	2656	2787	2768	19
Other deciduous and needleleaf trees	46563	42999	41592	1407

[16] Statistical Yearbook of the Republic of Macedonia, 2007.

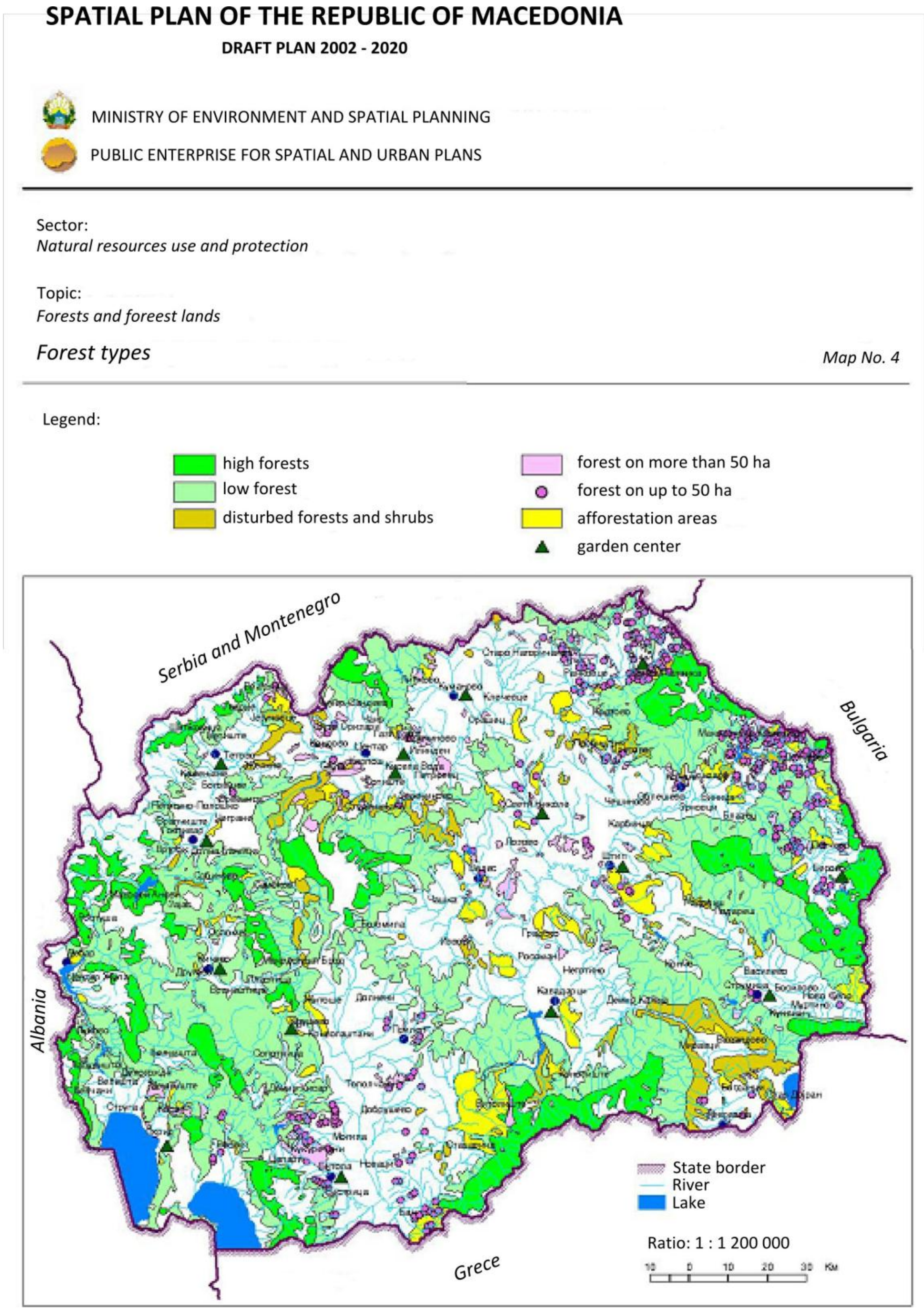

Figure 2.2.1 Forests according to forest type

Table 2.2.2 Forest categories in the Republic of Macedonia[17]

Forest categories (situation as recorded on 31 December 2004)	
Per types	
High forests	262790 ha with 46958000 m^3 wood mass
Low forests	643210 ha with 27375000 m^3 wood mass
By composition	
Broadleaf	825370 ha
Needleleaf	39860 ha
Mixed	40770 ha
By purpose	
Economy purpose	834347 ha
Protected	17617 ha
National parks and other forest with special purpose	54036 ha

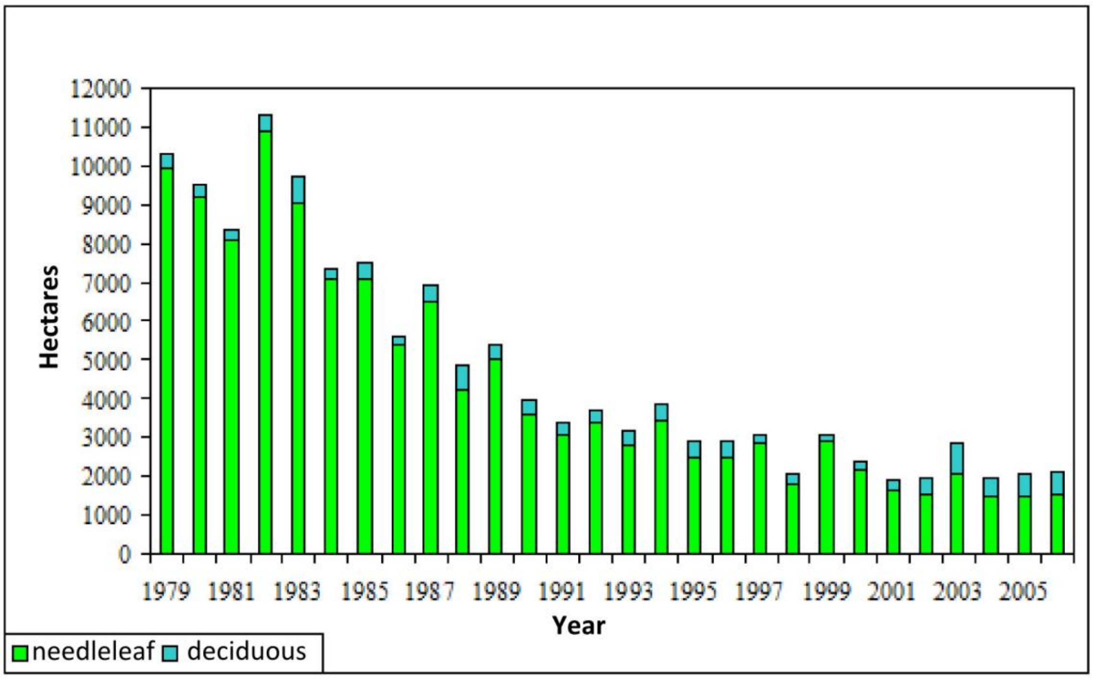

Figure 2.2.2 Afforestation 1979 - 2006

Total area under woods, forest plants and intensive plantations in Macedonia accounts for 38.8% of the total territory, which is relatively high share compared to Europe (29.3%) and compared to the neighbouring countries (Serbia 26.2%, Bulgaria 28.7%, Greece 16%). However, with 82 m^3/ha Macedonia is considered poor as regards the forest quality. Around 71% of the area is covered with shrublands and disturbed natural forests and only 37% of total wooden mass. Another important feature is the existence of large areas in Macedonia under low afforestation, as well as empty and non-wooded lands which are suitable for afforestation.

With the assistance of the Afforestation Fund, which was operational until 1990, more than 140 thousand hectares of empty land were afforested and an

[17] Strategy on Sustainable Development of Forestry in the Republic of Macedonia, Ministry of Agriculture, Forestry, and Water Economy, 2007.

increase index of 1.6 was achieved in terms of afforestation. From around 10 thousand hectares afforested annually during the 70s and 80s of the last century, in the last decade the afforestation was reduced to only 2 thousand hectares annually (Figure2.2.2).From that 75% concern needleleaf forests and the remaining belong to deciduous trees.

Encouraging are the afforestation actions implemented in the last years and as a cooperation venture between the Government of the Republic of Macedonia and the non-governmental sector.

Forestry in the Republic of Macedonia is an economy activity, which contributes with 0.3 – 0.5 % in the gross domestic product, however under valuation of its common beneficial functions, the forestry's contribution is significantly higher.

The wood mass growth rate is given in Table 2.2.3.

Table 2.2.3 Growth rate and use of wood[18]

Forest categories per type (situation as recorded on 31.12.2004)	**Growth**	
	m^3	**m^3/ha**
High forests	906141	3.45
Mix-aged	690977	4.14
Even-aged	215164	2.24
Low forests	888475	1.59
Other	34415	0.40
Shrub	31370	0.40
Macchia	648	0.40
Bush	2397	0.39
Total	1829030	2.02

Contribution of forestry in the national economy is mainly attributed to the PE Macedonian Forests, which was established on 15 December 1997 by means of a decision taken by the Government. The main activity of this enterprise is to manage state-owned forests, which implies use, maintenance and protection of forests.

After 2001, PE Macedonian Forests supplies the market with 600 – 720 thousands m^3 fire and technical wood annually[19], while private forests have marked additional 120 – 180 thousands m^3. Around 90% thereof are deciduous and the remaining are needleleaf trees.

Having in mind that as high as 71% of maintained forests are low forest that do not provide technical mass (Table 2.2.2), it is only logical that they are used to produce fire wood. In the total produced wood products, fire wood accounts for 70 to 75%, but such data cannot be considered precise as most of the population is supplied with fire wood from illegal forest-cutting which cannot be registered.

Total forest-cutting in the forests in Macedonia is shown in Table 2.2.4 and Figure 2.2.3.

[18] Strategy on Sustainable Development of Forestry in the Republic of Macedonia, Ministry of Agriculture, Forestry and Water Economy, 2007.

[19] Statistical Yearbook of the Republic of Macedonia, 2007.

Table 2.2.4. Forest-cutting in the Republic of Macedonia [20]

In thousand m³					
Year	2002	2003	2004	2005	2006
State-owned forests	***657***	***764***	***724***	***682***	***821***
Private forests	***153***	***166***	***121***	***139***	***80***
Technical wood	133	142	141	158	162
Fire wood	602	709	642	600	662
Residue	75	79	62	63	77
Total wood mass	**810**	**930**	**845**	**821**	**901**

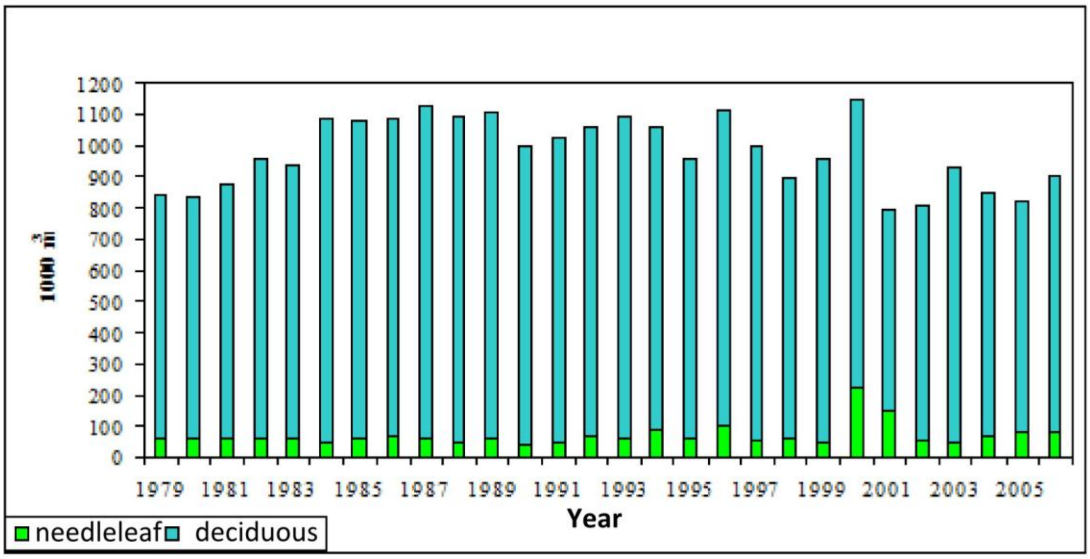

Figure 2.2.3. Forest use in Macedonia for the period 1979-2006[21]

2.2.1. Waste biomass

Waste biomass is comprised of:

- residue from forest-cutting,
- residue from wood processing,
- residue from agriculture,
- residue from livestock breeding,
- industrial residue, and
- solid municipal waste.

Several studies have been developed to estimate the waste biomass in the Republic of Macedonia[22], including studies with comprehensive scope and quality[23], but one cannot say they contain sufficiently reliable data on the estimated cost-

[20] Statistical Yearbook of the Republic of Macedonia, 2007.
[21] Statistical Yearbook of the Republic of Macedonia, 2007.
[22] Biomass Availability Study for Macedonia, A.B. van der Hem, SENTER project PSO99/MA/2/2, February 2001.
[23] Energy from Biomass, Slave Armenski, Skopje, 2009

effectiveness, nor there are sufficient experiences in regard to construction of such facilities.

The present Strategy already informed that in the total biomass used for energy purposes, wood and wooden coal account for 80%. The remaining 20% or around 380 GWh are contributed to waste biomass, primarily residue from forest-cutting and wood processing, vine sprouts, rice chaff and fruit tree branches.

Waste biomass from wood and agriculture

Macedonia is experienced in terms of use of waste biomass from forest-cutting, wood processing and agriculture, where its primary use is related to heat generation. However, this type of waste biomass is suitable also for use by cogeneration plants for heat and electricity generation.

Residue from forest-cutting. Planned forest-cutting, forest-reduction, forest-cutting intended for road construction and forest-cutting of fire-affected and ill-trees create residue in the form of branches, trunk parts, crust, roots, wood chips, etc. According to Table 2.2.4, in average residue from forest-cutting accounts for around 70 thousand m^3 annually, which represents 8% from total forest-cutting[24]. According to some research[25] from 2000, residue from forest-cutting in Macedonia is estimated at around 14% from total forest-cutting or around 150 thousand m^3. However, these research indicate that this is a result of the old machinery used for forest-cutting and of intentional creation of residue for future non-registered use. Of course, the use of modern cutting technologies would result in a residue of around 7% from total forest-cutting or around 75 thousand m^3 annually. This accounts for 47 thousand tons per year. Small portion of such residue - 40 - 100 m^3 annually – is used by forestry companies to heat their premises, while the remaining portion is left in the forest. Even more developed European countries, where the companies charged with forest-cutting by law are obliged to clean the reside from forest-cutting activities, fail to comply with such provisions due to the high price of residue collection in mountain areas that are difficult for access. Under the assumption that in Macedonia around 40% from forest residue can be used by small cogeneration plants for heat and electricity generation located to the closest heat consumers, such would account for 30 thousand m^3 annually, or nearly 20 thousand tons annually.

Residue from wood processing. In the Republic of Macedonia, every year around 160 thousand m^3 technical wood is processed (Table 2.2.4). There are around 100 companies for wood processing. Most of them are small sawmills. A number of bigger companies deal exclusively with furniture production, while another group of companies deal with primary and secondary wood processing. Residue created in the course of wood processing is comprised of wood chips, chips, cut-off from timber, logs, wood dust, etc.

It is estimated [26] that larger companies, primarily dealing with primary and secondary wood processing, process around 50 thousand m^3 technical wood per year. In that, they produce around 18 thousand m^3 wood residue. However, most of it is used in the companies' boilers to produce steam and heat. Portion of the wood dust is

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[24] Statistical Yearbook of the Republic of Macedonia, 2007.

[25] Biomass Availability Study for Macedonia, A.B. van der Hem, SENTER project PSO99/MA/2/2, February 2001.

[26] Biomass Availability Study for Macedonia, A.B. van der Hem, SENTER project PSO99/MA/2/2, February 2001.

used to produce briquettes and pellets. This quantity of biomass is already calculated in the statistical data on the consumption of biomass for combustion. However, some boilers are quite old and their replacement with new cogeneration plants for heat and electricity can be expected. Under the assumption that this share accounts for 40%, the available biomass for this purpose accounts for around 7 thousand m^3 wood residue per year.

Smaller companies, mainly sawmills, process around 110 thousand m^3 technical wood and produce around 55 thousand m^3 wood residue per year. This wood residue is not used. The problem lies in the fact that most of these companies do not need heat. If 30% of this residue is used by smaller plants, it would account for 16 thousand m^3 wood residue per year.

Total potential of residue from wood processing that could be used for heat and electricity cogeneration is estimated at 23 thousand m^3 or around 10 thousand tons wood residue per year.

Residue from agriculture. The residue from agriculture in Macedonia, which is relevant for heat and electricity cogeneration includes vine sprouts, fruit tree branches and cereal and industrial crops, as well as residue from food processing. Portion of them is used for heat generation.

Around 26000 ha in Macedonia are under vine plantations. The average annual production of 3 tons of vine sprouts per hectare [27] created in the course of vineyard trimming process accounts for 80 thousand tons of waste biomass. The practical availability of vine sprouts is estimated at around 30 thousand tons per year.

Total area under fruit tree plantations is estimated at 17 thousand hectares. Under production of at least 1 ton residue per hectare, it would account for at least 20 thousand tons waste biomass per year. Portion of this biomass is used and can be expected to be used by cogeneration plants for heat and electricity in the amount of 4 thousand tons per year.

Macedonia has a significant production of straw from cereal crops (around 350 thousand tons per year), but it is considered more cost-effective to use it for fertilizers, livestock feed and production of cellulose, and thereby it is not available for energy purposes. Ice chaff is also available for energy purposes and is estimated at around 7 thousand tons annually. Combustion boilers using rice chaff have been installed in Kocani, but they can rely only on around thousand tons of rice chaff per year for heat and electricity cogeneration.

Total waste biomass from agriculture that can be used in an cost-effective manner for heat and electricity cogeneration is estimated at nearly 35 thousand tons per year.

Total. When summarizing the above presented data, it can be concluded that Macedonia uses around 380 GWh waste biomass, primarily from forest-cutting and wood processing, vine sprouts, rice chaff and fruit tree branches. However, there is a significant portion of non-utilized waste biomass from forest-cutting, wood processing and from agriculture. The results shown in Table 2.2.1.1 were obtained by summing up the non-utilized biomass whose use for heat and electricity cogeneration can be considered cost-effective, together with the portion of biomass used for heat generation by old boilers that can be redirected for use by cogeneration plants.

[27] Data on 5-6 t/ha used for Macedonia is considered unrealistic by most experts (Biomass Availability Study for Macedonia, A.B. van der Hem, SENTER project PSO99/MA/2/2, February 2001).

Table 2.2.1.1. Waste biomass from forest-cutting, wood processing and from agriculture that can be used for heat and electricity cogeneration in a cost-effective manner

	Thousand tons per year
Residue from forest-cutting	20
Residue from wood processing	10
Residue from agriculture	35
Total	**65**

The 65 thousand tons of waste biomass from forest-cutting, wood processing and from agriculture can generate around 50 - 70 GWh electricity and 120 – 180 GWh heat at congeneration plants depending on the demand and accessibility to heating energy consumers.

Solid municipal waste

The term solid municipal waste refers to waste collected from households, together with the public hygiene maintenance and collection of waste from parks, commercial and institutional waste, waste from construction and waste from industry similar to that produced by the households.

Solid municipal waste in Macedonia is disposed at large number of landfills. However, only landfill Drisla, servicing the region of Skopje, is properly managed. For the forthcoming period plans have been made to establish integrated regional management of solid municipal waste. Seven regional landfills have been planned for establishment throughout Macedonia[28]. Total quantity of solid municipal waste in Macedonia accounts for nearly 700 thousand tons per year. From this amount, the regional landfill Drisla accounts for around 200 thousand tons, while the other regional landfills account for 50 or 100 thousand tons. Lower heating value of municipal waste in Macedonia is estimated at 7860 kJ/kg[29]. It is estimated that paper and plastic waste contribute with 24% and 6% in the total waste quantity, respectively. If the average degree of 50% paper and plastic waste recycling is achieved, the waste quantity would be reduced to approximately 600 thousand tons and the calorific value of waste would be 6200 kJ/kg, while under a high degree of paper and plastic recycling[30] the waste quantity will be reduced to around 500 thousand tons and the calorific value of waste would be less than 4000 kJ/kg. Depending on the option pursued, the potential of solid municipal waste in Macedonia ranges from 500 to 1500 GWh annually. If it is used only for electricity generation[31] it would imply a generation in the range of 200 – 500 GWh annually provided the total potential in Macedonia is put into use. The upper limit implies that Macedonia will not implement plastic and paper recycling, which – of course – is

[28] National Strategy on Environmental Investments (2009-2013), Ministry of Environment and Spatial Planning of the Republic of Macedonia, March 2009

[29] Slave Armenski, Energy from Solid Municipal Waste, (in Renewable Energy Sources in Macedonia, K Popovski and others, MAGA, Skopje 2006.

[30] Croatia has reached PVC recycling level of almost 100%.

[31] Landfills, in particular Drisla are distant from the heat consumption, and if plants are anticipated for construction near cities, it would be conditioned by extremely high environmental protection costs.

unrealistic, while the lower limit under high degree of waste and paper recycling, implies cogeneration technologies with high investment costs due to the low calorific value of waste. Even under the optimistic scenario, the annual generation of electricity from solid municipal waste in Macedonia would hardly reach 20 GWh.

Industrial waste

In addition to industrial residue from wood processing and residue landfilled as solid municipal waste, which have been addressed above, as well as the waste recycled in the course of the industrial production process, there is also other waste suitable for energy generation. This potential has not been explored in details, but it has been estimated that it can significantly contribute in the total energy generation from biomass.

Residue from livestock breeding

Residue from livestock breeding contains stable-generated waste used for energy purposes, primarily biogas obtained from anaerobic fermentation. Biogas is obtained from methane and carbon-dioxide in the ratio 2:1 and from small quantities of NH_3 and H_2S. In Macedonia, the residue from stable breeding of livestock and poultry is estimated at around 3.5 million tons per year. It can be used to obtain a total of around 90 thousand m^3 biogas per year, with a total energy of around 600 GWh. However, experiences in terms of cost-effective use of biogas in the region are modest and the actual potential does not exceed 25% from the total potential. It is estimated that such potential can result in a maximum of less than 50 GWh electricity.

2.2.2. Biofuels

The first factory for biofuels in the Republic of Macedonia was established in 2007. The refinery is owned by the private company Makpetrol and has the capacity of 30 thousand tons annually. Biodiesel fuel is produced from non-refined oil obtained from rape seed. At the moment, non-refined rape oil is secured from imports.

Two other factories on biodiesel fuel production have been planned for construction in the Republic of Macedonia; the first one owned by "Blagoj Gorev" from Veles will extract the oil from sunflowers, rape and soya, and is planned with the capacity of raw material processing exceeding 20000 tons per year and resulting in the production of 13000 tons biodiesel fuel.

The consumption of biofuels by 2020 is planned at the level of 10% from total consumption of fuels for transport[32], i.e., around 48 - 56 ktoe/year, which is within the range of planned production facilities.

These quantities of biofuel would replace the appropriate quantities of diesel and petrol fuel consumption for transport.

It should be noted that the European Union, i.e., the Committee on Industry, Research and Energy within the European Parliament – after it has reconsidered the target for biofuels – positively assessed the mandatory target of 10% of biofuels in the total petrol and diesel fuel consumption by 2020, but has proposed a limitation in

[32] Strategy on Energy Development for the Republic of Macedonia until 2030, MASA, 2010.

regard to biofuels produced from seed, as that might distort the competitiveness in food production. It has been proposed for 60% of the overall target to be comprised of biofuels produced from raw food materials, while the remaining 40 % to be biofuels from the second generation or electricity and hydrogen, if produced from renewable energy sources. The Directive 2009/28/EC does not include this obligation, but emphasizes that the Community shall undertake all measures required to promote the sustainability criteria in the production of biomass for biofuels, as well as measures to develop the second and third generation of biofuels. Production of biomass for biofuels shall be supported in the light of increasing the overall agricultural production and use of degraded lands. Further on, production of biofuels from waste, residue, non-food cellulosic materials, etc., shall be promoted.

The second generation of biofuels are fuels obtained from agricultural waste, residues from agricultural production, non-food cellulosic materials and ligno-cellulosic materials.

Despite the fact that technologies for second-generation biofuels are under development (high degree of development), conditions need to be created in the Republic of Macedonia for their application.

Notably, from the total biomass created on the agricultural fields, 40% must be restored to the soil, 30% are used as livestock feed or at farms, and the remaining 30% can be used for production of biofuels.

2.3. GEOTHERMAL ENERGY

Macedonia has a long-standing experience in terms of geothermal energy use. Nevertheless, the last 20 years for Macedonia have been a period of standstill as concerns the development of geothermal energy. No investments were made in research, development or new projects. As as result, the use of geothermal energy has significantly declined in the last several years: from 21 ktoe annually in 2001 it was reduced to 9 ktoe (around 400 TJ; 110 GWh) in 2006. In the total primary energy consumption, geothermal energy accounts for around 0.4%, while its share in the final energy consumption accounts for 0.5%.

Significant use of geothermal energy is seen in balneology.

The territory of the Republic of Macedonia belongs to the region of Alps-Himalayas, with a sub-zone characterized by no contemporary volcanic activity. At the moment, 18 geothermal fields are known with more than 50 geothermal springs and wells. Total flow is around 1000 l/sec at a temperature of 20-78 ºC. Hot waters are predominately of hydrocarbon nature, having in mind their dominant anion and mixed structure with equal presence of sodium, calcium and magnesium. Dissolved minerals are within the range of 0.5 to 3.7 g/l.

All thermal waters in Macedonia are of meteoric origin. The hot spring is the regional flow of heat, and in the Vardar area it accounts for 100 mV/m^2, under earth layer thickness of around 32 km.

Use of thermal waters in Macedonia is comprised of several geothermal projects and a number of spas. All of them are fully equipped and operate since the 80s from the last century.

Use of this potential for energy purpose pertains to local government competences. Having in mind the relatively low temperature (highest temperature recorded is 78 ºC in the Kocani region), it is mainly used to meet heating demand. Basic (dominant) use was noted in regard to heating greenhouse complexes. As far as the industry is concerned, (in Kocani) this energy was used for heating administrative buildings and hot water preparation at the paper factory (which is not in operation for a longer period of time). Minimum quantity of energy is used for heating buildings (several administrative buildings in Kocani, the hotel complex “Zar Samoil” with the accommodation facilities in its vicinity, as well as the facilities at Negorski banji).

The already researched geothermal potential indicates that Macedonia has no springs that would enable electricity generation. Such purpose would necessitate geothermal water temperature of at least 120 ^{o}C for the project to be considered economically justifiable. Certain studies indicate that at depth of around 5000 m steam can be found at a temperature exceeding 100 ^{o}C. However, the price for drilling wells exceeds the amount of 1 million USD per well. Such investment cannot be recovered under the current electricity prices[33].

Under current capacity of geothermal springs, it cannot be expected the use of geothermal energy for heating buildings in Kocani to increase, as the existing capacity borders with the limit required to meet the heating demand of connected greenhouse complexes, while the underground capacity (quantity of waters that can be used) is limited. Under quite lower atmospheric temperatures, the greenhouses need to re-heat the water or lower the temperature in the protected area to the level suitable for plants to sustain, or sacrifice the entire crop.

In the last period, activities have been taken to modernize the geothermal system “Geotherma” in Kocani, and they are financially supported with the bilateral assistance from the Government of Austria. Last year a new well was drilled in Istibanja near Vinica. The construction of a new exploitation well is underway and new exploratory drilling was made on the location in Kocansko pole. With additional funding for research work, it has been estimated that additional capacities can be developed in the Strumica region as well. Partial recovery of used geothermal waters (re-injection) has been anticipated as well by means of existing wells in the spa Banjsko, but they require previous elimination of colloid materials contained in the waters. There are also private initiatives for drilling new wells. Such activities have been undertaken in Dojran as well. A study is being developed on well drilling for the power plant with capacity of 5 MW in Kocani. There is also a study on binary cycle power plant with capacity of 750 kW. Initiation of activities on oil prospection will certainly contribute to identification of new wells with higher temperature waters.

The geothermal energy potential for heating greenhouses should be correlated to agriculture development and the need for greenhouses. In order to achieve this goal, in addition to already undertaken activities, new actions are needed by the local government and the Government.

2.4. SOLAR ENERGY

Symbolic level of solar energy use is noted in regard to hot water preparation in households. Macedonia's geographic position and climate, however, offer a much better perspective on the use of solar energy. Total annual solar radiation varies from minimum 1250 kWh/m^2 in the northern part of the country to maximum 1530 kWh/m^2 in the south-western part and provides an average annual solar radiation of 1385 kWh/m^2 (Figure 2.4.1.).

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[33] Energy Sector Policy Note, World Bank, Report No. 48983-MK, October 2009

Annual average of daily radiation varies between 3.4 kWh/m^2 in the northern part of the country (Skopje) and 4.2 kWh/m^2 in the south-western part (Bitola). Climate conditions – high solar intensity and duration, temperature, humidity – provide favourable conditions for successful development of solar energy. The continental climate with hot and dry summers classifies Macedonia among the countries with high potential for use of solar energy, compared to the average of European countries.

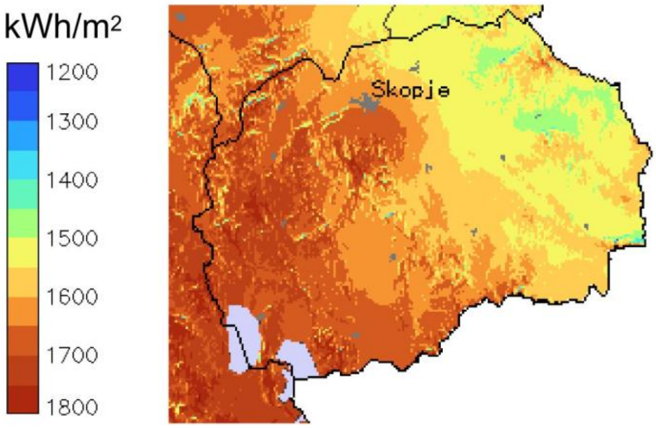


Figure 2.4.1. Map of solar energy resources [34]

2.4.1. Thermal systems

When speaking of solar energy technologies, they primarily refer to solar thermal systems for hot water preparation. According to the climate in Macedonia, interesting is the behaviour of household systems, as well as large solar systems which are usually installed as part of hospitals, hotels and other similar buildings. Typical household system include S1, with boiler storage capacity of 160 l and collector area of 2.6 m^2 (which meets the needs of 4-6 people) and S2 with boiler storage capacity of 115 l and collector area of 1.9 m^2 (which meets the needs of 3-4 people). In regard to these two systems, annual estimates have been made for the cities of Skopje, Stip and Bitola. Anticipated annual output parameters of both systems are given in Table 2.4.1, under conditions of consumption of one boiler volume by the end of the day, which is a realistic assumption if the relevant size system is installed.

Table 2.4.1.1. Annual energy delivery (kWh/m^2) from household solar system for hot water preparation [35]

City	Household solar system	
	S1(160/2.6)	S2(115/1.9)
Skopje	620	549
Stip	624	558
Bitola	734	697

[34] Photovoltaic Geographical Information System (PVGIS), http://re.jrc.ec.europa.eu/pvgis/countries/countries-europe.htm#wb

[35] EXERGIA S.A, Markovska N., local expert for solar energy: **Use of Renewable Energies and Energy Conservation**, **Part D: Report on solar energy, biomass and wind energy**, in Investment Options in the Energy Sector, Component 6, PHARE Programme, January 2003.

The table shows that the capacity for annual energy delivery of relevant systems in average accounts for 600 kWh/m^2. It is assumed that household solar systems for hot water will partially replace the system using electricity. Accordingly, in average households will benefit from around 450 kWh/m^2 annually from the system.

The financial assessment takes the average solar system with boiler volume size of 130 l and collector area of 2.2 m^2. The price of such system would be in the range of 700 EUR. Average annual use of energy from the system is 990 kWh (2.2 m^2 × 450 kWh/m^2). The price of electricity to meet household needs in Macedonia is within the range 0.05 EUR/kWh. Annual savings amount to around 50 EUR (990 kWh × 0.05 EUR). Consequently, the return period for such system is loner than 10 years, and thereby is not considered attractive investment. One of the reasons is the relatively low electricity price for households. It is expected that the introduction of market electricity prices (in 2015) and the expected increase of electricity prices in the region (due to the price paid by TPPs on the account of greenhouse gas emissions) will make the solar systems more attractive. The situation will be improved with new households or under conditions of replacing defected electricity water heaters, where the solar system cost should be deducted from the heater cost. It should be noted that households with installed solar systems spend more hot water and thereby increase their quality of life.

The assessment of the potential in the household sector can be made when starting from the number of households in Macedonia, which is around 600000 and in long-term perspective assuming that 25% of them (150000) will be able to install individual solar systems for hot water. The annual energy delivered under such assumptions would be around 149 GWh (150000 × 2.2 m^2 × 450 kWh/m^2).

The penetration rate of solar systems in the public and commercial sector is relatively low, for example in Greece large systems account for a small share of systems installed by households (around 10%), although there are large number of hotels that can use solar energy for hot water preparation. In Macedonia, under the assumption that this share will be twice as smaller (5%), the potential is estimated at around 7 GWh (149 GWh × 0.05).

2.4.2. Electricity-generating systems

Solar thermal power plants

These power plants use solar energy to heat the working fluid which is then used by the conventional power plant to generate electricity. There is a variety of solutions and technologies and installations of solar thermal power plants. The use of such plants is increasing throughout the world, in particular in Spain (more than 200 MW in operation and over 1 GW under construction) and USA (more than 400 MW in operation and nearly 100 MW under construction and over 8 GW planned). Only few other systems of this type (3-4) have been constructed outside these two countries and several more are under construction.

AD ELEM plans to develop a feasibility study on the solar power plant project with thermal technology and installed capacity of 50 MW and annual generation of 104 GWh. If the study recommendations are positive, the process will continue with the announcement of a tender procedure aimed to identify a strategic partner for the public-private partnership, followed by the construction of the solar power plant in the period after 2020.

Photovoltaic systems

Despite solar energy advantages of Macedonia as a country located in the the south of Europe, poor country in terms of in-country energy resources, but with long tradition of theoretical and experimental research in the field of photovoltaic systems, the practical application of such systems is still limited to several pilot installations under telecommunications and street lighting projects in several municipalities.

In order to stimulate investment in photovoltaic systems, the Energy Regulatory Commission has recently adopted feed-in tariffs for purchase of electricity generated and delivered by photovoltaic systems at the rate of 46 Euro cents/kWh (for systems with capacity below 50 kW) and 41 Euro cents/kWh (for systems with capacity above 50 kW). These tariffs make the investments more cost-effective, but their realization requires elimination of technical, administrative and legislative barriers.

2.5. WIND ENERGY

Use of wind energy is a current discussed and exploited matter in the light of electricity generation from renewable energy sources. According to their geographic position, sites most suitable for use of wind energy are divided into two groups, those being: offshore sites and inland sites. Due to the meteorological conditions and air mass flows, offshore sites are more favourable for construction of wind power plants. For landlocked countries, such as Macedonia, additional research is needed to identifying suitable sites for WPP construction.

According to the international classification, potential sites for WPP construction are divided into two classes[36] according to the wind power density (WPD), or according to the wind speed. Classes are given in Table 2.5.1.

Table 2.5.1. Wind classes according to the wind power density and wind speed at 10 meters and 50 meters altitude.

10 meters		
	WPD*	v
class	W/m2	m/s
1	<100	<4.4
2	100-150	4.4-5.1
3	150-200	5.1-5.6
4	200-250	5.6-6.0
5	250-300	6.0-6.4
6	300-400	6.4-7.0
7	>400	>7.0

50 meters		
	WPD	v
class	W/m2	m/s
1	<200	<5.6
2	200-300	5.6-6.4
3	300-400	6.4-7.0
4	400-500	7.0-7.5
5	500-600	7.5-8.0
6	600-700	8.0-8.8
7	>800	>8.8

* $WPD=0.5\rho v^3$, *where* ρ *and* v *are wind density and speed.*

WPPs are constructed as complex of several individual wind turbines, which provide energy in an integral manner by means of connecting the WPPs to the electricity system. The selection of commercially available wind turbines depends on

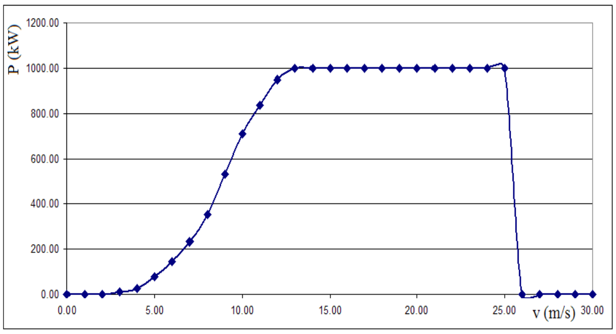
[36] American Wind Energy Association (www.awea.org/faq/basicwr.html).

the investor's preference and WPP designer's idea. Almost all commercially available wind turbines operate within the wind speed range of 4m/s to 25m/s, but the speed suitable for the turbine's installed capacity is around 12m/s. For the purpose of estimating the wing energy potential of sites covered with metered values, we have selected 3 types of commercially available wind turbine-generator systems for electricity generation with their own energy specifics.

Type of wind turbine –1000 kW
Start-up speed
3 m/s

Rated speed
13 m/s

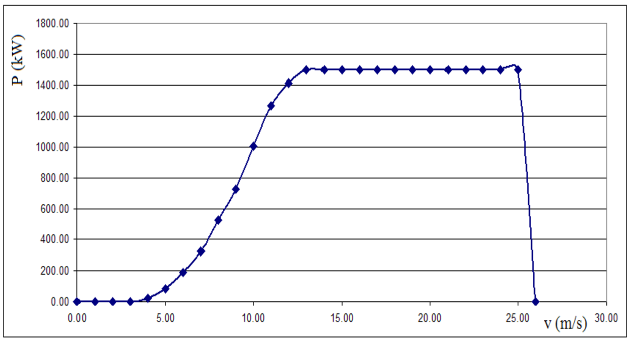
Shut-down speed
25 m/s



Type of wind turbine – 1500 kW
Start-up speed
4 m/s

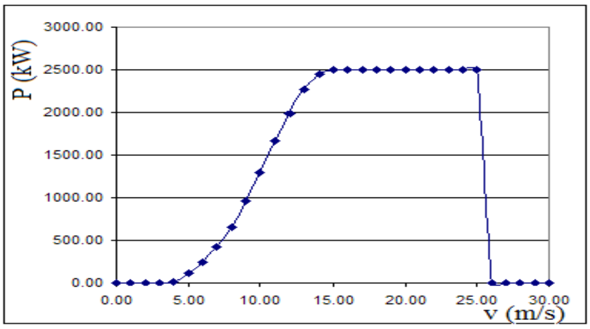
Rated speed
13 m/s

Shut-down speed 25 m/s



Type of wind turbine – 2500 kW
Start-up speed
4 m/s

Rated speed
15 m/s
Shut-down speed
25 m/s



2.5.1. Energy potential

Up to this moment, several studies have been conducted in Macedonia aimed to identify most favourable sites for WPP construction, as well as to estimate the wind energy potential at relevant sites. According to the study developed on the basis of satellite images from AWSTruewind[37], the Atlas on wing energy potential in Macedonia was designed.

In compliance with the study, 15 most favourable sites for WPP construction were selected in Macedonia and are presented in Figure 2.5.1.1. The Figure also shows the wind map in Macedonia.

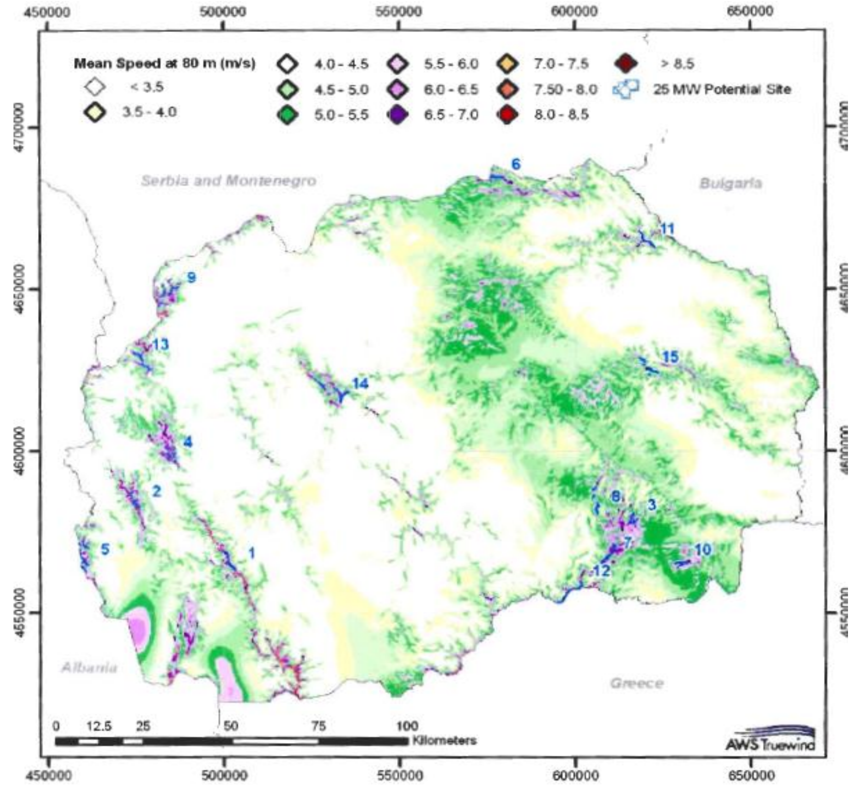


Figure 2.5.1.1. Map of most favourable sites for WPP construction

According to the geographic location and landscape configuration, favourable sites for WPP construction in Macedonia include the valley of the river Vardar, i.e., the Povardarie region, Ovce Pole in the vicinity of Sveti Nikole, as well as higher mountains characterized by high wind speeds.

Table 2.5.1.1 shows the basis values of 15 sites selected as most favourable for WPP construction and are thereby included in the Atlas.

Only 3 from the 15 sites are located on an altitude of 1000 meters, while the remaining are located in mountainous areas throughout the country, where 6 sites are on altitude of 2000 meters, which is considered non-conductive to WPP construction. Construction of WPPs with installed capacity of around 25 MW and operational capacity or CF (Capacity Factor) in the range of 0.27 to 0.39 is planned for all sites.

[37] Wind Energy Resource Atlas and Site Screening of the R. of Macedonia, AWSTruewind, June 2005

Table 2.5.1.1. Data on most favourable sites for WPP construction

	Altitude	Wind speed at altitude of 80 m (m/s)	CF*	P (MW)	Estimate on low costs for connection to the electricity system (mil. €)
1	1896	8.41	0.389	25	2.02
2	2079	7.97	0.347	25	2.10
3	566	7.35	0.338	24.9	1.50
4	1994	7.63	0.325	25	2.00
5	2088	7.85	0.329	25	2.38
6	1159	7.53	0.347	25	3.76
7	1453	7.45	0.324	25.4	2.14
8	641	6.96	0.313	26.4	1.39
9	2511	8.06	0.325	25.4	2.55
10	408	7.04	0.305	25	1.39
11	2003	7.30	0.306	25	2.13
12	1998	7.43	0.314	25.9	3.05
13	2134	7.13	0.288	25	1.99
14	2319	7.29	0.297	27.4	2.92
15	1577	6.68	0.272	25.9	1.79

**CF=W/(8760·P) where W is the annual electricity generation and P is installed capacity of the WPP; CF is the factor of annual engagement of the WPP with the installed capacity.*

Pursuant to the Atlas, selection was made of the most favourable sites for further wind energy research. Four sites were selected[38], where from 2006 onwards continuous measurements are performed in terms of wind speed, wind direction, as well as other meteorological parameters. Preparations are underway to perform measurements at the remaining five sites.

Selected locations where metering stations are installed include (Figure 2.5.1.2):

- Ranavec (Bogdanci) at altitude of 472 meters,
- Sasavarlija (Stip) at altitude of 857 meters,
- Bogoslovec (Sveti Nikole) at altitude of 733 meters,
- Flora (Kozuf) at altitude of 1730 meters.

The energy potential is estimated pursuant to the wind speed data obtained for the sites in Macedonia covered with measurements. Measurements were made at altitude of 50 meters and extrapolation was used to determine wind speed at altitude of 60 meters.

Simulations have been performed for all 4 sites covered with metered data in order to estimate the energy potential under two scenarios of assumed installed capacity for the relevant WPP. For that purpose, the Weibull distribution was calculated, as well as the expected generation per turbine and for the entire WPP.

[38] Pilot Project – Wind Farm, ELEM, Skopje 2008.

Figure 2.5.1.2. Map of 4 sites with installed metering stations

Average wind speed at sites considered for WPP construction in Macedonia ranges from 6.7 m/s to 8.5 m/s, which according to experiences is conductive for WPP construction. Selection of sites depends on other conditions as well, such as: land tenure issue (private or state-owned), infrastructure and access to roads (for equipment transportation), distance from the high voltage or medium voltage grid, the cost-effectiveness as precondition for attracting investors, etc.

According to the wind map, as well as according to metered data for the 4 sites, the anticipated installed capacity per site ranges from 20 MW to 30 MW. The selection of turbine type and number, as well their position on the location would necessitate additional research as regards the terrain configuration and will depend on investors' possibilities. Metered data available for Macedonia show that the efficiency factor of a WPP with installed capacity of 30 MW ranges from 0.13 to 0.25. This means that expected annual generation of WPP with installed capacity of 25 MW ranges from 30 GWh to 55 GWh.

Certainly, the selection of sites for WPP construction and their relevant installed capacity should take into consideration the stochastic nature of wind occurrence. This is of particular importance due to wind occurrence dynamics and capacity, as well as energy injection into the electricity system under unpredictable dynamics. Actual possibilities in Macedonia for construction of WPP include 6 most favourable sites (first group) with total capacity of around 150 MW to 180 MW, which accounts for around 10% of the current installed capacity in the electricity system of Macedonia. Expected annual generation output of these 6 sites ranges from 300 GWh to 360 GWh.

First group of 6 priority sites:

No.	Site name	Altitude	Metered data
1	Ranavec (Bogdanci)	472 meters	Available
2	Sasavarlija (Stip)	857 meters	Available
3	Bogoslovec (Sveti Nikole)	733 meters	Available
4	Flora (Kozuf)	1730 meters	Available
5	Venec (Sveti Nikole)	853 meters	Not available
6	Erdzelija (Sveti Nikole)	-	Not available

The first 4 locations from the priority group for WPP construction are covered with metering stations and metered data. Last two sites are located in the vicinity of Sveti Nikole in Ovce Pole and are conductive to WPP construction, but are yet to be covered with metered stations so as to collect wind metering data. By 2020, WPPs can be constructed on the first group of 6 priority sites, with total installed capacity of around 180 MW and expected annual generation of around 360 GWh.

The second group of potential sites for WPP construction are selected from the wind map and the number in brackets indicates the locations.

The second group of 3 potential sites includes:

No.	Site name	Altitude	Metered data
1	Demir Kapija (8)	641 meters	Not available
2	Turtel Kocani (15)	1577 meters	Not available
3	Demir Kapija (3)	566 meters	Not available

This group of sites is not covered with metering data. Therefore metering stations need to be installed in order to obtain data on expected generation output. However, in terms of their terrain configuration these sites are similar to the sites covered with metered data or are located in their vicinity, so it can be expected for their relevant generation to move within the range applicable for first group sites covered with metered data. Certainly, these potential sites for WPP construction need to be additionally researched in terms of obtaining wind metering data, terrain configuration, and therefore, it is expected that WPP construction dynamics and intensity to continue in the period 2020-2030. Total installed capacity by 2030 is planned at the level of 360 MW with estimated annual generation of around 720 GWh.

All sites from the first and second group require additional research of the terrain configuration, surrounding infrastructure, possibilities for connection to the electricity system, etc.

2.5.2. Analysis of WPP operation

Special analysis should be made of the wind occurrence's stochastic nature in terms of dynamic effects of power and energy injected in the electricity system. Although the uncertainty is high, additional efforts can be made to determine certain expected capacity of WPPs at particular season and day periods. This section attempts an analysis of power and energy occurrence for WPP on one site in Macedonia with P_{inst} = 50 MW (50 × 1MW). Particularly important is the energy distribution per season (winter, spring, summer and fall), as well as annual occurrence of energy during night hours of low consumption (24 - 07) and day hours of high consumption. (08 - 23 hours).

Also the WPP's time factor in the grid will be analysed on hourly basis, as well as in percentages, depending on the minimum capacity. Table 2.5.2.1 and Figure 2.5.2.1 show the annual WPP's operation in the grid depending on the minimum capacity, generation and TF and CF.

Table 2.5.2.1. Time factor in hours and percentages, generation output and capacity factor (%) depending on the minimum capacity of WPP

P_{inst}=50 MW (50x1MW)	hours	TF(%)	W (GWh)	CF(%)
min _0%	7537	86.04	90.65	20.70
min_5%	5039	57.52	88.45	20.19
min_10%	4262	48.65	85.53	19.53
min_15%	3678	41.99	81.90	18.70
min_20%	3251	37.11	78.16	17.84
min_60%	1363	15.56	40.38	9.22

**TF time factor – annual operation time of the WPP*

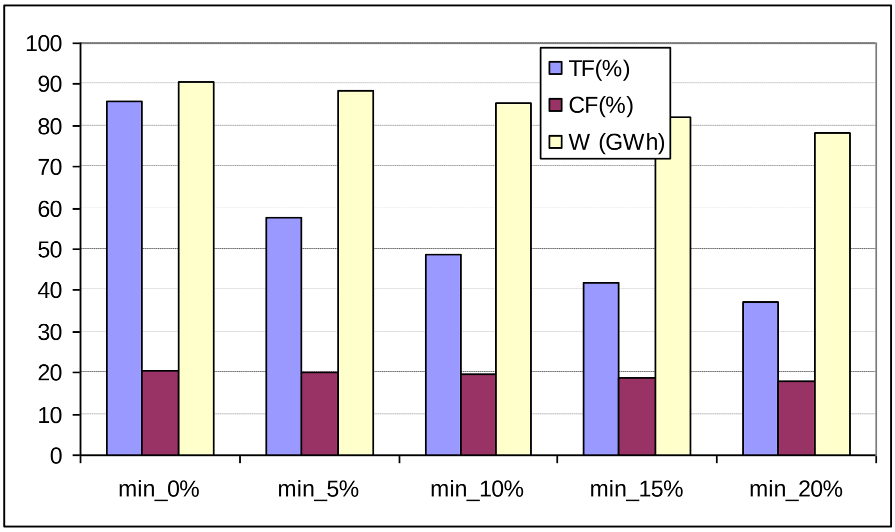


Figure 2.5.2.1. TF and CF and WPP generation output in Macedonia

Analyses show that if the grid receives the entire energy generated, i.e., the WPPs operates under full capacity, the WPP operation time will be more than 7500 hours, whereas if the grid receives the only the energy from engaged capacity above 15% (7.5 MW), the time factor on the grid is almost twice as less (around 3600 hours). This clearly indicates that dominant is the operation of WPPs under lower capacity, while the operation of WPPs with higher capacity (almost total installed capacity) is smaller. The last line provides data on WPP operation where the energy is received under engaged capacity exceeding 60% (30 MW) or operation of WPP with higher installed capacity accounts for around 1400 hours anually, i.e, TF is around 15%.

Wind availability, i.e., generated energy depending on the season (winter, spring, summer and fall) is shown in Table 2.5.2.2 and Figure 2.5.2.2.

Table 2.5.2.2. Season occurrence of energy for WPPs

P_{inst}=50 MW (50x1MW)	GWh	%
Winter	29.80	32.87
Spring	19.49	21.50
Summer	16.97	18.73
Fall	24.39	26.90
Total	90.65	100.00

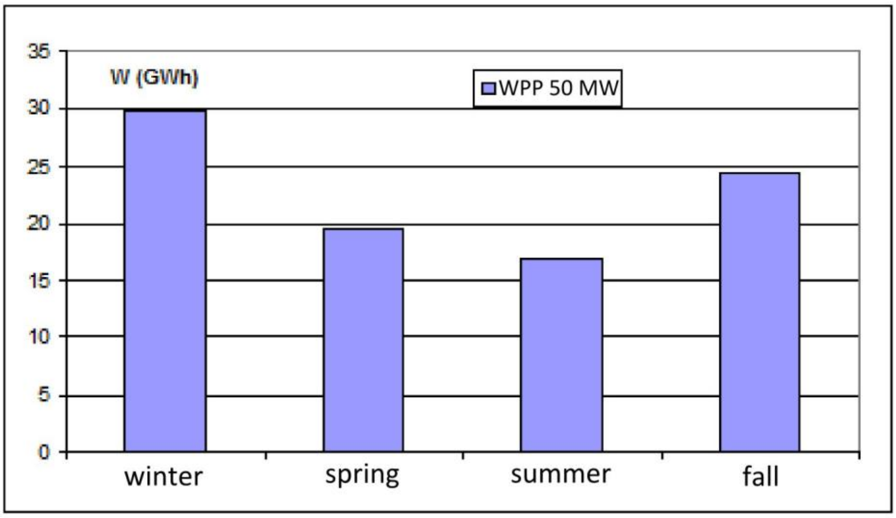


Figure 2.5.2.2. Season occurrence of energy for WPPs in Macedonia

Break-down of expected WPP generation output per season varies and is the highest during winter and fall season, and lowest in the summer. Expected gross annual generation at times of cheap tariff (8 hours) and expensive tariff (16 hours) is shown in Table 2.5.1.1.3.

Table 2.5.2.3. Expected annual generation under cheap and expensive tariff

P_{inst}=50 MW (50x1MW)	W(GWh)	Hours	CF
Cheap (8 hours: (24-07)	33.55	2920	0.23
Expensive (16 hours: 08-23)	57.10	5840	0.20
Total	90.65	8760	0.21

WPP operates with CF=0.23 under cheap tariff and CF=0.20 under expensive tariff. However, gross electricity generation output is significantly higher during expensive tariff time.

Due to the stochastic nature of wind occurrence and its unpredictable intensity, WPPs in the electricity system are treated as sources of additional energy, but their capacity cannot be taken into account in the energy supply planning process. Due to the intermittent nature of WPP's power and energy injection in the electricity system, the same quantity of power should be kept as reserve in the electricity system at all times. This reserve power should be made available as spinning reserve that can be rapidly activated and deactivated in the system depending on the wind occurrence dynamics, i.e., the variations of WPP power rates. For that purpose, most appropriate electricity sources are considered to be reservoir-based or reversible HPPs or gas plants. Under the current situation in the electricity system of Macedonia, this function can be performed by a number of aggregates at existing HPPs or TPP Negotino when operating as spinning reserve. For the period after 2015, when the complete construction of new HPPs is expected, this role can also be performed by the reversible HPP Cebren or other reservoir-based HPPs, or the spinning reserve of a gas plant or coal-fuelled TPP.

In terms of electricity system's operation, a special problem can arise when the wind intensity is higher during night hours of cheap tariff (low consumption). In such cases, TPP work under minimum power, while reservoir-based HPPs are turned off. The occurrence of additionally injected power and energy from WPPs during this time of day, and especially during seasons of low consumption (spring, summer) when HPPs reservoirs are full, WPP-generated energy can appear as surplus in the electricity system.

WPP operation mode, i.e., connection and disconnection from the grid is a dynamic one with unpredictable nature and variable intensity. Also, WPPs operation in the electricity system is characterized by intermittent intervals and variable power engagement. This means that the electricity system where WPPs are connected should be prepared to accommodate such intermittent mode of operation in terms of generation capacity. The preparedness of the electricity system would imply that it disposes with other generation capacities that would be activated or deactivated depending on the WPP operation mode, as well appropriate units and systems to secure quality electricity. In such cases, frequency regulation systems and voltage regulation methods are of special importance.

Taking into consideration all factors and in terms of the electricity system's reliable operation, it is best for the WPP installed capacity in the system to account to up to 10% from the total installed capacity in the electricity system comprised of TPPs and HPPs. The dynamics of WPP construction and connection should be tuned to the construction of the entire electricity system of Macedonia.

As concerns the selection of individual turbines for WPPs in Macedonia, it is obvious that in energy terms more favourable are smaller units with capacities of up to 1 MW. On the other side, in economic terms larger units with capacity of 1.5 MW, 2 MW or 2.5 MW imply lower investment costs for the same WPP power. However, winds in Macedonia are characterized by average annual value of speed in the range of 6 to 7.5 m/s, thereby requiring individual capacity to be determined in light of technical and economical optimal operation.

2.5.3. Electricity generation price for WPPs

Price of electricity generated by WPPs is comprised of investment costs for WPP construction and operational costs. Investment cost for WPPs is different from the aspect of equipment selection and infrastructure, as well as the site terrain. Parameters affecting the establishment of electricity price generated by WPPs include: investment costs (€/kW), installed capacity P(MW), annual electricity generation W(GWh) and discount rate (%). This section will include different scenarios for WPPs with the following technical and economic parameters:

- Installed capacity of 30 MW and 50 MW,
- Annual generation in the range of 50 GWh to 110 GWh,

– Investments in the range of 800 (€/kW) to 1600 (€/kW),

– Discount rate of 5%, 7% and 10%.

Table 2.5.3.1 and Figure 2.5.3.1 show the generation price of electricity for different WPP parameters. This option includes smaller installed capacity of WPP and lower annual generation output. Operational costs for all options addressed with relevant scenarios were calculated for price rate of 0.12 (c€/kWh)[39] and WPP lifespan of 20 years.

Table 2.5.3.1. Generation price (c€/kWh) for WPPs under different scenarios for investment, generation and discount rate and under installed capacity of 50 MW

Investments (€/kW)	P_W_discount rate (MW)_(GWh)_(%)					
	30_50_10	30_50_7	30_50_5	50_70_10	50_70_7	50_70_5
1600	12.16	9.79	8.33	14.46	11.64	9.90
1400	10.65	8.58	7.30	12.66	10.19	8.68
1200	9.14	7.36	6.27	10.87	8.75	7.45
1000	7.63	6.15	5.24	9.07	7.31	6.23
800	6.13	4.94	4.21	7.27	5.86	5.00

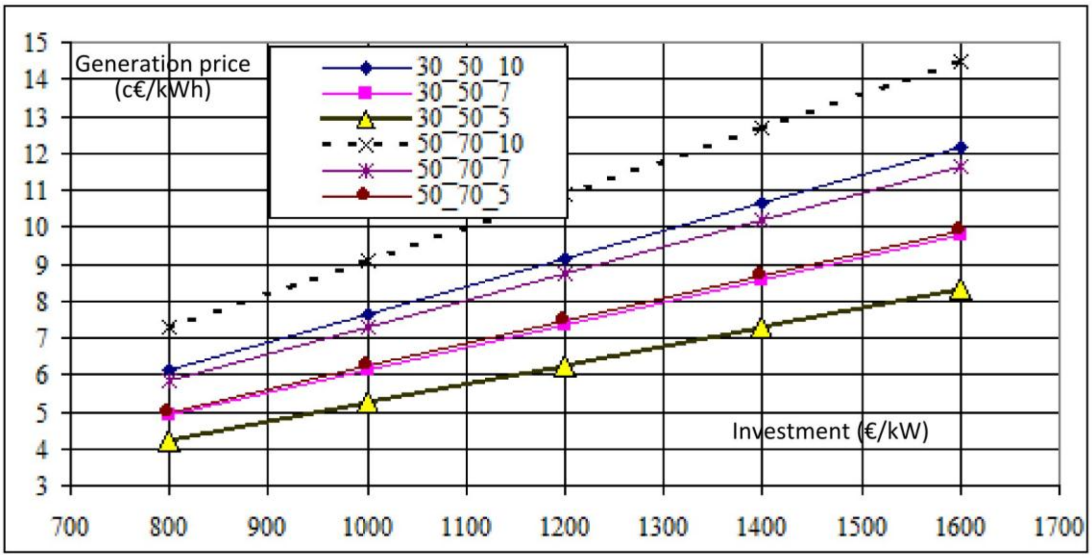


Figure 2.5.3.1. Generation price (c€/kWh) from WPPs under different scenarios for investment, generation and discount rate and under installed capacity of 50 MW

The results show that the generation price is in the range of 4.21 (c€/kWh) for each case 30_50_5 at installed capacity of 30 MW with annual generation of 50 GWh, discount rate of 5% and lowest investment cost of 800 (€/kW), to 14.46 (c€/kWh) for each case 50_70_10 at installed capacity of 50 MW with annual generation of 70 GWh, discount price of 10% and highest investment cost of 1600 (€/kW)

[39] UBS Report for Energy Prices

Table 2.5.3.2 and Figure 2.5.3.2 show the generation price of electricity under different WPP parameters. The table provides selection of higher installed capacity of WPPs and generation of 90 GWh and 110 GWh under different discount rates of 5% ,7% and 10%.

Table 2.5.3.2. Generation price (c€/kWh) from WPP under different scenarios for investment, installed capacity, generation and discount rate

Investments	P_W_discount rate					
(€/kW)	(MW)_(GWh)_(%)					
	50_90_10	50_90_7	50_90_5	50_110_10	50_110_7	50_110_5
1600	11.26	9.07	7.72	9.23	7.44	6.34
1400	9.87	7.95	6.77	8.09	6.52	5.56
1200	8.47	6.83	5.82	6.95	5.60	4.78
1000	7.07	5.70	4.86	5.81	4.68	4.00
800	5.68	4.58	3.91	4.66	3.77	3.21

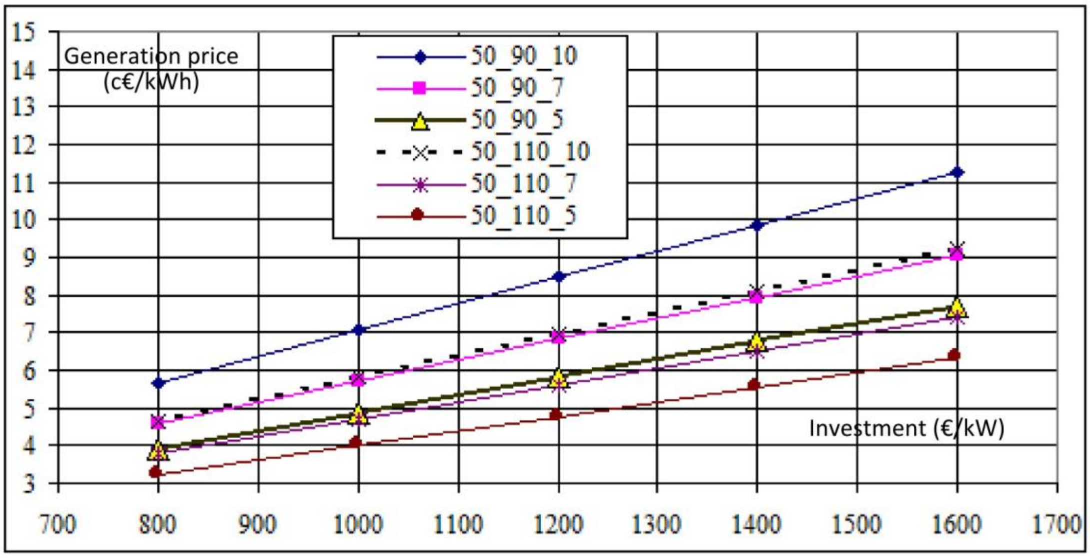


Figure 2.5.3.2. Generation price as function of installed capacity, annual generation, investments and discount rate.

The results show that the generation price ranges from 3.21 c€/kWh for any case of 50_110_5 and installed capacity of 50 MW with annual generation of 110 GWh, discount rate of 5% and lowest level of investment in the amount of 800 €/kW, to 11.26 c€/kWh for any case of 50_90_10 and installed capacity of 50 MW with annual generation of 90 GWh, discount rate of 10% and highest level of investments in the amount of 1600 €/kW.

The selection of options for WPP construction given in both tables (2.5.3.1 and 2.5.3.2) provide a broad range of technical and economic parameters of Wind Farms on the favourable sites in Macedonia. Certainly, the economically more favourable option is the one that includes high installation of WPPs with greater generation output, but also a lower discount rate, as the setting of electricity generation price would be dominated only by the investment costs.

Electricity generation price mostly depends on investments, but the discount rate will have significant impact on the price as well. The results shown in Tables 2.5.3.1 and 2.5.3.2 and Figures 2.5.3.1 and 2.5.3.2 provide the conclusion that for WPPs of 50 MW with generation of 110 Gwh, the electricity generation price is lower than the feed-in tariff of 8.9 c€/kWh for the entire range of analysed parameters.

According to the recent Study[40] undertaken on a location in Bogdanci A, the price per installed capacity only for the wind turbine amounts to around 1100 €/kW. Additional investment costs depend on the site itself, such as infrastructure needs (road and access transport corridors), assembling and disassembling the crane together with construction works related to installation of wind turbines, electricity equipment and transformation substation to connect the WPP to the electricity grid, transportation of equipment and insurance. All these additional costs can add up to 30% from the total investment in WPP. Therefore recent estimates on the total investments go as high as 1500 €/kW.

Under generation of 110 GWh annually, such plant would generate electricity at the price of around 7 c€/kWh.

[40] Wind Park Development Project Macedonia – Feasibility Study Bogdanci A, Infrastructure Project Facility for Western Balkans, EU's CARDS Programme, February 2010

3. ANALYSIS OF RES IMPACT ON THE ELECTRICITY SYSTEM

3.1. BRIEF DESCRIPTION OF THE ELECTRICITY SYSTEM OF THE REPUBLIC OF MACEDONIA

AD MEPSO (Joint Stock Company) – Skopje (Macedonian Electricity Transmission System Operator) is the owner of electricity transmission assets and performs the activity of electricity transmission system operator, electricity system operator and market operator.

AD ELEM (Joint Stock Company), is the owner of seven Large Hydro Power Plants and two Thermal Power Plants. In addition, AD ELEM is the owner and operator of the smaller distribution system that supplies industrial consumers.

EVN Macedonia AD (Joint Stock Company), is the owner of the biggest distribution system in the Republic of Macedonia and performs the activity of distribution system operator and electricity supplier for captive consumers connected to the distribution grid. Also, it owns four Small Hydro Power Plants, whose number is to increase in 2012, upon the completion of concession contracts signed with other companies.

TPP Negotino uses crude oil and holds a license on electricity generation.

3.1.1. Transmission System

The high voltage transmission grid in the Republic of Macedonia, as given in Figure 3.1.1.1, is comprised of three different voltage levels, those being: 110, 220 and 400 kV.

Basic data on the high voltage transmission grid is given in Tables 3.1.1.1 and 3.1.1.2.

Table 3.1.1.1. Data on Aerial High Voltage Grid Lines

Aerial lines	400 kV	220 kV	110 kV
Length (km)	594	103	1480

48 km from the total length of aerial lines at 400 kV level are operated under voltage level of 110 kV.

Table 3.1.1.2. Data on Power Substations in the High Voltage Grid

Power Substations	400/110 kV/kV	220/110 kV/kV	150/110 kV/kV
Number of PS	4	2	1
Number of transformers	7	3	2
Total installed capacity (MVA)	2100	450	100

As regards the high voltage electricity grid, the portion operated under 220 kV is the least developed grid, and is comprised of three aerial lines (AL) and two power substations (PS). There are two AL used as interconnections to the electricity system in the neighbouring Kosovo, i.e., interconnecting PS Skopje 1 and PE Kosovo A, but only one of them is in operation. Exchanges between the two neighbouring ES though this line were limited in the last period. Due to the current insignificant role of the 220 kV electricity grid and the limited prospects for future changes thereto, for the time being there are no plans to upgrade this line.

Figure 3.1.1.1. High Voltage Electricity Transmission Grid in the Republic of Macedonia

Sections of the transmission grid under rated voltage level of 110 and 400 kV are interconnected by means of five PS, while grid sections under rated voltage level of 110 and 220 kV are interconnected by means of two PS. Grids under rated voltage level of 220 and 400 kV are not interconnected. The role of the 400 kV transmission grid is to connect the largest generation facilities (TPP Bitola and TPP Negotino), located in the south part of the country to the largest consumer group concentrated in the north, i.e., in the City of Skopje and its surrounding. Moreover, the 400 kV transmission grid provides interconnections with the neighbouring countries (two AL with Greece, one with Kosovo and one with Bulgaria). Until the construction of the several 400 kV lines, the 110 kV grid played the major role in the transmission gird in Macedonia. Today, this role is changed and the 110 kV grid is of greater local importance in the transmission system operation.

AD ELEM's generation facilities are connected to the electricity transmission grid on eight different locations. The transmission grid on the 110 kV voltage level also provides direct connection to eight industrial consumers, units used to supply the railway with electricity and to the distribution grids.

Despite the occurrence of voltage levels lower than their rated value, usually in the peripheral nods of the transmission system (north-west and north-east parts of the country), no major problems have been identified in the normal operation mode of the electricity transmission system. Actually, no major outages due to transmission grid defects have been registered in the last twenty years, while transmission grid losses account for less than 3% of the total electricity transmitted.

AD MEPSO has detected weaker nods in the system and has taken relevant measures to address the problems. In addition, work is underway on projects targeting transmission grid's modernization and upgrade. According to AD MEPSO[41], the medium-term plans to upgrade the transmission grid anticipate the construction of a 400 kV interconnection transmission line Stip-Nis, while the long-term plans include the construction of interconnection transmission lines with Albania and Kosovo. The ultimate goal of such investments is to improve the transmission capacity of the system.

3.1.2. Distribution System

The distribution grid is comprised of medium voltage (MV) and low voltage (LV) grid, and includes several sections of the high voltage grid. MV grid is comprised of three-phase lines on three different voltage levels: 10, 20 and 35 kV. LV grid lines are usually three-phase 400 V or one-phase 230 V. In the past, the transformation was usually performed on three levels, as follows : 110/35, 35/10 and 10/0,4 kV. Recently, densely populated consumer areas provide two levels of transformation, those being: 110/10 and 10/0.4 or 110/20 and 20/0.4 kV. Table 3.1.2.1 shows the basis information on the distribution system.

Table 3.1.2.1. Distribution system's basic data

Aerial lines and cables (km)				Transformers					
				110/x		35/x		10(20)/0.4	
110kV	35 kV	10(20) kV	0.4 kV	number	Total MVA	number	Total MVA	number	Total MVA
50	1008	9640	12841	93	2058	166	673	7630	2682

The distribution system supplies around 650,000 industrial and commercial consumers and households. Households account for 87% from the total pool of consumers. Distribution system sections are radial grids connected to PS. Most commonly they are interconnected by means of 35 kV lines, which are not overloaded under normal operation mode, i.e., serve as reserve and ensure greater reliability of supply. In most cases, the border between the distribution and transmission grid is comprised of HV sides of transformers on bordering Power Substations. The HV side switch on these PS is owned and controlled by AD MEPSO.

MV and LV grids have been constructed as partially looped grids, but operate as radial. Another feature of the distribution system is the relatively low use of automated and remote control, and the reason thereof lies in the lack of investments in the last twenty years. Investments in SCADA system installations on major sections were initiated in the mid 80s of the last century, but the process was soon stopped due to the poor financial situation at ESM (Electricity Company of Macedonia). The operation of the distribution system operator was made difficult due to the absence of remote controls on MV grid sections.

[41] AD MEPSO – Future Electricity Transmission Assets.

Actually, in general, the distribution system is in worse situation compared to the transmission system. From the pool of reasons thereto, low electricity prices in the last period had the major effect on the said situation. Low prices, especially for households, have triggered increased consumption. This in conjunction with the fact that there were few alternatives to heating energy supply resulted in the households using electricity for heating purposes. On the other hand, the increased consumption was not accompanied with appropriate development of the distribution grid, in particular the LV sections thereof, which were most affected by the increased consumption.

Another problem are the distribution system losses, which by the end of 2006 accounted for 24% in the grid operated by EVN Macedonia. In addition to the increased consumption, there are other reasons behind the occurrence of losses, those being: old meters that indicate lower consumption from the actual, increased number of thefts, the case law under which electricity thefts are not considered criminal acts, absence of social programs targeting households with financial difficulties, etc. Nevertheless, after EVN AG bought the majority share of ESM Distribution the trend on loss increase was discontinued.

3.1.3. Generation

AD ELEM, Power Plants of Macedonia

AD ELEM is the biggest electricity generator in Macedonia and is a state-owned company. AD ELEM is the owner of seven large HPPs, two small HPPs and two TPPs. Basic data on HPP generation is given in Tables 2.1.1.1.1, 2.1.2.1.1 and 2.1.3.1.

Large HPPs have a total installed capacity of 552 MW (Table 2.1.1.1.1). Two of them are run-of-river HPPs, while the others are reversible HPPs, with a total capacity of 1300 million square meters.

TPP Bitola, with installed capacity of 675 MW is the most important power plant in the electricity system of Macedonia. TPP Bitola generation units are of Soviet production, but have been modernized in the 90s, and today they achieve an average output of 7700 working hours annually.

TPP Oslomej (125 MW) does not provide an output similar to TPP Bitola. TPP Oslomej is of Polish production and was put into operation in 1980. In the last ten years, the average number of working hours accounts for 5500 hours annually, which is due to problems related to the equipment and the mine. Works are underway to open the second section of the mine that would secure fuel for the next ten years.

At the moment, portion of AD ELEM's investments are aimed to secure lignite for TPP Bitola by means of new mines.

It is expected for AD ELEM to also invest in the rehabilitation of existing HPPs, while currently under construction is the HPP St. Petka with an installed capacity of 36 MW.

The construction of the gas-fuelled co-generation plant with installed capacity of 300 MW for electricity and 150 MW for heating energy is also planned.

TPP Negotino

TPP Negotino is the oldest thermal power plant in the country using crude oil . Due to high prices of crude oil, in the last thirty years its average annual output is

1080 hours annually, while there are also years when it does not generate electricity. It is mainly used as reserve in situations of need.

In the course of 2005 ESM unbundling, TPP Negotino was established as a separate state-owned company. This power plant is located in the vicinity of PS Dubrovo and connected to it via 400 kV grid.

Other generators

SHPPs constructed in Macedonia have a total capacity of 27 MW (See Chapter 2.1.2). Four of them are owned by EVN Macedonia AD, and seven will be returned to company ownership upon the expiration of relevant concession contracts (by 2012) signed with the Czech company MAKHYDRO.

Several industrial facilities dispose with co-generation plants used for generation of hot water/steam and electricity. Usually they do not provide surplus output that can be marketed.

At the moment, AD Toplifikacija with the Russian partner is constructing a co-generation plant with installed capacity of 220 MW for electricity and 160 MW for heating energy. It is expected for this plan to be put into operation in 2010. The co-generation plant KOGEL with installed capacity of 30 MW has already been constructed and is expected to be put into operation in 2010.

Under tender procedures, the Ministry of Economy grants concessions for a number of SHPPs. Construction of other SHPPs is also anticipated, namely as part of hydro systems and water-supply or irrigation undertakings. Total installed capacity of SHPPs planned to be constructed by 2020 is estimated in the range of 80 – 120 MW. The construction of the reservoir lake Lukovo Pole and of HPP Crn Kamen and HPP Boskov Most is also planned. The Government announced concession-awarding procedure for private investors and under public-private partnership for the construction of other large HPPs (Cebren and Galiste). Total installed capacity of planned HPPs by 2020 should account for around 700 MW.

3.1.4. Consumption

Peak load to the electricity system of Macedonia most often occurs by the end of December and in the course of January. In 2007, the system's peak load accounted for 1450 MW. Existing capacities supply electricity under peak load, but the system suffers from insufficient reserve power. At times of peak load, the energy needed is secured from import, while TPP Negotino serves as reserve as its operation is not cost-effective due to its high operation costs.

In the last ten years, total electricity consumption in Macedonia has increased by 33%. Consumption of major industrial facilities accounts between 1 and 2 TWh.

In the last 20 years, generation has increased by only 150 GWh (due to the connection of HPP Kozjak). Until 2000, in-country generation covered the consumer demand, but as of 2006 import was increased from 2 to 22%.

In the period 1997 - 2006, greatest consumption growth was noticed among commercial consumers connected to LV grid (56%), while the consumption of industrial facilities connected to MV grid, at 10 and 35 kV, was decreased by 17%.

Distribution grid consumption is unequally distributed, where the City of Skopje and its region are marked with the highest consumption level.

3.2. ELECTRICITY SYSTEM'S ABSORPTION CAPACITY

The effect of power plants using RES on the electricity system is of technical and economic nature. Main problem related to technical aspects concerns the relatively intermittent availability of RES for electricity generation (in particular, wind, solar energy and water). Actually, this feature of certain renewable energy sources is also related to the availability of power plants using RES that are part of the electricity system, which will be elaborated in detail below. In technical terms, there are other problems primarily related to the connection of power plants using RES to the appropriate (transmission or distribution) grid. These problems are specific for each individual power plant and because their connection to the electricity grids is regulated under the relevant Grid Code, the present Strategy does not consider their connection as particular problem.

Hydro energy's unpredictability is of medium-term nature and considering the fact that certain HPPs dispose with reservoirs their effect on the electricity system is of lower intensity. Moreover, reservoirs can be used to balance the system at peak load hours.

Contrary to HPPs, wind power plants and solar power plants are characterized by a significantly greater short-term intermittence and thereby create problems in the operation of the electricity system and in regard to daily demand balancing. To compensate the unavailability of these power plants, the electricity system and market operator is forced to activate the additional reserves from generation units, which increases the system operation costs.

Under ideal circumstances of electricity market operation (i.e., the operation of its segments: energy market, ancillary services and balancing market) and in the absence of subsidies for generators the share of RES use for electricity generation would be determined only by economic principles. In such cases, the decision to construct plants using RES will be based on market conditions and there would be no problems as concerns the share of use of RES. Notably, power plants using RES - as a rule - are characterized by short period of operation under maximum capacity, so the energy generation price would to a large extent be based on the investment costs, particularly as they use technologies whose price is high at the moment.

Moreover, the inability to accumulate energy during intervals of low market prices and sell it during peak load intervals (when market prices are high) makes these power plants less attractive for investment unless there are subsidies.

However, if electricity generation from RES is subsidized there is great danger of technologies liable to higher subventions to account for higher shares in the generation and - if characterized by intermittent nature of occurrence - to create problems in the operation of the electricity system. Therefore, it is necessary to limit the electricity generation from RES subject to preferential status (subsidies).

Determining the electricity system's absorption capacity for particular types of RES is a complex procedure and implies complex technical and economic analyses. As part of the present Strategy a comparative analysis will be made to see how this capacity is determined and regulated in the electricity systems similar to our electricity system (in size and in terms of generation facilities' structure).

From the pool of renewable energy sources, wind and solar energy are characterized by highest intermittent occurrence and most often their relevant shares are subject to limitations. In general, there are no major problems related to other technologies (characterized by a relatively high intermittence).

3.2.1. HPPs

HPPs, in particular those that dispose with reservoirs, improve the operation of the electricity system and should not be subject to limitations. Of course, this applies only if the system disposes with power plants with sufficient capacity to cover the basic consumption (TPPs). Moreover, large HPPs are not liable to subsidies and their investment return is based solely on market principles. On the other hand, total installed capacity of SHPPs (liable to subsidies) in the Republic of Macedonia is relatively low, and even under the assumption that all facilities anticipated are constructed, they would not cause problems in the operation of the electricity system.

3.2.2. Power plants using biomass

Power plants using biomass are more reliable in terms of availability of their primary fuel and since most of them would be cogeneration plants they do not create problems in the operation of the electricity system and should not be subject to general limitations.

3.2.3. PVPPs

Although availability of solar energy is characterized with higher (short-term) availability compared to wind energy, this technology also requires certain limitations as regards its total share in the country's electricity balance. This is of great importance as photovoltaic-based generation is decreased during seasons of lower energy (and power) supply.

3.2.4. WPPs

In is expected that in the forthcoming period, the Study on the absorption capacity of the electricity system of the Republic of Macedonia for wind power plants will be developed for the benefit of AD MEPSO and funded by the World Bank. The Study shall take into consideration the system's technical limitations. Moreover, in the light of determining the system's absorption capacity one should also consider the financial effects of the need for increased activation of reserve generation units, as well as the the financial effects of the relevant balancing. Chapter 2.5. provides details on this issue.

Total installed capacity of WPPs connected to an electricity system depends on the system's size and structure of its generation units (in terms of their capacity and technology used). The smaller the electricity system and the bigger the system generation units, the lower is the possibility to connect WPPs with high installed capacity. For systems similar to the one of the Republic of Macedonia, the absorption capacity ranges from 10% to 15% of the system's total installed capacity.

Some studies[42] indicate that the share of intermittent RES lower than 5% would not cause problems that originate from short-term power fluctuations. In order to compensate such fluctuations it is necessary to have reserve generation capacity to be activated at intervals of insufficient wind power. Moreover, greater flexibility is needed on behalf of other generation facilities or additional consumption control so as to maintain the system's balance. All these imply additional costs, which are higher with the increased participation of WPPs in the system. In cases when WPP

[42] D.Milborrow, Penalties for Intermittent Sources of Energy

share reaches 15% to 20% of system's peak load these costs are high and require additional measures to secure sufficient system flexibility. Examples from European countries (Portugal, Spain) show that the required system flexibility can be secured by means of construction of large HPPs. Of course, this solution is closely related to the hydrological status and hydro potential in the country.

From the aspect of the electricity system, costs to integrate WPPs are set based on two factors: balancing needs and electricity grid. In addition to the stochastic nature of wind energy, balancing costs are also related to the size of the balancing territory, type and costs of power plants serving as reserve in the electricity system, the wind energy forecasts and costs for energy accumulation. The last indicates a possible situation, i.e., a situation when the system cannot accept the electricity generated by WPPs and thereby some WPPs need to reduce their generation output.

From the aspect of the electricity system's status, the effect of new WPP's connection thereto is analysed same as the effect of any other power plant. Connection of large number of WPPs and thereby the increase of total installed capacity in the electricity system implies previous research and resolution of series of issues that might be grouped into several categories, as follows:

electricity system planning and operation, i.e., securing reserve installed capacity and balancing electricity, forecasting WPP generation output, demand side management and electricity accumulation systems;

electricity grid, i.e., optimization of the existing electricity grid, upgrading, establishing the so called offshore grids, improving interconnections with neighbouring electricity systems;

WPP connection to the electricity system, i.e., adopting the Grid Code, Electricity Quality Rules and the Rulebook on the operation of WPPs connected to the electricity grid;

electricity market, i.e., adopting the Electricity Market Code aimed to increase market flexibility, especially in terms of cross-border exchanges;

electricity sector policies, i.e., subsidies for market participants and non-discrimination of generators as concerns their connection.

When assessing the WPP absorption capacity of the electricity system due attention should be paid to the WPPs distribution in a particular service area, which is correlated to movement of air masses. Notably, a greater distribution would prevent correlation of short-term, local fluctuations and would thereby facilitate the balancing process. Evidence in support thereto is the information that one WPP can change its generated active power for up to 60% in the course of one hour interval, while the WPPs with total installed capacity of 350 MW distributed throughout Germany do not show variations in the generated power exceeding 20%. Better utilization of disbursed WPPs necessitates good interconnections with the neighbouring systems.

Additional option is the setting of limits as concerns the maximum capacity per location. Notably, there is danger of the total maximum capacity to be allocated on one location. Limits thereto would enable sources to be disbursed to as greater territory as possible and to avoid situations of unavailability of one (large) source due to absence of wind on its territory. Occurrence of (sufficient) wind power is more likely for several distant locations. However, relatively precise and transparent criteria on the distance between WPPs, etc are needed to set these limitations. On the other hand, other technical limitations might achieve the same effect.

Assumptions on WPPs in the Republic of Macedonia

Let us assume that the system's absorption capacity for WPPs accounts for 10% or 150 MW of the total installed capacity of power plants integrated in the electricity system of the Republic of Macedonia. Having in mind the current status of the high voltage gird in the Republic of Macedonia, the possibilities to connect one generation facility with installed capacity of 150 MW are limited. Notably, possible site for WPPs are relatively distant from large distribution substations. Connecting a WPP with installed capacity of 150 MW to an existing, though relatively distant substation is not cost-effective as the connection costs (levied to the investor) will significantly burden the investment in the WPP.

On the other side, connecting a power plant with capacity of 150 MW through the so called "entry-exit" of existing (close-by) lines is either technically infeasible (low capacity of 110 kV lines) or is not cost-effective for the investor due to the relatively small reliability of such connections. Therefore, it seems that (technical) limitations originating from the principles set forth in the (transmission or distribution) Grid Code will limit the plant's highest capacity.

In the context of previous analyses, Annex_1 provides and overview of experiences related to wind utilization for electricity generation and the absorption capacity of electricity systems in the neighbouring countries.

3.3. APPLICATION OF FEED-IN TARIFFS IN THE REPUBLIC OF MACEDONIA

According to the Energy Law, feed-in tariffs and installed capacity of power plants eligible to obtain the status of preferential generators are set by the Energy Regulatory Commission of the Republic of Macedonia.

When the present Strategy was developed, the Energy Regulatory Commission has adopted the Rulebooks and the relevant decisions on feed-in tariffs for the following technologies: SHPP, WPP, PVPPs, power plants using biogas obtained from biomass and power plants using biomass.

Table 3.3.1 shows the feed-in tariffs of 2010. Preferential generators can apply the feed-in tariffs for SJJP and wind mills for a period of 20 years, and for PVPPs, power plants using biogas obtained from biomass and power plants using biomass for a period of 15 years

There are no feed-in tariffs for power plants generating electricity from heat obtained from geothermal sources. If research shows that in the Republic of Macedonia there are geothermal sources with appropriate features (high temperature), the possibility to introduce feed-in tariffs for such energy sources can be reconsidered, but in that due attention should be given for the said plants not to obtain the status of preferential generators if they use significant quantity of fossil fuel for electricity generation.

Table 3.3.1 Feed-in tariffs in the Republic of Macedonia at the end of 2009

Plant type	Maximum installed capacity	Feed-in tariff EUR/MWh
SHPP	10 MW	120 for $E^* < 1020$ 80 for $1020 < E^* < 2040$ 60 for $2040 < E^* \leq 4200$ 50 for $4200 < E^* \leq 8400$ 45 for $E^* > 8400$
WPPs	No	89
PVPPs	No	300 for $P^{**} \leq 50$ kW 260 за 50 kW $< P^{**} \leq$ 1000 kW
Power plants using biogas obtained from biomass	No	150 for $P^{**} \leq 500$ kW 130 for 500 kW$< P^{**} >$ 2000 kW
Power plants using biomass	No	110 за $P^{**} \leq 1000$ kW 90 за 1000 kW$< P^{**} \leq$ 3000 kW

* *E – annual electricity generation expressed in MWh.*
** *P – Plant's installed capacity*

Table 3.3.1 shows that feed-in tariffs are higher from the electricity market price and considering that pursuant to the Energy Law the difference in the price is covered by all consumers as part of the transmission charge, it is clear that preferential generators' high share in the electricity generated will affect the end prices for consumers. Accordingly, many European countries have different mechanisms on limiting preferential generators' share in the total electricity generation.

Based on analysis made and experiences from EU countries and countries from the region (Annex_4), it is proposed for the Republic of Macedonia to limit the installed capacity of power plants that would qualify for application of feed-in tariffs. In that, the limitations should be different for different technologies and therefore two types of limitations should be in effect: the first limit concerns the total installed capacity (expressed in MW) for the electric power system in the Republic of Macedonia for power plants using certain technologies and the second limit concerns the installed capacity of individual facilities (plants).

Table 3.3.2 shows the limitations per individual technology.

Table 3.3.2. Installed capacity of plants using RES to qualify for application of feed-in tariffs

Type of plant	Total capacity eligible for application of feed-in tariffs (MW)	Installed capacity per plant eligible for application of feed-in tariffs
SHPPs	No limitation	Up to 10 MW
WPPs	150	Up to 50 MW
PVPPs with installed capacity up to 50 kW	2	Up to 50 kW
PVPPs with installed capacity above 50 kW	8	Up to 1 MW
Cogeneration plants using biomass	10	Up to 3 MW
Plants using biogas obtained from biomass with installed capacity up to 500 kW	2	Up to 500 kW
Plant using biogas obtained from biomass with installed capacity above 500 kW	8	Up to 2 MW

Limits are introduced in order to prevent disturbances in the operation of the electric power system of the Republic of Macedonia, both from technical and economic terms, having in mind the additional costs that consumers will have to pay (in one way or the other) in order to secure funds to settle the feed-in tariffs.

The economic analysis was performed under the following assumptions:

- level of constriction of plants using RES is assumed at the maximum level, as given in Table 3.3.2;
- electricity generation is calculated under the assumed load factor of 2000 h/year for plants using wind and biogas, 1400 h/year for PVPPs[43], 5000 h/year for cogeneration plants using biomass and around 2650 h/year for SHPPs;
- average wholesale electricity price is assumed to be in the range from 60 (low value) to 80 (high value) EUR/MWh;
- feed-in tariffs for certain technologies are at the same level from 2010(average 100 EUR/MWh for SHPPs, 89 EUR/MWh for WPPs and average 268 EUR/MWh for PVPPs, average 134 EUR/MWh for plants using biogas and average 104 EUR/MWh for plants using biomass);
- total electricity consumption in the electric power system of the Republic of Macedonia is 10500 GWh (which corresponds to the consumption level in 2015);
- electricity market in the Republic of Macedonia will be fully liberalized and prices of regulated services (losses) will be based on wholesale electricity market prices.

In other words, the previous assumptions have made an attempt to assess the additional costs in the electric power system in the Republic of Macedonia (on annual level) if the RES plants are constructed up to their relevant total capacity, as given in Table 3.3.2.

Capacities listed under Table 3.3.2 (and the possible generation output given in the tables below) should not be considered as possible scenario on the level of constriction of RES up to a given year. Simply put, they are used to show the impact of feed-in tariffs on end prices for consumers if the facilities indicated are constructed. The Government of the Republic of Macedonia (by means of its competent institutions) should continuously monitor the situation as regards the construction of RES plants and duly react by increasing or decreasing limits given in Table 3.3.2. Analysis results should serve as basis in the process on taking decisions on the limit of installed capacity per RES type eligible for application of feed-in tariffs. If competent institutions assess that the analysed construction of RES eligible to apply feed-in tariffs has greater negative impact on the end prices for consumers, they can lower the limits given in Table 3.3.2.

Feed-in tariffs' effect on end prices for consumers was analysed for a period of only one year, because any long-term analysis would be much difficult without knowledge (or solid assessment) as regards the construction dynamics and putting into operation of individual RES plants.

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[43] http://re.jrc.ec.europa.eu/pvgis/

3.3.1. SHPPs

No limits on the total installed capacity of SHPPs has been anticipated for the application of feed-in tariffs as SHPPs do not create problems in the operation of the electric power system in technical and economic terms. However, it is recommended to limit the installed capacity of individual HPPs whose generation output is eligible for the application of feed-in tariffs. Such limits are common in the European practice and serve the purpose of stimulating construction of SHPPs with installed capacity of up to 10 MW, as LHPPs (with or without reservoir) can operate under commercial principles on the electricity markets.

Since there are no limits for SHPPs, the calculations assume that the installed capacity of newly constructed SHPPs would be around 82 MW.

Additional costs for electricity purchase from SHPPs under feed-in tariffs are given in Tables 3.3.1.1 and 3.3.1.2.

Table 3.3.1.1. Additional costs from feed-in tariffs for HPPs

Total installed capacity MW	Total annual generation MWh	Purchase costs per (10^6 EUR)			Additional purchase costs compared to electricity market price (10^6 EUR)	
		Feed-in tariff EUR/MWh 100	Electricity market price (EUR/MWh)			
			Low value 60	High value 80	Low value	High value
82	216.000	21.60	12.96	17.28	8.64	4.32

Table 3.3.1.2. Cost increase due to feed-in tariffs for HPPs

Cost increase for electricity purchase compared to market prices (EUR/MWh)		Cost increase for electricity purchase compared to market prices (%)	
Low value	High value	Low value	High value
0.82	0.41	1.37 %	0.51 %

From the data given in Tables 3.3.1.1 and 3.3.1.2 it can be concluded that additional costs for electricity purchase under feed-in tariffs are in the range from to 4,32 to 8,64 million EUR, i.e., electricity purchase costs will increase by 0,51% to 1,37 %.

3.3.2. WPPs

When the present Strategy was developed there were no clear and precisely set limits on the absorption capacity of the electric power system of the Republic of Macedonia to accept WPPs in technical terms. According to the experiences of EU-27[44], WPPs' share of up to 10% in their relevant peak loads insignificantly increases problems and costs related to the system operation. This means that for the anticipated consumption level of 10500 GWh (i.e., system load of around 1900 MW) WPPs with an installed capacity of around 190 to 200 MW .

[44] Wind Energy – The Facts, EWEA, 2009, http://www.wind-energy-the-facts.org.

Therefore, the present Strategy proposes the limit to be set at around 8 % (150 MW) from the expected system peak load for the year 2015, i.e., their annual generation to account for around 3% of the total consumption for the same year.

The limit of 50 MW installed capacity per plant to obtain the status of preferential generator was introduced from the same reasons as the limits introduced world-wide. It is our opinion that there are possibilities to connect WPPs with higher capacity to the 110 kV grid, but on the other hand such WPP (or a group of WPPs connected to the same point) can cause different problems in the operation of the electric power system (dynamic stability and like).

We propose these limits to be changed based on the results obtained under future studies targeting the electric power system 's capacity to accept WPPs in the Republic of Macedonia.

WPPs connection to the system and feed-in tariffs contribute to increased costs of the Electric Power System Operator (ESO) related to the (secondary) reserve and ESO/EMO (Electricity Market Operator) costs related to system balancing.

According to the existing legislation (Energy Law), electricity generators using RES are given primacy in dispatching, which means that the operators of systems to which they are connected are obliged to receive the total quantity of energy generated by these generators. On the other hand, EMO is obliged to buy that energy under feed-in tariffs. In the absence of adopted Market Code (or common practice in the electric power system of the Republic of Macedonia), there are no clear procedures as regards the manner in which EMO will collect the additional funds necessary to balance these plants, especially knowing that their intermittent generation output.

According to the experiences and analyses from EU-27[45], additional costs for the spinning reserve (under low penetration of WPPs in the system) are equal to 1 - 4 EUR/MWh of wind energy generated. The higher price thereof is more common for smaller electric power system s. On the other hand, similar analyses have shown that additional balancing costs are in the range of 2 to 4 EUR/MWh per WPP generation output unit. As was the previous case, the higher price is more common for smaller systems.

Accordingly, additional costs for the operation of WPP in the electric power system of similar size to the electric power system in the Republic of Macedonia can be estimated at around 8 EUR/MWh per WPP generation output unit. As feed-in tariffs for WPP generation output are set at 89 EUR/MWh, the total financial effect of preferential generators can be assessed when the calculation includes the purchase cost of 97 EUR/MWh for WPP generated energy[46].

Table 3.3.2.1 and 3.3.2.2 show additional costs and increased cost from the electricity purchase when WPPs with total installed capacity of 150 MW are introduced in the electric power system of the Republic of Macedonia and when they are treated as preferential generators.

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45 Wind Energy – The Facts, EWEA, 2009, http://www.wind-energy-the-facts.org

46 According to the Energy Law, preferential electricity producers have primacy in dispatching, and accordingly the additional costs for their operation will be covered by the ESO and shall be recovered through the transmission charge.

Table 3.3.2.1. Additional costs from feed-in tariffs for WPPs

Total installed capacity MW	Total annual generation MWh	Purchase costs per (10^6 EUR)			Additional purchase costs compared to electricity market price (10^6 EUR)	
		Feed-in tariff EUR/MWh 97	Electricity market price (EUR/MWh)			
			Low value 60	High value 80	Low value	High value
150	300.000	29,10	18,00	24,00	11,10	5,10

Table 3.3.2.2. Cost increase due to feed-in tariffs for WPPs

Cost increase for electricity purchase compared to market prices (EUR/MWh)		Cost increase for electricity purchase compared to market prices (%)	
Low value	High value	Low value	High value
1,06	0,49	1,76%	0,61%

3.3.3. PVPPs

It is recommended to limit the total installed capacity of PVPPs at 10 MW. This is a small share of the electric power system 's capacity, but considering the high feed-in tariff (260 to 300 EUR/MWh), the increased cost in the electric power system would be much higher. In that, it is recommended that the total installed capacity of PVPPs with installed capacity of up to 50 kW to account for 2 MW. For PVPPs with installed capacity above 50 KW the total installed capacity in the system should not be higher than 8 MW. The Rulebook on Feed-in Tariffs for PVPPs does not stipulate a limit for the installed capacity of individual plants to qualify for obtaining the status of preferential generators.

Tables 3.3.3.1 and 3.3.3.2 show the additional costs of feed-in tariffs for PVPPs and they do not include additional balancing costs or secondary reserve costs.

Table 3.3.3.1. Additional costs from feed-in tariffs for PVPPs

Total installed capacity MW	Total annual generation MWh	Purchase costs per (10^6 EUR)			Additional purchase costs compared to electricity market price (10^6 EUR)	
		Feed-in tariff EUR/MWh 268	Electricity market price (EUR/MWh)			
			Low value 60	High value 80	Low value	High value
10	14,000	3.75	0.84	1.12	2,91	2,63

Table 3.3.3.2. Cost increase due to feed-in tariffs for PVPPs

Cost increase for electricity purchase compared to market prices (EUR/MWh)		Cost increase for electricity purchase compared to market prices (%)	
Low value	High value	Low value	High value
0.28	0.25	0.46%	0.31%

The same analysis but under the assumption of higher level of PVPPs construction (~21 GWh annual generation, i.e., around 15 MW installed capacity) provides higher costs compared to the market price (from 0,47 % to 0,69%), i.e., cost increase for electricity purchase will be around 0,42 EUR/MWh. Due to relatively high costs, it is proposed that the limit for PVPP preferential generators to be set at only 10 MW, whereas the said limit can be higher in future if it is assessed that the economic effect will be lower (lower feed-in tariffs).

3.3.4. Power Plants Using Biomass

Limitation for the generation from cogeneration plants using biomass which can use feed in tariffs is determinate base on (limitation) potential and it is 10 MW for the whole system or 3 MW per unit separately.

In accordance with the existing laws cogeneration plants using biomass can use feed in tariffs for electricity generation from 90 EUR/MWh for install capacity until 1000 kW and 110 EUR/MWh for install capacity between 1000 kW and 3000 kW.

For these plants, the future secondary legislation must stipulate percise limitations for the application of feed-in tariffs only to wood (forest and industrial) and agricultural residue, i.e., to prevent the use of fire wood for electricity generation (and heat) under feed-in tariffs.

Table 3.3.4.1. Additional costs from feed-in tariffs for cogeneration plants

Total installed capacity MW	Total annual generation MWh	Purchase costs per (10^6 EUR)			Additional purchase costs compared to electricity market price (10^6 EUR)	
		Feed-in tariff EUR/MWh 104	Electricity market price (EUR/MWh)			
			Low value 60	High value 80	Low value	High value
10	50.000	5,20	3,0	4,00	2,20	1,20

Table 3.3.4.2. Cost increase due to feed-in tariffs for cogeneration plants

Cost increase for electricity purchase compared to market prices (EUR/MWh)		Cost increase for electricity purchase compared to market prices (%)	
Low value	High value	Low value	High value
0,21	0,11	0,35%	0,14%

3.3.5. Power plants using biogas obtained from biomass

Pursuant to the existing legislation, power plants using biogas obtained from biomass can apply feed-in tariffs for electricity generation set at the rate of 150 to EUR/MWh for installed capacity of up to 500 kW and 130 EUR/MWh for insta;;ed capacity between 500 kW and 2000 kW.

Total installed capacity of such plant that is eligible for the application of feed-in tariffs is limited to 10 MW.

Table 3.3.5.1. Additional costs from feed-in tariffs for plants using biogas

Total installed capacity MW	Total annual generation MWh	Purchase costs per (10^6 EUR)			Additional purchase costs compared to electricity market price (10^6 EUR)	
		Feed-in tariff EUR/MWh 134	Electricity market price (EUR/MWh)			
			Low value 60	High value 80	Low value	High value
10	20.000	2,68	1,20	1,60	0,48	1,08

Table 3.3.5.2. Cost increase due to feed-in tariffs for plants using biogas

Cost increase for electricity purchase compared to market prices (EUR/MWh)		Cost increase for electricity purchase compared to market prices (%)	
Low value	High value	Low value	High value
0,14	0,10	0,23%	0,13%

3.3.6. Total for plants using RES

Based on previous economic analyses and anticipated construction level of RES plants, Tables 3.3.6.1 and 3.3.6.2 show the summed financial effects for the entire electric power system.

Based on data given in Tables 3.3.6.1 and 3.3.6.2 it can be concluded that the increased cost for the wholesale market electricity purchase will be in the range of 2,0% to 4,6 %, depending on the electricity market price.

Table 3.3.6.1. Additional costs from feed-in tariffs for RES

Total installed capacity MW	Total annual generation MWh	Purchase costs per (10^6 EUR)			Additional purchase costs compared to electricity market price (10^6 EUR)	
		Feed-in tariff	Electricity market price (EUR/MWh)			
			Low value 60	High value 80	Low value	High value
262	600,000	62.33	36.00	48.00	26.33	14.33

Table 3.3.6.2. Cost increase due to feed-in tariffs for RES

Cost increase for electricity purchase compared to market prices (EUR/MWh)		Cost increase for electricity purchase compared to market prices (%)	
Low value	High value	Low value	High value
2.51	1.36	4.18%	1.71%

The proposed manner of collection and financing the costs incurred with the application of feed-in tariffs (explained below) will guarantee that all consumers pay equal amounts to cover the additional costs for each KWh electricity consumed. The effect on the end price paid by consumers will be different depending on the system to which the consumer in question is connected.

Table 3.3.6.3 shows the end prices for consumers for different market prices without the additional costs for RES. Data contained in the Table are calculated under the assumption that the common methodology will be used to set the transmission, distribution and supply tariffs.

Price increase for end consumers as a result of increased costs incurred on the basis of feed-in tariffs is shown in Table 3.3.6.4. According to the data presented it can be concluded that the end price increase for distribution consumers is in the range of 1,2% to 2, 8 %, while the end price for direct consumers is in the range of 1,6 % to 3,8 %. .

Accordingly, the relatively small price increase for end consumers can secure financing of feed-in tariffs for approximately 600000 MWh annual generation output from RES.

On the other hand, as the result of generation from renewable sources the reduction of CO_2 emissions will be equal to 720 kt CO_2/annually.

Table 3.3.6.3 Prices for end users without RES plants

	Market price (EUR/MWh) 60	80
	Price for end consumers	
Direct consumers	65.4	85.7
Distribution consumers	89.6	114.3

Table 3.3.6.4 Prices for end consumers with RES plants

	Market price (EUR/MWh)		Market price (EUR/MWh)	
	60	80	60	80
	Average price increased by RES (EUR/MWh)		Difference	
Direct consumers	67.9	87.1	3.8 %	1.6 %
Distribution consumers	92.1	115.7	2.8 %	1.2 %

3.4. FINANCING MECHANISMS FOR FEED-IN TARIFFS IN THE REPUBLIC OF MACEDONIA

According to the Energy Law, the entire generation from preferential generators should be purchased by ESO and it is not precisely stipulated how ESO will reimburse these costs. According to the Rulebook on the Manner and Conditions for Setting Electricity Prices, these costs are treated as "pass-through costs", i.e., MEPSO can pass them to its users through the charge for the use of the electric power system. This charge includes the costs of: system operation, technical losses, ancillary services, etc., (ESO costs) and the costs for electricity market organization and balancing, etc., (EMO costs).

EMO can transfer the electricity to system users (for example, system operators, suppliers, etc.) under regulated prices or under market prices. In the situation when feed-in tariffs for electricity generated from RES are higher than the market price or regulated price, EMO will be in financial deficit. This financial deficit should be recovered from sources such as: Funds, charges for the use of the electricity market, etc.

Different countries have different mechanisms to collect funds in order to reimburse preferential generators. Most countries (Croatia, for example) have delegated this obligation to the electricity suppliers.

Details on market participants' transactions and obligations (including those of preferential generators) should be stipulated by means of, for example, Market Code. In the absence of Market Code, the text below proposes a simple procedure that would enable operation of this electricity market segment.

As the electric power system of our country is relatively small, the establishment and organization of a Fund would unnecessarily burden and complicate matters and therefore it is proposed EMO's financial deficit incurred on the basis of electricity purchase under feed-in tariffs to be recovered through the charge on the electricity market use, i.e., until the establishment of this charge the said funds to be recovered as part of the transmission tariff. This service will be covered by all consumers and it shall be applied to the energy transmitted through the transmission system. As part of the *Rulebook on the manner and conditions for electricity price regulation from* 31.12.2008 (Annex 2, item 4), the Energy Regulatory Commission acknowledges the costs for electricity purchase from preferential generators as *pass-through costs*, i.e., they are included as part of the regulated maximum revenue of EMO/ESO, which on the other hand is collected from consumers through the charge on the electric power system use.

It is proposed for the electricity generated by preferential generators and purchased by EMO to be transferred to the retail supplier for captive consumers (hereinafter: supplier) under regulated prices approved by the Energy Regulatory Commission. On the other hand, the supplier shall purchase a smaller quantity of electricity (under same price) from the regulated generator. Such transactions will have no negative effects on the supplier.

Depending on the grid to which the preferential generator is connected (transmission or distribution), EMO shall transfer the energy to the supplier with or without the charge for the transmission grid use (Figures 3.4.1 and 3.4.2). EMO shall include the difference between the purchase price (feed-in tariffs) and sales price (regulated price) in the transmission charge levied to all consumers connected to both, transmission and distribution grids.

The proposed manner of funds collection to support RES will secure a simple mechanism, but due attention should made of the fact that this mechanism will not be applicable upon the full liberalization of the electricity market.

The proposed model of funding feed-in tariffs for RES electricity guarantees the following:

– transparent manner of funds collection;
– equitable contribution (per kWh) of all electric power system users in financing feed-in tariffs;
– simple method that minimizes the costs for the model operation and does not imply additional liabilities for energy companies.

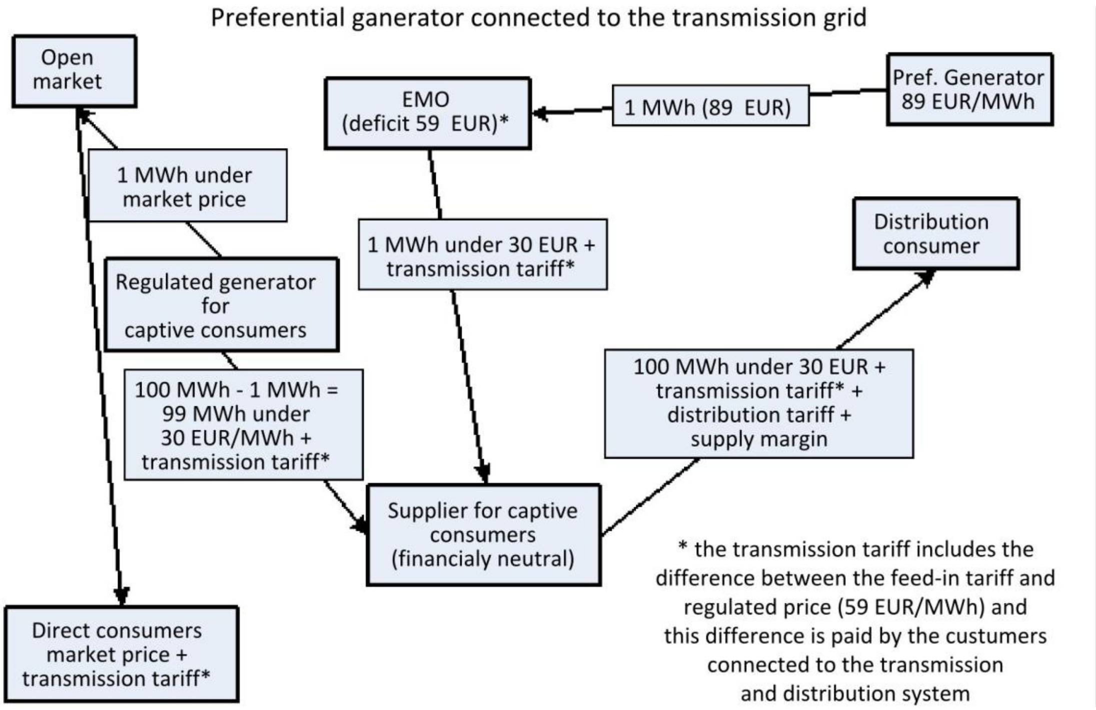

Figure 3.4.1. Payment mechanism for feed-in tariff for preferential generators connected to the transmission grid

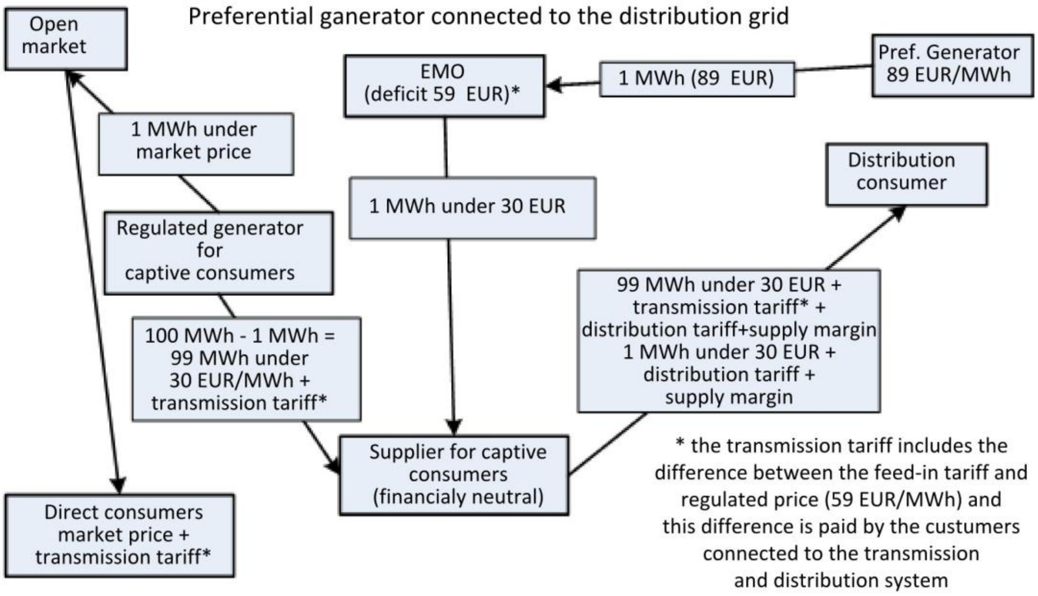

Figure 3.4.2. Payment mechanism for feed-in tariff for preferential generators connected to the distribution grid

4. SETTING THE RES TARGET AND RES ELECTRICITY TARGET

The share of 13.8% of renewable energy sources in the final energy consumption for 2005 makes Macedonia a country with relatively high rate for use of renewable energy sources (Figure 4.1).

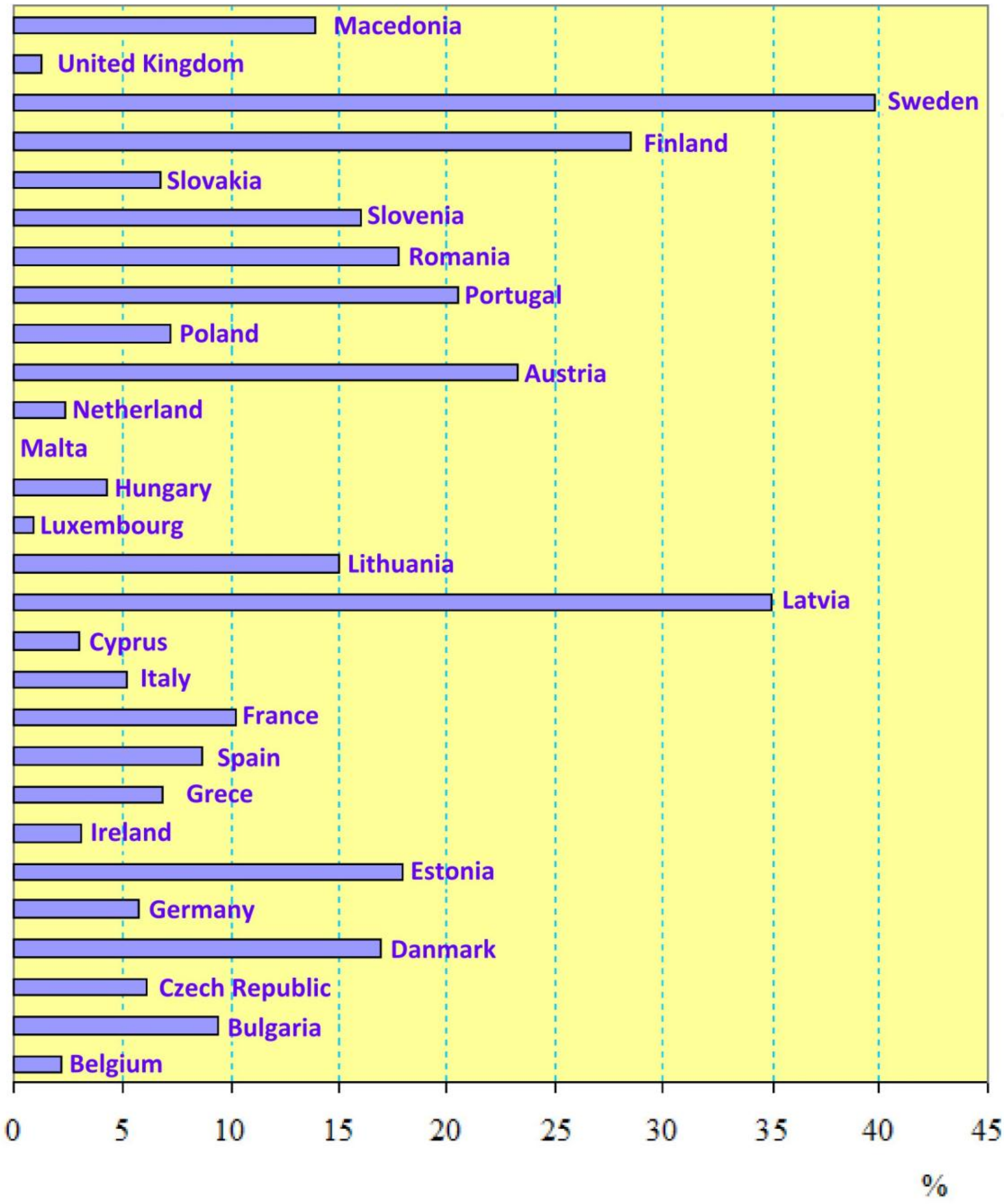

Figure 4.1. RES share in final energy consumption, for the year 2005

In the last period, use of renewable energy sources in Macedonia included hydro energy (for electricity generation), biomass (mostly wood mass for household heat), geothermal energy (to a large extent for greenhouse heating purposes) and modest use of solar energy (for household hot water) and biofuels.

Use of RES in Macedonia in the year 2005, reduced to average hydrology (Table 4.2.1), amounted to 3016 GWh. In that, biomass was used as final energy in the amount of 1767 GWh[47] with 59% share in the total use of RES in Macedonia (Figure 4.2). In 2005, the share of hydro energy accounted for 1477 GWh[48]. When this generation is reduced to average hydrology in the last 15 years, it accounts for 1144 GWh, which is a relatively high share of 38%. The generation ration of large and small HPPs in 2005 accounted for 94% to 6 %, respectively. In 2005, geothermal energy contributed with 105 GWh[49] or 3%. In 2005, a modest share of solar energy was noted (around 0.2% from total use of RES), but the said share was not statistically registered.

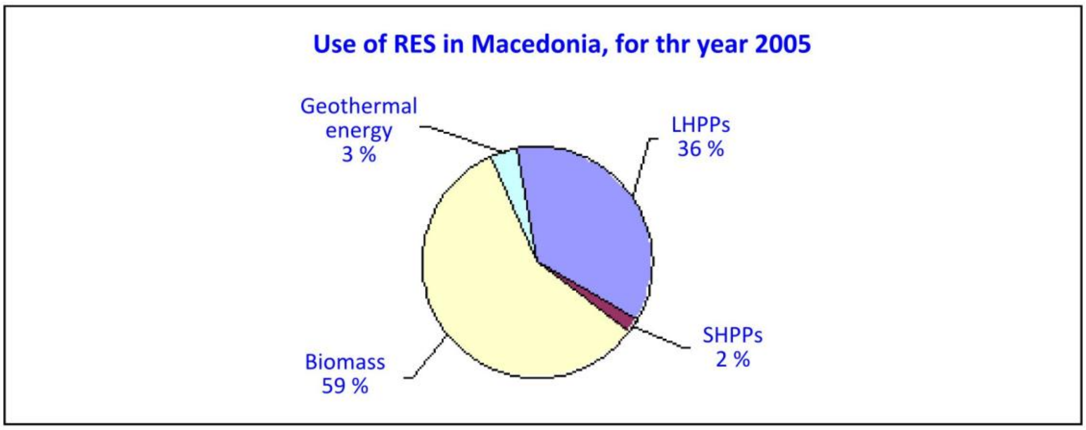

Figure 4.2. Relative shares of RES in Macedonia for the year 2005, reduced to average hydrology

4.1. PLANNED USE OF RES UNTIL 2020 AND 2030

In future, increased use of previously listed renewable energy sources is planned, as well additional use of wind and solar energy and biogas for electricity generation and waste biomass for cogeneration of electricity and heat.

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 International Energy Annual 2006, U.S. Energy Information Administration. Според IEA Online Database hydropower generation in 2005 accounted for 1489 Gwh, which is by 0.8% higher.

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

4.1.1. Hydro energy

Macedonia disposes with technical potential of hydro energy for the generation of around 5500 GWh electricity annually under average hydrology[50]. At the moment, HPPs have been constructed with total installed capacity of 580 MW (Tables 2.1.1.1.1, 2.1.2.1.1) and average generation of around 1500 GWh, which accounts for 27% of the available potential. According to the referenced study, the use of additional HPPs with generation of approximately 2500 GWh is planned, which would result in total generation equal to 4000 GWh or 73% of the available technical potential.

The Strategy on Energy Development of the Republic of Macedonia[51], under the basic scenario anticipates the construction of 6 LHPPs in the period until 2020 (HPP St. Petka until 2010, HPP Boskov Most until 2015, Lukovo Pole with HPP Crn Kamen and HPP Galiste until 2016, HPP Gradec until 2017 and HPP Cebren until 2019) with total installed capacity of around 690 MW and average annual generation output of nearly 1200 GWh (Table 4.1.1.1 – upper limit (UL)). Having in mind that concession-awarding procedures (tenders) announced on several occasions did not provide the expected results, i.e., were unsuccessful, it is likely for the construction of these HPPs to be delayed. Under the assumption of HPP construction delayed for several years, it can be expected that HPP Gradec and HPP Cebren will be completed after 2020. In that case, the generation from new LHPPs in 2020 would be reduced to 600 GWh (Table 4.1.1.1 - lower limit (LL)). The realistically achievable scenario assumes a delay in HPPs construction as well, where only the construction of HPP Gradec is anticipated after 2020. Consequently, new LHPPs constructed by 2020 will have a total capacity of 635 MW and annual generation output of 940 GWh (Table 4.1.1.1 - planned scenario (PS)).

In the period until 2030, in addition to listed HPPs the construction of HPP Veles and the remaining 10 smaller HPPs in the Vardar valley is also anticipated. With them the total capacity of newly constructed HPPs will account for 960 MW and annual average generation of around 2280 GWh.

The potential for construction of SHPPs on 400 possible sites[52] is assessed at 255 MW (Chapter 2.1.2.2). According to the average generation of existing SHPPs, the annual generation of the new 255 MW will account for 670 GWh. By means of announcing tender procedure, the Ministry of Economy awards concessions for sites suitable for SHPPs construction. Construction of SHPPs is also planned as part of water supply and irrigation systems. Despite certain administrative problems, as well as problems related to the vague hydrology of the sites in question, the realistic expectations include the construction of total 80 MW SHPPs by 2020 with annual generation of 210 GWh, or 160 MW by 2030 with annual generation of 420 GWh. At the same time, the optimistic scenario anticipates the construction of 120 MW SHPPs by 2020 with annual generation of 310 GWh and 240 MW by 2030 with annual generation of 620 GWh.

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[50] Energy Sector Development Strategy for Macedonia - Final Report, Ministry of Economy, Research Center for Energy Informatics and Materials of the Macedonian Academy of Sciences and Arts and Electrotek Concepts Inc., July 2000

[51] Strategy on Energy Development of the Republic of Macedonia until 2030, Macedonian Academy of Science and Arts, 2010.

[52] Study on the SHPP Hydro Potential, 1980.

Table 4.1.1.1. Planned LHPPs

HPPs	P (MW)	Annual generation output (GWh)		
		UL	LL	PS
St. Petka	36	60	60	60
Boskov Most	68	117	117	117
Lukovo Pole and HPP Crn Kamen	5	163	163	163
Galiste	193	264	264	264
Cebren**	333	340	340*	340
Gradec	55	252	252*	252*
Total in 2020	690;302;635	**1196**	**604**	**944**
Veles	93	300	300	300
Vardar Valley – 10 HPPs	177	784	784	784
Total in 2030	**960**	**2280**	**2280**	**2280**

* *Enters into operation after 2020.*
** *Pursuant to the Directive 2009/28/EC does not include the generation from the previously pumped water.*

4.1.2. Wind energy

Several studies were made in the last period to determine the wind energy potential in Macedonia and to select the best sites for WPP construction. In compliance with the Atlas of wind energy[53] a selection was made of the 15 most favourable sites for WPP construction. Detailed measurements were performed on 4 sites, while additional measurements are currently undertaken on 4 sites in the vicinity of Bogdanci. Preparations for measurements on other 5 sites are also underway. Plans are made to develop a study on the WPP absorption capacity of the electric power system in Macedonia.

Based on previous research, the realistic expectations include the construction of 90 – 180 MW WPPs by 2020 with annual generation of 180 – 360 GWh and a total of 180 – 360 MW by 2030 with annual generation of 360 – 720 GWh.

The lower limit is set at 5% of the electricity generation capacity in Macedonia for the year 2010 and according to previous experiences it should not create problems in the electric power system. The capacity of systems similar to the system in the Republic of Macedonia is assessed to be at minimum 10%. The planned 90 MW can be achieved with the construction of WPPs on two to three sites.

The planned total installed capacity of 180 MW for WPPs will account for 6% of planned electricity generation capacity in Macedonia for the year 2020, while the planned capacity of WPP at 360 MW is within the scope of 10% of planned electricity generation capacity in Macedonia for the year 2030.

4.1.3. Photovoltaic solar systems

Macedonia disposes with solid solar potential and applies high feed-in tariffs for electricity generated from solar energy. However, Macedonia does have in-country production of relevant technology and the feed-in tariff is fully levied to electricity consumers without indirect benefits for the economy. From this reason, no major penetration has been anticipated for photovoltaic systems in Macedonia, despite the high interest in their construction due to the applicable high feed-in

[53] Wind Energy Resource Atlas and Site Screening of the R. of Macedonia, AWSTruewind, June 2005

tariffs. The construction of total 10 – 30 MW photovoltaic systems has been anticipated by 2020 with an annual generation of 14 – 42 GWh, while 20 – 40 MW by 2030 with annual generation of 28 – 56 GWh. Upper limits can be considered achievable in case of significantly higher electricity market price and development of cheaper technologies on use of solar energy for electricity generation.

4.1.4. Waste biomass for electricity and heat cogeneration

Activities to assess this potential in Macedonia are underway, but there are no specific results as yet. According to our knowledge, the construction of total 5 – 10 MW with annual generation of 25 – 50 GWh is possible by 2020 and construction of 10 – 14 MW with generation of 50 – 70 GWh is possible by 2030.

4.1.5. Biogas

The potential for electricity generation from biogas has not been sufficiently researched. The present Strategy anticipates a total capacity of such plants in the range of 7 – 10 MW by 2020 with annual generation of 20 – 30 GWh and 10 – 15 MW by 2030 with generation output of 30 – 45 GWh.

4.1.6. Biomass for combustion

In 2005, the share of biomass for combustion in the total use of RES accounted for 59% (Figure 4.2) and is therefore considered an important fuel for meeting energy demand. Biomass is primarily used by households and meets 30 – 33% of total energy needs. Around 430000 households (76%) use biomass for heating purposes.

Fire wood and coal account for 80% of total biomass used for energy purposes. In the Republic of Macedonia common is also the use of vine sprouts, rice chaff and fruit tree branches for energy purposes, but most of straw is primarily used for fertilizers, livestock feed and production of cellulose. Therefore, straw is not available for energy purposes.

The planned use of biomass for combustion for heating purposes in 2020 is by less than 10% higher than the 2006 consumption, taking into account the registered and unregistered consumption. Table 4.2.1 provides the 2005 statistical data [54] that do not include the unregistered consumption. In the period until 2020, a gradual decrease of unregistered consumption is expected, as well as registration of portion thereof. Thereby, the total consumption for the period 2006-2020 will be increased by only 10%, which is in line with the available potential, despite the fact that the registered consumption will be increased by more than 40%. According to the basic scenario from the Strategy on Energy Development[55] consumption of biomass for combustion used for heating purposes will account for 236 ktoe (2740 Gwh) in 2020.

The scenario with stronger EE measures from the Strategy on Energy Development[56] anticipates a growth of biomass for combustion consumption for heating purposes by only 5.7% in the period 2006-2020, where in 2020 the consumption will reach 227 ktoe (2640 GWh).

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

[55] Strategy on Energy Development in the Republic of Macedonia until 2030, MASA, 2010.

[56] Strategy on Energy Development in the Republic of Macedonia until 2030, MASA, 2010.

According to the basic scenario from the Strategy[57] a mild decrease of biomass consumption used for heating purposes is anticipated by 2030, when it will account for 218 ktoe (2540 GWh). The scenario with stronger EE measure anticipates that consumption of biomass for combustion used for heating purposes will amount to 226 ktoe (2630 GWh) in 2030, which is practically at the same level with 2020. The second scenario anticipates higher penetration of high-efficiency stoves for biomass combustion before 2020, while the basic scenario anticipates higher penetration thereof in the period after 2020.

When calculating in the waste biomass for electricity and heating energy cogeneration, biomass consumption in 2020 will account for 244 - 249 ktoe (2840 – 2900 GWh). This implies an increase in biomass consumption by 12-14% in the given period. Total consumption of biomass for combustion in 2030 is planned to account for 252 - 258 ktoe (2930 – 3000 GWh).

4.1.7. Solar energy as heating energy

In the last period, the use of solar energy for heating purposes had a modest share in the energy balance of Macedonia. In that, Macedonia was characterized by small use of solar energy compared to the countries in the region, but also compared to northern countries. With only about 4000 collector systems for solar energy used for hot water in 2006, the solar energy consumption participated in the final energy consumption with modest 7.4 GWh (0.6 ktoe), i.e., with a share of 0.04%.

From 2007 the Government financially supports the introduction of solar collectors, but it is insufficient to promote mass introduction of this energy fuel in Macedonia. Main reason thereof is identified in the low electricity price, which makes the recovery period for household investments in solar energy for heating purposes longer than 10 years.

To promote greater penetration of solar energy used for heat purposes with households major financial support is needed and a change of the manner in which subsidies are provided, notably from campaign to mode of continuous support. The Government's support will be decreased in parallel to the electricity price increase until it reaches the level of market price. One of the measures to promote the introduction of solar collectors could include favourable loans to replace asbestos roofs with simultaneous installation of solar systems.

In order to promote greater introduction of solar systems in the industry sector, especially in the industrial branches that consume large quantity of hot water (dairy, meat and textile industries) and where the return period is relatively short, it is necessary to stimulate in-country manufacturers to venture a mass production of solar systems by facilitating export and administrative procedures. This will improve the quality of systems and will result in economic gains.

Solar energy as heat will be primarily used by households. It is anticipated that by 2020, 55000 – 80000 households will have such installation, which accounts for total use of solar energy (together with the commercial and service sector and the industry) in the range of 60 – 90 GWh annually. By 2030, the number of solar installations at households is anticipated in the range of 70000 – 140000. Thus, the use of solar energy as heat in all sectors will account for 83 – 155 GWh annually.

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[57] Strategy on Energy Development in the Republic of Macedonia until 2030, MASA, 2010.

4.1.8. Geothermal energy

It is planned that geothermal energy as final energy in 2020 will account for 400 – 520 GWh, and therefore has a significant contribution in the use of RES. In order to achieve this target, additional actions on behalf of the Government are needed to complement and advance the activities undertaken to use the existing sources and identify new sources. Start of activities on oil prospection will contribute to identification of new sources with high water temperature. In 2020, geothermal energy will contribute to primary energy consumption in the range of 440 – 570 GWh.

It is anticipated that in 2030 the geothermal energy will contribute to final energy consumption in the range of 560 – 660 GWh, where the geothermal energy's contribution in primary energy consumption will account for 620 – 730 GWh annually.

4.1.9. Biofuels

In the light of the EU Directive 2009/28/EC, the share of RES in the final energy consumption in transport is planned at the rate of at least 10% in 2020. Pursuant to the said Directive, the final energy consumption in transport includes only petrol, diesel and biofuels in road and railway transport and electricity. The use of RES includes all forms of RES used in transport. In Macedonia, it is planned that in 2020 the electricity contribution in final energy consumption in road and railway transport will account for less than 1%. Also, in addition to biofuels, the use of other RES in transport will account for less than 1%. Accordingly, the target set can be calculated primarily by means of contribution of biofuels in the consumption of petrol and diesel fuels in transport (Table. 4.1.9.1).

Table 4.1.9.1. Forecasted consumption of biofuels in transport for the Republic Macedonia by 2020 (ktoe/year)

	Basic scenario						Scenario with lower growth rate					
	Petrol fuels [ktoe]	Diesel [ktoe]	Total [ktoe]	RES [%]	Biofuel [%]	Biofuel [ktoe]	Petrol fuels [ktoe]	Diesel [ktoe]	Total [ktoe]	RES [%]	Biofuel [%]	Biofuel [ktoe]
2010	125	208	333	2.5	2.5	4**	120	198	318	2.5	2.5	4**
2011	129	221	349	3.4	3.4	12	119	204	324	3.4	3.4	11
2012	136	239	375	4	4	15	119	210	329	4	4	13
2013	142	259	401	4.7	4.7	19	121	220	341	4.7	4.7	16
2014	149	279	428	6	6	26	125	234	359	6	6	22
2015	156	299	455	7	7	32	131	252	383	7	7	27
2016	163	319	482	8	8	39	138	271	408	8	8	33
2017	169	340	509	8.5	8.5	43	144	290	433	8.5	8.5	37
2018	175	361	536	9	9	48	150	309	459	9	9	41
2019	182	382	563	9.5	9.2	52	156	328	484	9.5	9.2	44
2020	188	403	591	10	9.5	56	162	347	508	10	9.5	48

**By 2018, use of REs in transport includes only biofuels. Accordingly, the share of biofuels by 2018 is equal to the RES share. In 2019 and 2020 use of other RES in transport is also planned with a share of 0.5%.*

***Total quantity of biofuels that will be consumed in 2010 will depend on the enforcement date of the by-law that is to stipulate the minimum share of blends of fuels for transport with clean biofuels.*

The attainment of the target set forth in the Directive on the share of RES in the final energy consumption in transport implies that in 2020 biofuels will contribute with 48 – 56 ktoe (560 - 655 GWh), in compliance with the consumption of petrol and diesel fuels as anticipated under the Strategy on Energy Development in Macedonia and under the scenario with stronger EE measure and the basic scenario, respectively.

In 2030 the share of biofuels is estimated at the level of at least 20% of the total consumption of petrol and diesel fuels in transport and their contribution will account for 145 – 163 ktoe (1700 - 1900 GWh).

There are no research data on the possibility to secure biomass for biofuels generation and therefore special studies and incentives are needed in order to address this issue. In addition to incentives for production of raw materials, incentives are also needed to promote the production and use of biofuels (for example, by reducing the relevant excise). Considering the fact that the Directive allows biofuel import, great attention should also be paid to incentives and obligations to use them.

4.2. RES SHARE IN THE FINAL ENERGY CONSUMPTION FOR THE YEAR 2020

RES contribution in final energy consumption [58] is defined as the share of energy from RES in the total final energy consumption, where:

- energy from RES is the sum of:
  - electricity form all types of renewable energy sources;
  - final consumption of RES for heating and cooling; and
  - biofuels consumed in transport;
- gross final energy consumption (GFEC) is defined as the sum of:
  - final energy consumption (in the industry, household, commercial and service sector, and agriculture and forestry sector);
  - electricity and heat distribution losses;
  - energy companies' own consumption (notably, electricity and heat generation companies).

The Directive takes 2005 data as baseline year data. In that, the electricity generation from HPPs in 2005 is calculated pursuant to the capacity of all in-country HPPs in the said year and the generation is calculated as the average relative generation per capacity unit for the last fifteen years. This provides information on the 2005 generation output under the given capacity and average hydrology for the last 15 years. Accordingly, the planned generation for the period until 2020 is calculated on the basis of average hydrology data. The generation output of pumped-storage HPPs does not include the generation of previously pumped water. Similar method was applied to calculate the average generation output of wind energy for the last 4 years.

[58] Directive 2009/28/EC

Mandatory targets for EU Member-States were calculated based on 2005 RES shares in the total final energy consumption for the country in question, plus 5.5% for all members and plus a certain share weighted by the country's GDP per capita. Pursuant to that method, the target for Macedonia is set at 20.5% (Table 4.2.1). In compliance with the EU-developed methodology, the given share is rounded to 21%.

At the same time, the European Community Secretariat develops a study on the implementation of the new Directive on the promotion of the use of RES[59], which in addition to the Strategy will provide guidelines for the attainment of national RES targets.

Table 4.2.1. Setting the national target for RES share in the final energy consumption, in the year 2020

RES share in 2005	Value	Source
Final energy consumption, GWh	19666	(1)
+ non-energy consumption, GWh	407	(1)
+ electricity losses, GWh	1593	(1)
+ heat losses, GWh	93	(1)
+ own electricity consumption, GWh	721	(1)
+ own heat consumption, GWh	116	(1)
Gross final energy consumption in the year 2005, GWh (A)	21783	
HPP generation in 2005, GWh	1477	(2)
÷ Capacity factor (CF) in 2005	32.70%	(2)
× Average capacity factor (CF) for the period 1992-2005	25.30%	(2)
Normalized HPP generation in 2005, GWh (B)	1144	
Other RES in 2005, GWh (C)	1872	(1)
Total normalized generation from RES, GWh (D) = (B) + (C)	3016	
RES share in 2005 (E) = (D) / (A)	13.8%	
Equitable RES increase by 2020 (G)	5.5%	
Additional RES increase weighted by GDP, (H)	1.2%	(3)
National target on RES share in 2020, (E) + (G) + (H)	20.5%	

(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) International Energy Annual 2006, U.S. Energy Information Administration
(3) IPA Energy + Water Economics & EPU-NTUA Study on the Implementation of the New EU Renewable Directive in the EC, Draft, December 2009

Table 4.2.2 shows RES share and final energy consumption (FEC) under the lower limit (LL), upper limit (UL) and values estimated under the four scenarios (S1, S2, S3 and S4) that are to contribute to the attainment of the target share 21%.

Lowest share of RES (LL) in the final consumption of energy was obtained under the lowest estimated shares of all RES types separately in the final energy consumption as given in the basic scenario from the Strategy on Energy Development in Macedonia.

Highest share of RES (UL) in the final consumption of energy was obtained under the highest estimated shares of all RES types separately in the simultaneous

[59] IPA Energy + Water Economics & EPU-NTUA Study on the Implementation of the New EU Renewable Directive in the EC, Draft, December 2009

final energy consumption as given in the scenario with stronger EE measures from the Strategy on Energy Development in Macedonia.

Target RES share of 21% can be attained with different combinations of use of RES and final energy consumption in the given limits. Four possible scenarios thereof were analysed.

Table 4.2.2. RES share in the final energy consumption (GWh)

	2020 LL	2020 UL	2020 S1	2020 S2	2020 S3	2020 S4
Electricity from RES	**2539**	**3482**	**3139**	**3039**	**2679**	**2492**
HPPs	2300	3000	2900	2710	2350	2010
LHPPs	2000	2600	2600	2350	2000	1610
SHPPs	300	400	300	360	350	400
WPPs	180	360	180	270	270	360
PVPPs	14	42	14	14	14	42
Biomass	25	50	25	25	25	50
Biogas	20	30	20	20	20	30
Heat from RES	**3100**	**3350**	**3100**	**3200**	**3240**	**3350**
Biomass	2640	2740	2640	2740	2740	2740
Solar energy	60	90	60	60	60	90
Geothermal energy	400	520	400	400	440	520
Biofuels	**560**	**655**	**655**	**655**	**560**	**560**
TOTAL RES	**6199**	**7487**	**6894**	**6894**	**6479**	**6402**
FEC	**32873**	**30825**	**32873**	**32873**	**30825**	**30825**
Share of RES (%)	**18.9**	**24.3**	**21.0**	**21.0**	**21.0**	**20.8**

Scenario S1

This scenario is heavily relies on electricity generated by LHPPs and is based on the basic scenario from the Strategy on Energy Development of Macedonia. The construction of HPP St. Petka, HPP Boskov Most, Lukovo Pole with HPP Crn Kamen, HPP Galiste, HPP Gradec and HPP Cebren is anticipated to be completed by 2020.

Expected electricity generation output of SHPPs, WPPs, PPPs, waste biomass and from biogas, as well as the use of solar energy as heat, biomass and geothermal energy is anticipated at the level of lower quantities planned.

This scenario assumes the final energy consumption and biofuels consumption according to the basic scenario from the Strategy on Energy Development of Macedonia.

It can be noted (Table 4.2.2) that in reality the target RES share for 2020 can be exceeded if the planned LHPPs construction is completed.

Scenario S2

The above analysis implies a certain uncertainty in regard to the LHPPs construction. Therefore, the mandatory target set for this scenario includes a delay in the LHPPs construction. Delayed construction is anticipated for all LHPPs from the basic scenario: HPP St. Petka for one year, HPP Boskov Most for two years, Lukovo Pole with HPP Crn Kamen and HPP Galiste for two years, HPP Cebren for one year and HPP Gradec for more than three years. This will mean that the construction of HPP Gradec will be completed after 2020. The necessary difference to attain the target share of 21% of renewable energy sources will be covered by the additional construction of SHPPs and WPPs with relevant capacities accounting for the medium between the lowest and highest estimated values and with increased biomass consumption for combustion from 2640 to 2740 GWh compared to the scenario S1. Use of biomass for combustion planned for 2020 is within the upper limit, which is by less than 10% higher than the 2006 consumption, both registered and unregistered[60]. This rate of biomass use can realistically be achieved with small increase of fire wood potential and improving the forest cutting and wood processing technology and by reducing non-utilized waste biomass. Biofuels share is within the upper limit range and is appropriate for the final consumption of energy and fuel consumption in transport. Share of other RES types is within the lower limit.

Scenario S3

This scenario is based on the final energy consumption anticipated under the scenario with stronger EE measures from the Strategy on Energy Development of Macedonia.

The dynamic of LHPPs construction anticipates an additional delay for a period of one year, where the construction of HPP Cebren will be completed after 2020. The necessary difference to attain the target share of 21% of RES will be covered with additional use of geothermal energy by 40 GWh and under same capacity of other RES types as given in the scenario S2. Biofuels share is within the lower limit range in compliance with the estimated consumption from the scenario with stronger EE measures.

Scenario S4

This scenario analyses the situation when in addition to HPP Gradec also HPPs Cebren, Galiste and Boskov Most will be put into operation after 2020 or the situation when green certificates for electricity generated by these four HPPs will belong to a foreign investor. In that case, the projected target on RES share in final energy consumption will not be achieved even under the maximum rate of use of all other RES types in the final energy consumption and biofuels consumption as given in the scenario with strong EE measures. Therefore, LHPP generation must be used to attain the target share of RES in the final energy consumption.

Conclusion

The above given scenarios indicate the fact that in 2020 the Republic of Macedonia can realistically attain the target share of RES set at 21%. Scenarios S2 and S3 are considered to be most probable. Scenario S3 is based on final energy consumption according to the scenario with stronger EE measures from the Strategy on Energy Development of Macedonia and is considered the target option. Scenario

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[60] Strategy on Energy Development in the Republic of Macedonia until 2030, MASA, 2010.

S2 anticipates final energy consumption according to the basic scenario from the Strategy. Both scenarios anticipate the reduction of electricity and heat losses in the transmission and distribution systems to acceptable European levels.

The implementation of scenarios S2 and S3 or any option between them by 2020 will necessitate the use of:

- hydro energy from LHPPs in the amount of 2000 - 2350 GWh (construction of HPP St. Petka, HPP Boskov Most, Lukovo Pole with HPP Crn Kamen and HPP Galiste pursuant to the scenario S3 and plus HPP Cebren pursuant to S2);
- hydro energy from SHPPs in the amount of 350 – 360 GWh;
- wind energy in the amount of 270 GWh;
- solar energy for electricity generation in the amount of 14 GWh;
- waste biomass by TPP-HP for electricity generation in the amount of 25 GWh;
- biogas for electricity generation in the amount of 20 GWh;
- biomass for combustion for heat generation in the amount of 2740 GWh;
- solar energy for heat generation in the amount of 60 GWh;
- geothermal energy in the amount of 400 – 440 GWh; and
- biofuels in the amount of 560 – 655 GWh.

Scenario S2

Under the S2 the share of RES share will grow with the dynamic given in Table 4.2.3 and Figure 4.2.1.

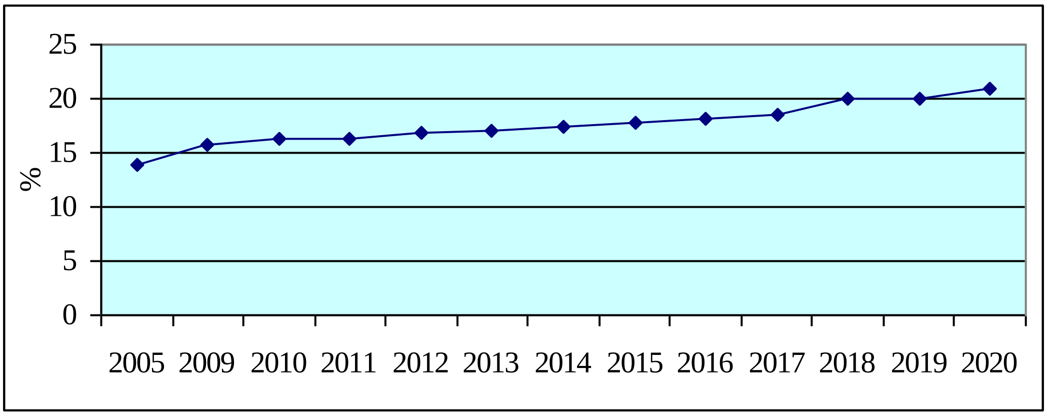

Figure 4.2.1. RES share in total final energy consumption (Scenario S2)

Figure 4.2.2 shows the share of individual RES types in the total amount of RES for the year 2020 according to S2.

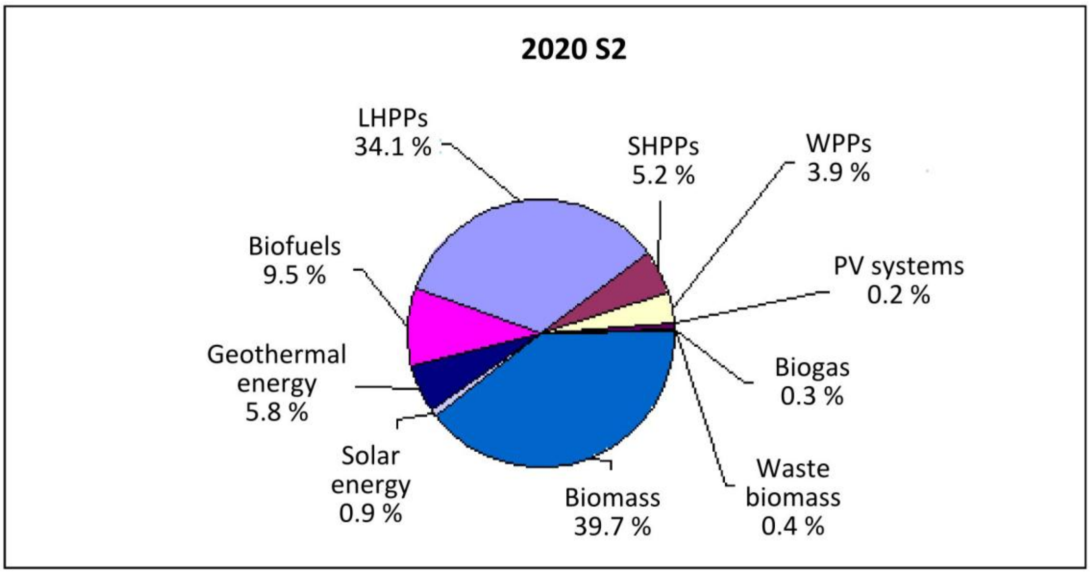

Figure 4.2.2. Shares of individual RES types in 2020 (Scenario S2)

Biomass for incineration and hydro energy have the highest shares, 39.7% and 39.3% (34.1+5.2), respectively. Following are biofuels (9.5%), geothermal energy (5.8%), WPPs (3.9%) and solar energy as heat (0.9%). Electricity from biogas, waste biomass for TPP-HP and from photovoltaic systems contributes with a total of 0.9%.

In order to achieve the target share of 21%, this scenario anticipates additional measures available, those being:

- improving the energy efficiency:
    - by including additional energy saving and improving energy efficiency measures the final energy consumption in 2020 will be reduced by 6.2%.
- increase of RES share:
    - WPP: according to the optimistic scenario, in 2020 WPPs can provide a generation output of 360 GWh electricity. This is by 90 GWh higher from the output planned under scenario S2;
    - SHPP: according to the optimistic scenario, in 2020 SHPPs can provide a generation output of 400 GWh electricity. This is by 40 GWh higher from the output planned under scenario S2;
    - LHPP: according to the basic scenario, in 2020 additional 250 GWh can be expected;
    - geothermal energy: according to the optimistic scenario, in 2020 geothermal energy is planned in the range of 520 GWh. This is by 120 GWh higher from the amount planned under scenario S2;

According to the given analysis, in order to attain a RES share of 21% in the final energy consumption in Macedonia in 2020, the scenario S2 provides additional: 440 GWh from energy savings and improving energy efficiency, 90 GWh from wind energy, 40 GWh from SHPPs and 120 GWh from geothermal energy, or in sum it provides additional 690 GWh. This is nearly 20% of planned RES increase of around 3400 GWh in the period 2009-2020.

Additional 250 GWh from LHPPs are also possible, as well as the reduction of the mandatory target on biofuels by around 100 GWh by decreasing the total fuel consumption in transport pursuant to the scenario with strong EE measures.

Scenario S3

Under scenario S3, the RES share will grow with the dynamics given in Table 4.2.4 and Figure 4.2.3**.**

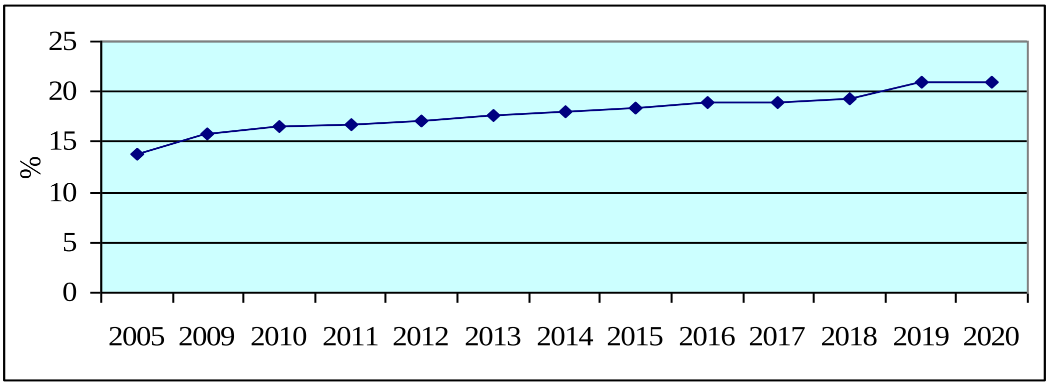

Figure 4.2.3. RES share in total final energy consumption (Scenario S3)

Figure 4.2.4 shows the shares of individual RES types in the total amount of RES for the year 2020 according to the scenario S3. Biomass for combustion has the highest contribution with a share of 42.3%, as well as the hydro energy with a share of 36.3% (30.9+5.4). Following are biofuels (8.6%), geothermal energy (6.8%), WPPs (4.2%) and solar energy as heating energy (0.9%). Electricity from biogas, waste biomass for TPP-HP and electricity from photovoltaic systems contribute with a total of 0.9%.

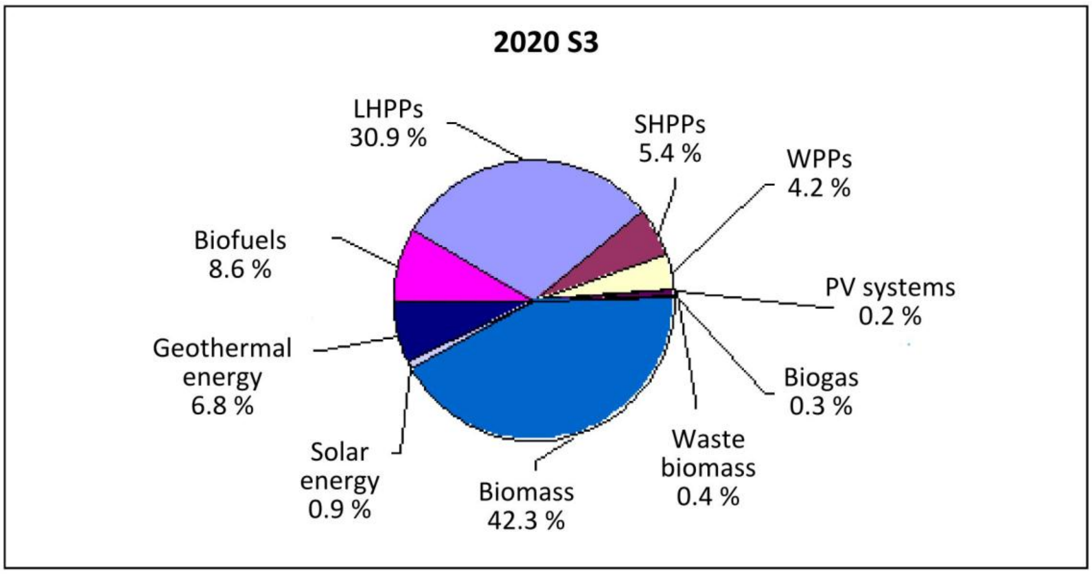

Figure 4.2.4. Shares of individual RES types, for the year 2020 (Scenario S3)

The implementation of this scenario uses the available differences from the values projected under the optimistic assumptions, those being: 50 GWh from SHPPs, 90 GWh from wind energy, 30 GWh from solar energy as heating energy and 80 GWh from geothermal energy, or in sum - 250 GWh.

Additional 600 GWh from LHPPs are also possible.

If the target for Macedonia is set at 21% in 2020, the dynamics for the target attainment in the period until 2020 should follow the following scheme (Chapter 1):

average 2011 – 2012, $S_{2011-2012}$ = 15.6%
average 2013 – 2014, $S_{2013-2014}$ = 16.3%
average 2015 – 2016, $S_{2015-2016}$ = 17.1%
average 2017 – 2018, $S_{2017-2018}$ = 18.5%.

These values are within the range of planned RES shares for the given years under both scenarios, S2 and S3 (Tables 4.2.3 and 4.2.4).

Table 4.2.3. RES share in the final energy consumption (Scenario S2)

GWh	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
Electricity from RES	**1481**	**1481**	**1573**	**1627**	**1733**	**1835**	**1929**	**2104**	**2599**	**2649**	**3039**
HPPs	1480	1480	1570	1610	1650	1690	1720	1865	2330	2350	2710
LHPPs	1390	1390	1450	1450	1450	1450	1450	1570	2010	2010	2350
SHPPs	90	90	120	160	200	240	270	295	320	340	360
WPPs	0	0	0	0	50	100	150	180	210	240	270
PV Systems	1	1	3	6	10	10	14	14	14	14	14
Biomass (TPP=HP)	0	0	0	6	13	20	25	25	25	25	25
Biogas	0	0	0	5	10	15	20	20	20	20	20
Heat from RES	**2198**	**2369**	**2499**	**2587**	**2686**	**2790**	**2880**	**2969**	**3048**	**3135**	**3200**
Biomass	2063	2220	2340	2420	2500	2580	2645	2687	2720	2740	2740
Solar energy	13	16	19	22	26	30	35	42	48	55	60
Geothermal energy	122	133	140	145	160	180	200	240	280	340	400
Biofuels	**46**	**138**	**174**	**219**	**299**	**370**	**448**	**503**	**561**	**605**	**655**
TOTAL RES	**3725**	**3988**	**4246**	**4433**	**4718**	**4995**	**5257**	**5576**	**6208**	**6389**	**6894**
FEC	**22819**	**23967**	**25050**	**26065**	**27015**	**28008**	**28927**	**29911**	**30826**	**31778**	**32873**
RES share (%)	**16.3**	**16.6**	**17.0**	**17.0**	**17.5**	**17.8**	**18.2**	**18.6**	**20.1**	**20.1**	**21.0**

Table 4.2.4. RES share in the final energy consumption (Scenario S3)

GWh	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
Electricity from RES	**1481**	**1481**	**1513**	**1627**	**1733**	**1835**	**1929**	**1979**	**2144**	**2629**	**2679**
HPPs	1480	1480	1510	1610	1650	1690	1720	1740	1875	2330	2350
LHPPs	1390	1390	1390	1450	1450	1450	1450	1450	1565	2000	2000
SHPPs	90	90	120	160	200	240	270	290	310	330	350
WPPs	0	0	0	0	50	100	150	180	210	240	270
PV Systems	1	1	3	6	10	10	14	14	14	14	14
Biomass (TPP-HP)	0	0	0	6	13	20	25	25	25	25	25
Biogas	0	0	0	5	10	15	20	20	20	20	20
Heat from RES	**2198**	**2369**	**2499**	**2587**	**2686**	**2790**	**2880**	**2962**	**3038**	**3135**	**3240**
Biomass	2063	2220	2340	2420	2500	2580	2645	2680	2690	2710	2740
Solar energy	13	16	19	22	26	30	35	42	48	55	60
Geothermal energy	122	133	140	145	160	180	200	240	300	370	440
Biofuels	**44**	**128**	**153**	**186**	**251**	**312**	**380**	**428**	**480**	**512**	**560**
TOTAL RES	**3723**	**3978**	**4165**	**4400**	**4670**	**4937**	**5189**	**5369**	**5662**	**6276**	**6479**
FEC	**22544**	**23518**	**24252**	**24975**	**25733**	**26622**	**27404**	**28226**	**29057**	**29925**	**30825**
RES share (%)	**16.5**	**16.9**	**17.2**	**17.6**	**18.1**	**18.5**	**18.9**	**19.0**	**19.5**	**21.0**	**21.0**

4.3. RES SHARE IN THE FINAL ENERGY CONSUMPTION BY 2030

Table 4.3.1 shows the RES share in the final energy consumption (FEC) under the lower limit (LL) and upper limit (UL). In 2030, RES share in the final energy consumption in Macedonia will be within the range of 21.1 to 27.6%, where the realistically achievable medium value is around 25%.

Table 4.3.1. RES share in the final energy consumption (GWh)

	2030 LL	2030 UL
Electricity from RES	**3898**	**5301**
HPPs	3430	4410
LHPPs	2920	3700
SHPPs	510	710
WPPs	360	720
PV Systems	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 to make a significant increase of hydro energy above the given upper limit. It is unlikely that wind potential in Macedonia will exceed the value of around 360 MW. This would imply construction of WPPs with capacity of 50 MW on seven sites. Considering their cost, photovoltaic systems are already planned under an excessively optimistic rate. Even in the case of double increase in the use of waste biomass, biogas and solar energy as heating energy compared to the optimistic values, which is an unrealistic target, RES share in the final energy consumption will increase by only 0.6 %.

If Macedonia sets the RES target share at a level higher than 27.6%, additional efforts will be needed, primarily in regard to reducing final energy consumption and increased use of biomass and geothermal energy. Each increase in the RES share by one percent will require additional 400 GWh energy from RES or final consumption saving.

4.4. RES SHARE IN ELECTRICITY GENERATION

Under average annual electricity generation growth rate of 3%, 2% and 2.5% and under electricity generation from RES pursuant to LL (2539 GWh, Table 4.4.1), UL (3482 GWh), S2 (3039 GWh) and S3 (2679 GWh), in 2020 the RES share in electricity generation will account for 20.1%, 31.5%, 25.7% and 24.2%, respectively. In compliance with previous analyses, it is realistically possible to expect that in 2020 the RES share in electricity generation will account for approximately 25%.

Table 4.4.1. RES share in electricity generation, for the year 2020

Electricity from RES	2020 LL	2020 UL	2020 S2	2020 S3
GWh	**2539**	**3482**	**3039**	**2679**
Total electricity generation growth rate	3%	2%	2.50%	2%
GWh	**12616**	**11060**	**11842**	**11060**
RES share (%)	**20.1**	**31.5**	**25.7**	**24.2**

Under average annual electricity generation growth rate of 3%, 2% and 2.5% and under electricity generation from RES pursuant to LL (3898 GWh, Table 4.4.2), UL (5301 GWh) and their medium values, MV (4600 GWh), in 2030 the RES share in electricity generation will account for 23%, 39.3% and 30.3%, respectively.

Table 4.4.2. RES share in electricity generation, for the year 2030

Electricity from RES	2030 LL	2030 UL	2030 MV
GWh	**3898**	**5301**	**4600**
Total electricity generation growth rate	3%	2%	2.5%
GWh	**16955**	**13482**	**15159**
RES share (%)	**23.0**	**39.3**	**30.3**

5. POSSIBILITIES FOR REDUCTION OF GREENHOUSE GAS EMISSIONS BY MEANS OF RES

This chapter provides the assessment of environmental effects of RES-based technologies by setting the total greenhouse gas emissions on annual level (expressed in kt CO_2-equivalents), which by 2020 can be reduced by means of use of RES. Calculations were made based on possible energy generation from RES anticipated under scenarios S2 and S3 from Chapter 4. Calculations are based on the following assumptions:

– reduction of greenhouse gas emissions by 2020 is calculated based on the coal scenario, i.e., the so called black scenario, which is defined as the basic scenario in the Second National Climate Change Report. In accordance with this scenario, the total greenhouse gas emissions in 2020 are 21500 kt CO2-eqv., while the network factor is 1,2 kt CO2-eqv/GWh, In addition to TPPs using coal, the black scenario also includes LHPPs, and therefore relevant emission reductions are not calculated in the total reduction achieved by use of RES;

– the network factor from the black scenario is accounted as the emission factor for electricity, and under certain electricity fuel composition, TPPs using coal and their revolving reserve will be replaced with RES;

– considering the fact that households to large extent use electricity for heating and hot water, it is assumed that the increased penetration of biomass and solar collectors will primarily contribute to electricity savings;

– biofuels shall replace petrol and diesel fuels for transport;

– emission factors of all fuels are taken from the National Inventory on Greenhouse Gases developed as part of the Second National Climate Change Report, which uses the methodology on greenhouse gas inventory developed by the Intergovernmental Panel on Climate Change, as given in Table 5.1.

Table 5.1. Emission factors of fuels (kt CO_2-equivalents/GWh)

Electricity from coal	1.20*
Crude oil	0.28
Petrol/diesel fuel	0.25
Biomass for combustion	0.39
Waste biomass	0.01
Biofuel	0.06
Biogas	0.12

**Analysis of greenhouse gas emissions reduction in Macedonia, RCEIM-MASA, 2007 (Table 1.14)*

Table 5.2. Reduction of greenhouse gas emissions with the use of RES

	2005	2020 S2	2020 S3	REF	Emissions - REF S2	Emissions-RES S2	Emissions – REF S3	Emissions RES S3	Reduction S2	Reduction S3
	GWh	GWh	GWh		kt CO_2-equivalents	kt CO_2-equivalents	kt CO_2-equivalents	kt CO_2-equivalents	kt CO_2-equivalents	kt CO_2-equivalents
Electricity from RES	**1144**	**3039**	**2679**							
HPPs	1144	2710	2350							
LHPPs	1090	2350	2000							
SHPPs	54	360	350	electricity from coal	367	0	355	0	367	355
WPPs	0	270	270	electricity from coal	324	0	324	0	324	324
PV Systems	0	14	14	electricity from coal	17	0	17	0	17	17
Biomass	0	25	25	electricity from coal	30	28	30	28	2	2
Biogas	0	20	20	electricity from coal	24	8	24	8	16	16
Heat from RES	**1872**	**3200**	**3240**							
Biomass	1767	2740	2740	electricity from coal	1168	480	1168	480	688	688
Solar energy	0	60	60	electricity from coal	72	0	72	0	72	72
Geothermal energy	105	400	440	crude oil	82	0	94	0	82	94
Biofuels	**0**	**655**	**560**	petrol	164	39	140	33	125	107
TOTAL RES	**3016**	**6894**	**6479**	**2020 total reduction by use of RES**					**1693**	**1674**
FEC	**21783**	**32873**	**30825**	**2020 emissions — coal scenario (black scenario)**					**21500**	**21500**
RES share (%)	**13.8**	**21.0**	**21.0**	**2020 relative reduction by use of RES**					**7.88%**	**7.79%**

As shown on Table 5.2, in 2020 the total annual reduction of greenhouse gas emissions achieved with the use of RES accounts for around 1693, i.e., 1674 kt CO_2-equivalents, pursuant to scenario S2 and S3, respectively. Under the coal scenario, reduction of total emissions with the use of RES accounts for 7.88 % (S2) and 7.79 % (S3). In addition to increased use of RES scenario S3 also anticipates stronger EE measures (lower energy consumption) that provide additional (higher) emission reductions.

It should be noted that RES-based projects, despite relevant reduction of greenhouse gas emissions can also be related to other sustainable development benefits. As such, these projects are eligible for carbon funding through the Clean Development Mechanism, and thereby improve the project's cost-effectiveness and accordingly increase investors' interest, in particular the interest of foreign investors.

As regards the cost-effectiveness of RES-based technologies, in general, it is lower compared to the cost-effectiveness of EE measures. Namely, the cost to reduce 1 t CO_2 by using RES-based technologies is higher due to the country's relatively high energy intensity and due to the relatively high investment costs for RES. Anyway, additional study is needed to determine the costs of greenhouse gas emission reductions with the use of different technologies and measures, as well as to determine appropriate priorities that would take into consideration the economic, environmental and social aspects.

6. ELEMENTS OF THE PROGRAM ON RENEWABLE ENERGY SOURCES

Increasing the share of renewable energy sources is not possible without adequate (incentive-providing) primary and secondary legislation. The legislation (primary and secondary) is to provide a framework that would enable simplified construction of generation facilities, incentives (financial measures) and implementation thereof.

The major problem, in particular affecting construction of facilities with lower installed capacity, is the complex procedure on obtaining construction permits, the right to land use and obtaining the status of preferential generator.

Also, it is recommended for future amendments to the Energy Law, as well as to the Electricity Market Code (that are to stipulate in detail the manner of electricity purchase from preferential generators), to stipulate adequate solutions that would simplify procedures on obtaining the status of preferential generator and would address certain shortcomings contained in the existing legislation.

6.1. LEGISLATION ON RENEWABLE ENERGY SOURCES

6.1.1. Adoption of new legislation

It is proposed to adopt the Rulebook on on Feed-In Tariffs for Plants Using Municipal Waste. With these Rulebooks will complete the legislation on feed-in tariffs and will stimulate construction of plants using municipal waste for electricity and heating energy generation.

6.1.2. Amendments to the existing legislation

Amendments to the Energy Law and related by-laws

According to the Energy Law, the status of preferential generator can be awarded to any facility that fulfils the terms and conditions stipulated by the Law and by the Rulebook on Preferential Generators. According to the Rulebook, the status of preferential generator can be awarded after the applicant has obtained the approval for operation for the plant in question. On the other hand, the decision on awarding the status of preferential generator is one of the documents required for the generator to obtain the right to application of feed-in tariffs from the Energy Regulatory Commission. In other words, potential investors are prevented from securing the document on guaranteed electricity purchase and electricity price – a document of key importance in the course of their credit application process.

Therefore, amendments to the Energy Law, the Rulebook on Preferential Generators and related Rulebooks on Feed-In Tariffs are proposed with the aim to enable obtaining of the temporary status of preferential generator immediately after:

- obtaining the construction authorization issued by the Government; or
- obtaining the construction permit for facilities that do not require approvals (small power plants with installed capacity of up to, for example, 10 MW); or

- signing the concession contract, in the cases when concession contracts are required for the facility in question (SHPPs); or
- signing the construction contract, in the cases when the facility is constructed by means of a tender procedure.

Moreover, considering the fact that the Energy Regulatory Commission is competent for setting feed-in tariffs and terms and conditions for their application, the Energy Law can anticipate changes by means of which the Energy Agency, and not the Energy Regulatory Commission, will be competent to issue decisions on preferential generators and keep the Registry of such plants. .

This would provide greater security for investors (and smaller risks for banks) and thereby would enable more favourable conditions for project financing and faster implementation.

In order to stimulate and simplify the procedure on construction of photovoltaic systems with small installed capacity as part of buildings (roof construction and like), the Energy Law and related by-laws (Rulebook on Preferential Generators, Rulebook on Feed-In Tariffs and Rulebook on Licenses) should provide for transferability of licenses and the right to apply feed-in tariffs in cases when the building is sold together with the photovoltaic system for electricity generation.

The 2006 Energy Law stipulates that the Electricity Market Operator shall purchase the entire quantity of electricity produced by preferential generators, while the costs thereof shall be recovered from the market participants. On the other hand, the Law does not stipulate the delivery manner and consumer of this electricity. It is recommended for the Energy Law to be amended under this section and to provide appropriate solutions, while the details thereof to be regulated under the Market Code that should be adopted in the shortest possible time.

In order to stimulate use of biofuels for transport, it is recommended for the Government of the Republic of Macedonia to adopt the by-law that would stipulate the minimum shares in blends of fuels for transport with biofuels. This by-law should stipulate that only blends of fossil fuels and biofuels will be placed on the market. Initially, this would only refer to diesel fuels, while petrol fuels will be included when the relevant conditions thereof are secured.

Amendments to other laws

Wind potential for electricity generation in the Republic of Macedonia has not been researched to a sufficient level and therefore the construction of potential WPPs is limited to those few sites covered by quality measurements. Hence the need to amend the legislation that would simplify the procedure on obtaining the right to measure wind potential and in the cases when such measurements indicate that certain sites have potential, the investor to obtain the right to construct WPPs.

Measuring wind potential requires the use of specialized equipment and relative small sites. But, if the measuring results are positive, the investors will need a significantly greater area to implement the project. Therefore, investors will not invest in measurements unless they are sure that after measuring the wind potential they will be able to secure sufficient land to construct WPPs, hence the need to amend the Law on Construction Land so as to provide the possibility for „reservation“ of land for potential WPPs. Also, considering the fact that WPPs will be constructed on lands that in some cases are considered agricultural, appropriate solutions should be anticipated so as to avoid the need to change the use purpose of the entire land from agricultural into construction, having in mind that most of the land anticipated for WPP construction can also be used for agriculture or livestock breeding in future.

6.2. IMPLEMENTATION OF LEGISLATION

In addition to the existence of quality legislation, a key precondition to increase the share of RES in the final consumption is the enforcement of the existing regulation. This is particularly important in order to increase investors' trust and thereby reduce their perceptions on investment risks.

In order to achieve the target share of renewable sources in the final consumption, it is recommended for the Energy Regulatory Commission and the Government of the Republic of Macedonia to regularly monitor the situation and depending on the degree of construction and the prospects for construction of new power plants using RES to appropriately change feed-in tariffs and terms and conditions for their application. In that, in order not to disturb the investor' trust, feed-in tariffs should not be changed until the upper limit on the total installed capacity for preferential generators of particular technology is reached, as defined in the Decision of the Government of Republic of Macedonia from 2009.

An important factor for reducing investors' risks is their security as concerns the right to land use for implementation of RES projects. This is particularly important if the right to construct a particular plant is obtained by means of tender procedures, including the concession-awarding tenders for use of waters by SHPPs. For that purpose, when the construction right has been awarded under a tender procedure, it is necessary to establish such practices where the State also awards the right to land use.

The Energy Law anticipates the possibility for the Energy Regulatory Commission to request the transmission or distribution system operators to connect preferential generators to the relevant grid and to cover the connection costs. Operators can then recover the connection costs incurred through the relevant grid charge. This will provide an additional stimulus for construction of plants using RES. Hence it is recommended for the Energy Regulatory Commission, on the proposal from the Government of the Republic of Macedonia, to use this possibility if the dynamic of RES project implementation is insufficient in the light of achieving the target set for RES share in the final consumption of energy.

6.3. ADDITIONAL ACTIVITIES TO PROMOTE USE OF RES

Apart from amendments to and completion of relevant legislation, as well as its proper enforcement, the attainment of target RES share will require additional activities tailored to suit each facility separately.

According to the analyses presented under Chapter 4 above, from the pool of renewable energy sources in Macedonia predominant is the share and non-utilized potential of hydro energy and biomass for combustion. Accordingly, the Program and its implementation should pay due attention to the rational use of existing and planned hydro energy and biomass potential.

6.3.1. LHPPs

Construction of HPP Galiste and HPP Cebren should be pursued by means of public-private partnership. The first step is to develop a program and to identify at least one interested strategic partner for public-private partnership in the venture for the construction of HPP Tikves and to announce the tender based on the Strategy for Energy Development until 2030 and jointly agreed conditions. The tender would also require the engagement of an investment consultant that will develop the tender documents pursuant to the conditions defined by the State and will assist in the selection of the strategic partner(s). Additional stimulus for attracting strategic partner(s), and also a selection criterion would be the possibility for construction of a hydro-nuclear complex (provided a positive decision is taken by the State to construct a nuclear power plant).

Small hydro power plants can be constructed by AD ELEM. Namely, it is recommended to develop an action plan for the construction of the reservoir Lukovo Pole with HPP Crn Kamen and HPP Boskov Most by AD ELEM and with state support as part of the Public Investment Program.

As for the project Vardar Valley, the first step implies the announcement of a tender on the development of an innovative study for the Vardar Valley that would provide precise answers as regards the railway track (temporary re-allocation or reallocation to an already defined new track or construction of a new contemporary railway track) and the leading champions (whether the idea on Vardar's navigation by ships is abandoned and thereby pursue the optimal energy utilization thereof). As was the case with Galiste and Cebren, the first step would imply the identification of an interested investor and announcement of a tender. An investment consultant should be engaged in the tender procedure in order to develop the tender documents pursuant to terms and conditions defined by the State and to assist in the selection of the most favourable bidder.

6.3.2. SHPPs

Pivotal in terms of support for SHPPs is the simplification of procedures on water concessions, which are to include a requirement for previously settled issue of land use. The procedure should guarantee the right to primacy to owners of the private land in question as concerns the concession awarding for SHPP construction.

The Energy Agency should be authorized to closely monitor all stages from the preparation and construction of the first ten SHPPs and to provide assistance in overcoming administrative and legislative burdens aimed at faster implementation of the projects in question. Moreover, based on the experiences gained the Energy Agency should develop guidelines with clearly defined procedure on SHPP construction to be used by future investors.

Considering the lack of trust and incomplete data available on the hydro energy potential, it is necessary to develop and implement the project to update data on hydro energy potential and other relevant parameters (possibly as a design idea) for all pre-determined sites prior to the announcement of future tenders for SHPP construction.

6.3.3. WPPs

Despite the fact that the Republic of Macedonia does not dispose with sufficient quality data on the wind potential, the State lacks sufficient expert, but also administrative experience in regard to developing projects of this type.

Therefore, it is recommended for the first WPP in the Republic of Macedonia to be constructed by AD ELEM as a “pilot” project that would also serve the purpose of identifying all possible legal and administrative barriers, but will also build the capacity of state administration and domestic companies involved in the project implementation (contractors, equipment suppliers, etc.). Other possible WPPs could be constructed by private investors or by means of public-private partnership with AD ELEM’s participation.

It should be mentioned that the construction of WPPs by means of tender procedures with or without public-private partnerships should target only the sites already covered by quality metered data and for which the pre-investment analyses have shown that the WPP construction is cost-effective.

Other sites in the Republic of Macedonia that are not covered with quality data on wind potential should be subjected to the procedure for authorization of interested investors issued by the Government of the Republic of Macedonia pursuant to the Energy Law. In such cases, due attention should be taken of the fact that in addition to the right to measure the wind potential the investor in question should also be secured with guarantees for the construction of WPPs if the measurements of potential provide positive results.

Also, it is recommended to continue the activities on measuring the wind potential in compliance with current practices.

6.3.4. Solar energy

Solar thermal systems

The promotion of this technology should include incentives both for consumers and generators. It is recommended to introduce a mechanism on regular subsidies (Fund that will support solar thermal systems) and proper taxation credits aimed to facilitate mass purchase and installation of these systems.

It is recommended to provide subsidies to manufacturers of solar thermal systems for each system sold (proportional to its size), in particular to provide financial support for the production of large systems intended for export.

As regards their mandatory use, the legal obligation on installation of solar thermal systems as part of new buildings and as part of major reconstructions of buildings of public interest should be stipulated under the relevant legislation.

Photovoltaic systems

The legal barriers as explained under item 6.1. should be eliminated.

6.3.5. Biomass

Biomass for combustion

Promotion activities for biomass for combustion are mainly targeted at:

- Incentive programs for small and medium industries to manufacture high-efficiency devices for biomass combustion;
- Subsidies to replace old and purchase new high-efficiency combustion devices, especially targeting vulnerable population groups;
- Measures to reduce losses in forest cutting;
- Measures to reduce the non-registered consumption;
- Technical support and assistance in finding creditors and investors for the first pilot TPP-HP fuelled by waste biomass and the first pilot TPP-HP as part of wood processing and wood products companies.

Biofuels

In order to achieve the target share for use of biofuels for transport, a clearly defined framework is needed in the light of increasing the share of biofuels, initially only for diesel fuels, and later for petrol fuels as well. This would necessitate measures by means of which the state will promote the use of blends with biofuels without significant increase of fuel prices. This can be achieved, for example, by means of reducing the excise on biofuels (which is a practice implemented by some EU countries) and by introducing higher excise for oil derivatives that are not used in transport. This would compensate portion of the budget decrease resulting from the reduction of the excise for biofuels. Considering the fact that it is a matter of a relatively small share of biofuels in the total consumption of fuels for transport, especially in the initial years, the combination of these two measures would insignificantly affect the fuel prices and the budget.

It is necessary to undertake adequate measures to enforce the legal obligation to follow EU standards on the quality of biofuels and blends.

Also, as part of the program on agricultural development, it is necessary to stimulate the production of domestic raw materials for biofuels by supporting producers of biofuels to invest in agricultural production of raw materials, guaranteed purchase, favourable crediting lines, etc. For that purpose, we should use the experiences gained in regard to support for the production of tobacco, grapes, etc. Stimulation of production of domestic raw materials for biofuels should be pursued in parallel with the increase of overall agricultural production and use of unused lands that would not reduce the production of food and other agricultural produce.

6.3.6. Geothermal energy

Encouraging the use of geothermal energy should be aimed at stimulation of development and use of heating pumps as part of the Energy Efficiency Program.
Geothermal water sources (steam) require coordinated activities by local governments and state institutions. The potential to use geothermal energy for heating greenhouse plantations should be correlated with agricultural development. In order to achieve this objective, apart from already undertaken measures to use existing sources and identify new, additional actions are also needed by the local governments and the Government. Additional funds should be allocated to support research of geothermal potentials.

6.4. FUNDS REQUIRED TO IMPLEMENT PLANNED ACTIVITIES

Funds required to implement the activities anticipated under the Strategy until 2020 are given in Table 6.1.

Table 6.1. Funds required

Activity	Finances (mil. EUR) Investor year	Note
Expanding the lifespan of existing HPPs	**70**	
Revitalization of existing HPPs	**70** AD ELEM 2012-2015	AD ELEM's assessment.
Construction of new HPPs	**790**	
Candidates for LHPPs	a) 519 public-private partnerships AD ELEM's share in HPP Tikves 2012-2019 b) 70 AD ELEM or DBOT model 2012-2016 c) 45 AD ELEM 2010-1014 d)156 concession 2014-2021	a) Cebren 319 and Galiste 200, b) Boskov Most 70, c) Lukovo Pole with HPP Crn Kamen 45, d) Gradec 156
Other RES	**660**	
SHPPs	**200** concessions	200 for 100 MW
Geothermal Energy	**60** concessions, budget, local governments	
WPPs	**230** a) AD ELEM b) public-private partnerships	230 MW a) 50 MW b) 2 × 50 MW
Photovoltaic Systems	**80** concessions	20 MW
Solar Systems for Hot Water	**60** private capital 50 and budget 10	80000 households
TPP-HP using waste biomass and TPP using biogas	**30** private capital	20 MW
TOTAL	**1520**	

Total investments for the implementation of the program on RES development in the period until 2020 are estimated at around 1.5 billion EUR.

Anticipated investments for the revitalization of existing and construction of new generation facilities can be achieved with investments made by AD ELEM in the amount of 260 million EUR (own funds and credits), public-private partnership in the amount of 670 million EUR, the concession holders should secure 480 million EUR and from private investors in the construction of plants fuelled by waste biomass and biogas in the amount of 30 million EUR.

The budget should allocate an amount of around 20 million EUR to support research of geothermal potentials.

Investments in the implementation of solar systems for hot water will be made by households and private companies in the amount of 50 million EUR and will be supported from the budget in the amount of around 10 million EUR.

It should be emphasized that the implementation of projects on electricity generation from renewable sources would require additional funds to cover the feed-in tariffs for electricity generated by SHPPs, WPPs and photovoltaic systems. These funds would be recovered from the increase of electricity prices.

Under the assumption that the currently applicable feed-in tariffs will be used (average of 100 EUR/MWh for SHPPs, 89 EUR/MWh for WPPs, average 268 EUR/MWh for photovoltaic systems, average 134 EUR/MWh for cogeneration plants using biogas and average 104 EUR/MWh for plants using waste biomass), the electricity generation from SHPPs in the quantity of 216 GWh, from WPPs in the quantity of 300 GWh, from photovoltaic systems in the quantity of 14 GWh, from TPP-HP using biomass 50 GWh and from biogas 20 GWh, (which would secure electricity generation of nearly 600 GWh), the funds required to cover the feed-in tariffs would increase the electricity price for distribution consumers by 1.2 – 2,8 % and for direct consumers by 1.6 – 3,8 % (the absolute value of the electricity price increase is the same for both categories) under market electricity price of 80 and 60 EUR/MWh, respectively.

This Strategy is published in the Official Gazette of the Republic of Macedonia.

ANNEX 1: EU NATIONAL OVERALL TARGETS FOR RES FOR THE YEAR 2020

Table A1.1. National overall targets for energy from renewable sources in gross final consumption of energy in 2020 for EU Member States (Directive 2009/28/EC, Annex I)

	Share of energy from renewable sources in gross final consumption of energy, 2005(S_{2005})	Target for share of energy from renewable sources in gross final consumption of energy, 2020 (S_{2020})
Belgium	2.2%	13%
Bulgaria	9.4%	16%
Czech Republic	6.1%	13%
Denmark	17.0%	30%
Germany	5.8%	18%
Estonia	18.0%	25%
Ireland	3.1%	16%
Greece	6.9%	18%
Spain	8.7%	20%
France	10.3%	23%
Italy	5.2%	17%
Cyprus	2.9%	13%
Latvia	34.9%	42%
Lithuania	15.0%	23%
Luxembourg	0.9%	11%
Hungary	4.3%	13%
Malta	0.0%	10%
Netherlands	2.4%	14%
Austria	23.3%	34%
Poland	7.2%	15%
Portugal	20.5%	31%
Romania	17.8%	24%
Slovenia	16.0%	25%
Slovak Republic	6.7%	14%
Finland	28.5%	38%
Sweden	39.8%	49%
United Kingdom	1.3%	15%

ANNEX 2: SMALL HYDRO POWER PLANTS OFFERED ON TENDERS

Insofar 3 tender procedures have been implemented for a total of 117 SHPPs. Table A2.1, Table A2.2, Table A2.3 and Table A.2.4 present data on SHPPs offered under the tender procedures in 4 tender, respectively.

Table A2.1. Data on SHPPs from TENDER 1

Ordinary number	Future number	Water-flow	Installed capacity	Annual generation
			(KW)	(GWh)
1	27	Baciska river	800	2.102
2	28	Baciska river	1053	2.767
3	31	Galicka river	1900	4.993
4	32	Galicka river	1900	4.993
5	33	Galicka river	1150	3.022
6	51	Ehlovecka river	757	1.989
7	75	Ljubanska river	220	0.578
8	85	Pena	2100	5.519
9	90	Pena	1700	4.468
10	93	Baecka	792	2.081
11	98	Bistrica	1770	4.652
12	99	Bistrica	1450	3.811
13	123	Kriva river	2130	5.598
14	125	Gosnici	1448	3.805
15	138	Malinska river	607	1.595
16	146	Patiska river	610	1.603
17	173	Stanecka river	591	1.553
18	174	Stanecka river	482	1.267
19	175	Krkljanska river	367	0.964
20	178	Kriva river	561	1.474
21	179	Toranica	1158	3.043
22	208	Kacani	1850	4.862
23	213	Bela river	2700	7.096
24	216	Buturica	660	1.734
25	229	Gradesnica	1023	2.688
26	235	Konjarska river	586	1.540
27	253	Ostrilska	190	0.499
28	254	Zaba	210	0.552
29	256	Kusnica	225	0.591
30	257	Golema ilinska river	415	1.091
31	267	Semnica	1010	2.654
32	339	Kamenicka river	1172	3.080
33	348	Brbusnica	554	1.456

34	350	Gradeska river	720	1.892
35	360	Golema river	1431	3.761
36	374	Kranska river	560	1.472
37	375	Brajcinska river	688	1.808
38	376	Brajcinska river	1386	3.642
39	378	Recica	849	2.231
40	384	Selecka	1552	4.079
41	399	Jablanica	2400	6.307
TOTAL			**43727**	**114.915**

Table A2.2. Data on SHPPs from TENDER 2

Ordinary number	Future number	Water-flow	Installed capacity	Annual generation
			(kW)	(GWh)
1	29	Recanska	220	0.578
2	30	Dupnica	399	1.049
3	81	Pena	1410	3.705
4	84	Pena	1740	4.573
5	92	Pena	2571	6.757
6	94	Brza voda	604	1.587
7	95	Brza voda	763	2.005
8	96	Brza voda	522	1.372
9	97	Brza voda	1705	4.481
10	115	Banjanska river	250	0.657
11	116	Banjanska river	100	0.263
12	121	Poboska	42	0.110
13	136	Otljanska	261	0.686
14	144	Markova river	417	1.096
15	145	Markova river	750	1.971
16	172	Spanecka river	1270	3.338
17	258	Mala river	214	0.562
18	259	Golemaca	352	0.925
19	260	Boiska river	271	0.712
20	261	Obednicka river	194	0.510
21	304	Oraovica	322	0.846
22	325	Kriva river	610	1.603
23	326	Jutacka	244	0.641
24	327	Kriva river	164	0.431
TOTAL			**15395**	**40.458**

Table A2.3. Data on SHPPs from TENDER 3

Ordinary number	Future number	Water-flow	Installed capacity	Annual generation
			(kW)	(GWh)
1	9	Jadovska river	1563	4.108
2	11	Tresonecka river	576	1.514
3	86	Carkit river	490	1.288
4	87	Carkit river	714	1.876
5	143	Markova river	336	0.883
6	157	Kadina river	1080	2.838
7	158	Kadina river	4684	12.310
8	214	Crna river	1000	2.628
9	268	Golema river	177	0.465
10	302	Sirava river	136	0.357
11	303	Sirava river	217	0.570
12	337	Bregalnica	64	0.168
13	338	Bregalnica	79	0.208
14	372	Estericka river	213	0.560
15	373	Estericka river	409	1.075
16	392	Pesocanka river	490	1.288
17	393	Pesocanka river	312	0.820
18	395	Slatinska river	719	1.890
19	407	Pena river	1408	3.700
20	408	Koselska river	35	0.092
TOTAL			**14702**	**38.637**

Table A2.4. Data on SHPPs from TENDER 4

Ordinary number	Future number	Water-flow	Installed capacity	Annual generation
			(kW)	(GWh)
1	66	Ljubotenska River	1920	8,699
2	67	Ljubotenska River	220	0,936
3	103	Gabrovska River	1330	7,500
4	104	Gabrovska River	508	2,163
5	105	Odranska River	170	0,723
6	106	Odranska River	151	0,643
7	107	Belovishka river	230	0,978
8	108	Belovishka River	268	1,140
9	143	Markova river	336	1,533
10	157	Kadina River	1080	4,912
11	158	Kadina river	4684	21,338
12	228	Gradesnica river	522	2,010

13	236	Konarka River	349	1,343
14	268	Golema river	177	0,531
15	277	Vodenesnici River	190	0,570
16	302	Suirava river	136	0,523
17	303	Siraba River	217	0,834
18	328	Trebomirska river	74	0,314
19	329	Bregalnica River	365	1,553
20	337	Bregalnica River	64	0,192
21	338	Bregalnica River	79	0,237
22	349	Blatecka river	104	0,312
23	351	Zrnovska River	661	2,814
24	352	Zrnovska River	533	2,270
25	353	Zrnovska River	264	1,123
26	354	Crvulevska River	110	0,467
27	355	Crvulevska River	117	0,498
28	358	Kozjacka river	233	0,991
29	361	Mala River	192	0,818
30	371	Zelengradska River	136	0,578
21	372	Esternicka River	213	0,907
32	373	Esternicka River	409	1,741
Total			**16042**	**71,191**

ANNEX 3: WIND POWER PLANTS AND RELEVANT WPP ABSORPTION CAPACITY IN SOUTH-EAST EUROPEAN COUNTRIES

Experiences from neighbouring countries indicate that use of wind power is growing, but is also closely related to the potential available in the relevant countries, the priorities set in regard to use of energy from renewable sources, manners of funding and specific features of the country's electric power system.

Figure A3.1 shows that except for Austria and Greece, which are characterized by significant electricity generation from WPPs, most of Central and South-East European countries have a relatively small share of wind-generated electricity. One should take into consideration the fact that due to their position certain countries do not have significant potential for the use of wind power (such as for example Slovenia) and therefore their generation is relatively small or does not exist. On the other hand, it can be noted that countries where there are conditions to use the wind potential (Bulgaria, Croatia, Turkey) have undertaken certain activities in the last years, which have resulted in the installation of first WPPs and are expected to further develop this sector as almost all countries have already adopted measures to promote the use of RES.

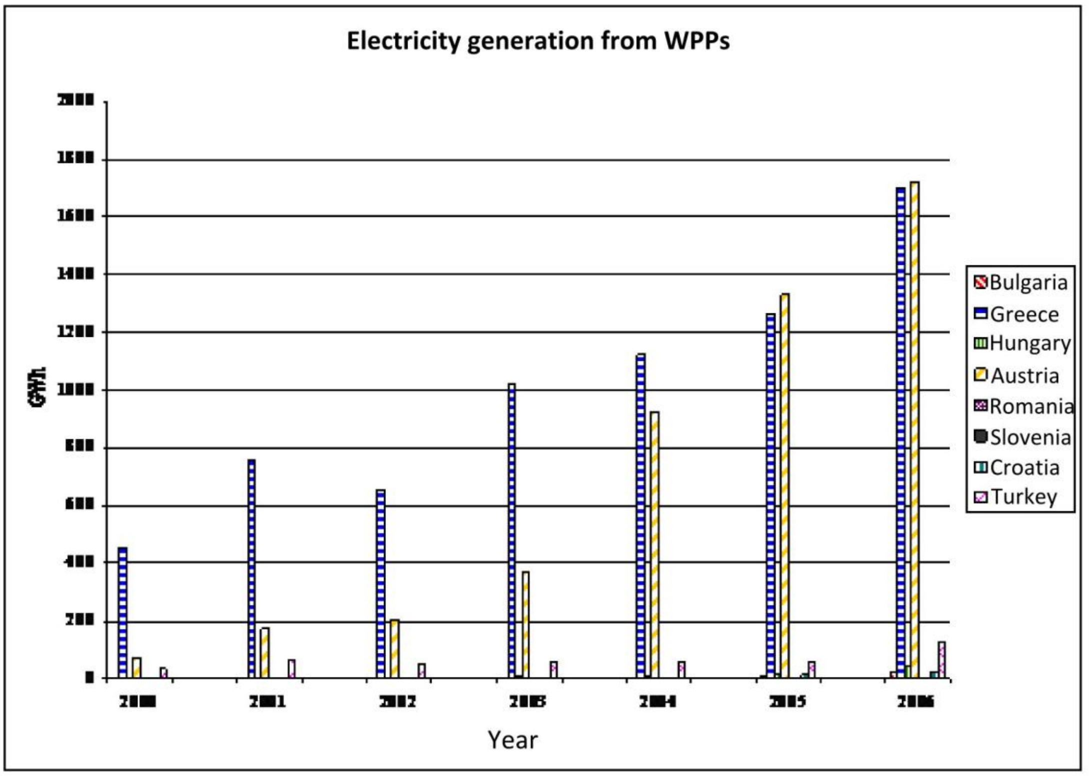

Figure A3.1. Annual electricity generation from wind for a selection of Central and South-East European countries, EUROSTAT data

From the aspect of determining the country's absorption capacity, interesting is the example of Croatia, where the limit has been set at around 370 MW, which

represents around 10% of the installed capacity in the Croatian electric power system.
For the time being, Croatia is far from achieving its upper limit as by the end of 2006 it has installed WPPs with a total capacity of 17 MW and in that year the said WPPs have generated 19 GWh electricity. In 2007, new WPPs were not constructed[61].

In Bulgaria, it has been assessed that WPPs with total capacity of 2200 to 3400 MW can be installed. Total installed capacity of the electric power system in Bulgaria accounts for around 11300 MW, where only the National Electricity Company disposes with 2500 MW in HPP capacity (1000 MW from reversible HPPs). By the end of 2007, WPPs with total capacity of 70 MW have been constructed in Bulgaria, which is a relatively major progress, having in mind that by the end of 2006 the total installed capacity accounted for only 36 MW and in the same year the WPPs generated a total of 30 GWh electricity.

In 2007, new WPPs with total installed capacity of 125 MW were constructed in Greece and resulted in total installed capacity of 871 MW by the end of 2007. 1699 GWh electricity was generated in 2006, when the total installed capacity accounted for 746 MW.

According to certain development scenarios by 2010 the wind power share in Greece is expected to reach 2170 MW, whereas in order to achieve the RES target share additional 3648 MW need to be installed.[62] According to optimistic scenarios, the electric power system of Greece will allow WPP share of up to 30%, which is a relatively high share, probably the highest in the region.[63] The reason thereof lies in the specific terrain configuration in the country, where some WPPs are installed on inland territory, while others on islands and in certain cases WPPs are part of isolated island (off-shore) systems. Nevertheless, in order to enable such high share of use and the necessary conditions, previous sets of measures are needed in the light of technical feasibility. According to Greek experts[64], in order to enable WPP absorption with total capacity in the range of 5000-5500 MW, the following conditions be secured:

- to secure uninterrupted supply to the high voltage electricity grid for consumers supplied by any new WPP;
- to create possibility to impose upper limit for entire WPP generation;
- to secure reliability of supply in the case of connecting large WPPs, and the most important precondition – to complete the already planned projects on transmission grid updates.

[61] *European Wind Energy Association and EUROSTAT*
[62] Greece - RES policy review, *EREC*
[63] Antonakis, *Analyses of the Maximum Wind Energy Penetration in the Island of Crete.*
[64] *SYNOPSIS_SEED_2008*

ANNEX 4: RES SUBSIDIES IN EU MEMBER STATES AND SOUTH-EAST EUROPEAN COUNTRIES

A4.1. UPPER LIMIT FOR POWER PLANTS' INSTALLED ELIGIBLE FOR OBTAINING THE STATUS OF PREFERENTIAL GENERATOR

A4.1.1. Upper limit for SHPP subsidies

European practices on subsidizing electricity generation from hydropower indicate that subsidies are provided only to small units (up to 10 MW), having in mind that specific (investment) costs per unit of installed capacity for these plants are significantly higher compared to LHPP costs. The logic behind this approach is based on the generally accepted fact that specific investment costs are smaller when the plant's installed capacity is higher. Moreover, LHPPs usually dispose with reservoir and are able to optimize their generation (at certain time periods), thereby effectuating higher electricity sale prices. Due to these features, LHPPs can be constructed on commercial principles.

For the Republic of Macedonia it is acceptable and justifiable to adopt the threshold of 10 MW for HPPs to obtain the status of preferential generator, in particular as the number of (potential) HPPs with installed capacity in the range of 2 to 10 MW is very small.

A4.1.2. Upper limit for biomass-fuelled plant subsidies

Similar is the situation with biomass-fuelled TPPs. Small units (due to their higher operational costs, which are a result of the lower efficiency and higher specific investment) should be subsidized (for example, by means of feed-in tariffs for electricity generated).

EU Member States have different strategies for subsidizing biomass-fuelled TPPs, as well as plants generating heating energy from biomass. Highest shares of electricity generation from biomass were observed in Finland, Germany, Netherlands, Denmark, Sweden and France. Most countries do not define upper limit for subsidies in terms of total installed capacity or installed capacity per generator. Nevertheless, some countries, where subsidies are used for a long period now and which have achieved significant results in terms of use of individual RES types, for example, Germany, Denmark, Spain, etc., are introducing certain changes in their relevant subsidizing schemes.

Thus, in Germany TPPs with installed capacity exceeding 20 MW are eligible to apply feed-in tariffs which are almost two times lower than those applied by plants with installed capacity in the range of 5 to 20 MW, while TPPs with installed capacity of up to 150 kW are eligible to apply the highest feed-in tariffs. Moreover, Germany has anticipated reduction of feed-in tariffs for all new generators using RES in the following year by a previously set percentage of price reduction.

Different subsidizing policies of EU Member States are mirrored in the duration of subsidy contracts signed for these power plants. For power plants using solid biomass, the duration of subsidy contracts is usually 10 to 20 years, whereas some countries (Cyprus, Hungary) do not set upper limits on the subsidy contract duration.

An important factor in subsidizing electricity generation from biomass is the fact that its use is CO_2 neutral (in the course of the vegetation period, biomass absorbs approximately the same quantity of CO_2 as emitted with its combustion) and therefore these plants are exempted from the so called environmental taxes that have been introduced by certain EU Member States and levied to electricity generators that contribute to increased level of CO_2. Thus, it is expected the biomass share in electricity generation to continue growing. Denmark can be given as an example thereof, because due to the introduced environmental tax, biomass (wood pulp, straw and other solid wood residue) became competitive to other fuels. It should be noted that in some cases biomass has greater use for heating energy generation, but due to subsidies in the last greater emphasis is put on TPPs .

It has been assessed that South-East European countries have great potential for use of biomass to generate electricity and heat. Some of them have significantly increased their use of biomass in the last several years, primarily due to introduced subsidy schemes. In Hungary, in 2001 a total of 7 GWh electricity was generated from biomass (primarily from forest residue), while in 2006 1208 GWh electricity was generated from biomass from forest residue and additional 20 GWh from biomass obtained from other sources. Serbia, Bulgaria, Romania and Croatia are characterized by high potential for use of biomass, but their relevant shares differ.

Serbia has not defined subsidy mechanisms for electricity generation from RES, while Bulgaria and Croatia have incorporated these mechanisms in their relevant legislation and have started their enforcement. The Bulgarian Energy Strategy until 2020 warns that lack of clear criteria on the use of biomass and biofuels could lead to unwarranted consequences (such as deforestation for obtaining biomass, use of agricultural land for growing biomass crops, etc.), but insofar no limits are introduced for subsidies.

The Croatian legislation stipulates that electricity generation from RES and by TPPs will be eligible for incentives until the equipment needed and electricity market are sufficiently developed, meaning, until necessary conditions are created for these technologies to become competitive, and therefore it does not set upper limits. In Croatia, however, preferential electricity producers from RES that use biomass together with another fossil fuel are eligible to apply feed-in tariffs provided the energy share of fossil fuels does not exceed 10% of total energy value of the fuel used.

A4.1.3. Upper limit for WPP and PVPP subsidies

Due to the high investment costs of WPPs and PVPPs, many EU and world-wide countries provide different types of subsidies. Some countries have not defined upper limits eligible for obtaining the status of preferential generator for these technologies due to following reasons: first, incentives are introduced to promote construction of such plants (increased equipment production) and to promote development of new technologies. In addition, WPPs and PPS are constructed as systems comprised of smaller units (wind generators or solar panels), so the efficiency factor of a big power plant will not be higher than the efficiency factor of a smaller power plant. Connection costs can represent a significant portion of total investments in there plants.

Nevertheless, some countries where rapid increase of WPP and PVPP total installed capacity was registered are now considering the introduction of subsidy limits. This is the case in Italy, where by the end of 2008 PVPPs with total installed capacity of around 280 MW were constructed, thereby making the country third in rank among European countries in terms of the country's PVPP capacity. For comparison, in 2007 the total installed capacity of PVPPs in Italy accounted for 50.2 MW, which ranked her behind Germany with total installed capacity of 1103 MW and Spain with 340 MW.

Italy set the upper limit for subsidies at total installed capacity of 3000 MW, which due to the current feed-in tariffs is anticipated to be reached in 2016. Italy provides feed-in tariffs for PVPPs with installed capacity above 1 kW. If the PVPPs installed capacity exceeds 3 kW, the owner is eligible to apply a tariff that is 5% lower. In 2009 feed-in tariffs are reduced by 2% annually and it is expected for this support measure to be discontinued in 2020.[65] Italy has committed to maintaining subsidy mechanisms until continuous growth and competitiveness is secured in this sector, i.e., to avoid the situation that occurred in Spain, where due to changes under subsidy schemes the number of new PVPPs in 2008 was significantly decreased.

In Spain, the upper limit for PVPP subsidies is also limited to total of 1200 MW, but at the time being there is no information on what the future steps would imply. These countries are leaders in regard to use of solar energy, and therefore the introduction of upper limit for subsidies is considered justified.

These countries have already introduced different tariffs for PV systems installed on buildings or other areas, where the first are eligible for application of higher tariffs.

In general, other European countries where use of solar energy is still low have not introduced such limits. Interesting is the example of the Croatian legislation, according to which the market operator signs the energy purchase contract with preferential electricity producers from PVPP and fuel cells until the total installed capacity of PVPPs and fuel cells plants reaches the value of 1 MW. In this regard, Greece is the most attractive country in the neighbourhood.[66] Pursuant to a special program and supported with high feed-in tariffs for PVPPs, Greece has anticipated the installation of PVPPs with total capacity of 540 MW for the inland territory, 200 MW for the islands and 50 MW for isolated systems in the period 2007-2010. In that, it has also anticipated a specific geographic distribution of PVPPs in compliance with the sun radiation throughout the country and the system's technical limitations.

Small power plants will be connected to the distribution grid, and thereby will imply lower costs. As a result thereof, investment costs that do not depend on the plant's capacity have significantly smaller impact on specific investments compared to other technologies.

A4.2. SUBSIDY SCHEMES FOR ELECTRICITY GENERATION FROM RES

The present document has already mentioned different subsidy schemes that are used in different European countries, but only in the context of upper limits for installed capacity of individual technologies. Nevertheless, the ultimate goal of different subsidy schemes for RES is to reduce the negative environmental impact of electricity generators.

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[65] Italy-RES policy review, *EREC*

[66] Greece-RES policy review. *EREC*

For some years now, most EU Member States apply different measures to subsidize electricity generation from RES. Actually, in this way they also guarantee the attainment of targets laid down in EU Directives. Due to application of subsidy measures for electricity generation from RES, in the last several years their relevant shares of electricity generated from RES in the consumption have significantly increased. From recent years, support is also provided to TPPs using biomass and biogas, as well as biofuels.

EU Governments use a wide range of measures to support electricity generation from RES[67] They can be divided into two categories:

- investment support (grants, tax exemptions/credits, discount for purchase of materials); and
- operational support (feed-in tariffs, green certificates, tenders, tax exemptions/credits, etc.)

Research show that operational support (support for Mwh energy generated) is far more important compared to the investment support.

EU Directives give primacy to market-based support measures, but Member States are at liberty to implement national measures to promote the use of different RES as well. Therefore, European countries usually subsidize investments in RES in pre-determined amounts for particular type of projects or by financing a pre-determined percentage of the initial investment. This group also includes different programs on environmental protection and green energy, where the support is provided in form of grants and credits under low interest rates. Governments in some countries have also decided to finance public sector projects that include use of electricity from RES in order to promote the use of energy generated from renewable sources. Recently, it has been noticed that such initiatives are replicated on local level as part of local sustainable development programs. Example of such initiative is the Italian National Program for 10000 sun-roofs and the similar program implemented in Germany.

Market-based measures that enable operational support can be classified under two categories: instruments to determine the quantity of electricity to be generated from RES and instruments to determine the price of electricity generated from RES. Under ideal circumstances, both categories of instruments can provide same cost-effectiveness.

A4.2.1.Quota-setting instruments

The term „setting the fixed quantity (quota) of electricity from RES“ shall mean a measure by means of which the Government sets the mandatory quota for consumers, suppliers and generators in regard to their respective shares of electricity from RES. This measure is usually correlated with the application of green certificates, where electricity generators using RES sell the electricity under market price, but can also trade with green certificates, which are used as guarantees of origin confirming that the electricity was generated from renewable sources.

[67] The support of electricity from renewable energy sources, *Accompanying document to the Proposal for a Directive of the European Parliament and of the Council on the promotion of the use of energy from renewable sources*, Commission Staff Working Document, Brussels January 2008

Suppliers verify that they have fulfilled their quota by purchasing these certificates. On the contrary, they are liable to fines imposed by the Government.

These instruments include procurement tenders on particular quantity of electricity generated from an individual RES technology. Tenders enable the selection of the most favourable offer under anticipated terms and conditions. In the past, this measure was actively pursued by three EU Member States, and in 2007 Denmark adopted a decision to announce tenders on off-shore WPPs.

A4.2.2. Price-setting instruments

This group of instruments includes feed-in tariffs, premiums and fiscal support measures.

Feed-in tariffs and premiums are awarded to in-country electricity generators from RES for the electricity they deliver in the electric power system. Feed-in tariffs and premiums have different rates for different technologies on electricity generation from RES, and they are set and amended by the Government. The difference between feed-in tariffs and premiums is the fact that feed-in tariffs imply a previously set amount to be paid for the quantity of electricity generated (currency/kWh), whereas premiums are paid as addition to the electricity market price. The last indicates that premiums provide greater competitiveness among electricity generators from RES. What is important for these measures is the fact that costs incurred by the grid operator are calculated as part of tariffs. Another feature of feed-in tariffs and premiums is the fact that usually they are guaranteed for a period of 10 to 20 years, thereby reducing risks of investors interested in this type of generation. It has been proved that feed-in tariffs and premiums can be applied in a manner that will enable stronger promotion of individual RES technologies and cost reduction, which is achieved by phasing-out feed-in tariffs and premiums.

Fiscal support implies a group of measures aimed to exempt or reduce taxes paid by electricity generators from RES. They are exempted from several taxes (for example the coal tax) in order to increase their competitiveness against generators using conventional technologies. Effects of these measures are highly visible in countries with high tax rates (such as the Scandinavian countries), where tax exemptions are sufficient to promote energy generation from RES.

In general, it can be said that application of single support measure is not sufficient to promote the practical application of different technologies for the use energy from renewable sources, and therefore common is the application of combined measures. In most countries, measures such as feed-in tariffs or quotas are accompanied with investment grants and loans under low interest rates.

A4.2.3. Application of measures in the European countries

Figure A4.2.3.1 provides an overview of measures aimed to promote the use of energy from renewable sources applied in EU Member States. [68]

Feed-in tariffs accompanied with mandatory purchase of total electricity quantity generated from RES are often applied as it has been proved that they successfully increase the total installed capacity of plants using RES. The reason

[68] Arne Klein, Anne Held, Mario Ragwitz, Gustave Resch, Thomas Faber, Evaluation of Different Feed-in Tariff Design Options: Best Practice paper for the International Feed-in Cooperation, Fraunhofer, EEG, 2006

thereof lies in the guaranteed prices for electricity purchase, which provide greater security for investors. This measure is applied in Austria, Czech Republic, Denmark, France, Germany, Greece, Ukraine, Luxembourg, Netherlands, Slovenia and Spain.

Fixed annual quotas for suppliers and green certificates have been introduced in Belgium, Italy, Sweden, United Kingdom, Poland and Romania. Recently more discussions have been raised on the valuation of certificates, as their implementation was difficult in some cases. Moreover, application of market-based measures shows greater success when conditions have been secured in advance for the market penetration of different technologies and when sustainable development has been secured for the use of RES. Sweden is a typical example thereof as it applies the green certificate trading system along with feed-in tariffs for electricity generated from inland WPPs, whose application was to be discontinued in 2009.[69] Italy, as mentioned above, applies feed-in tariffs for PVPPs, while it uses quotas for other generators.

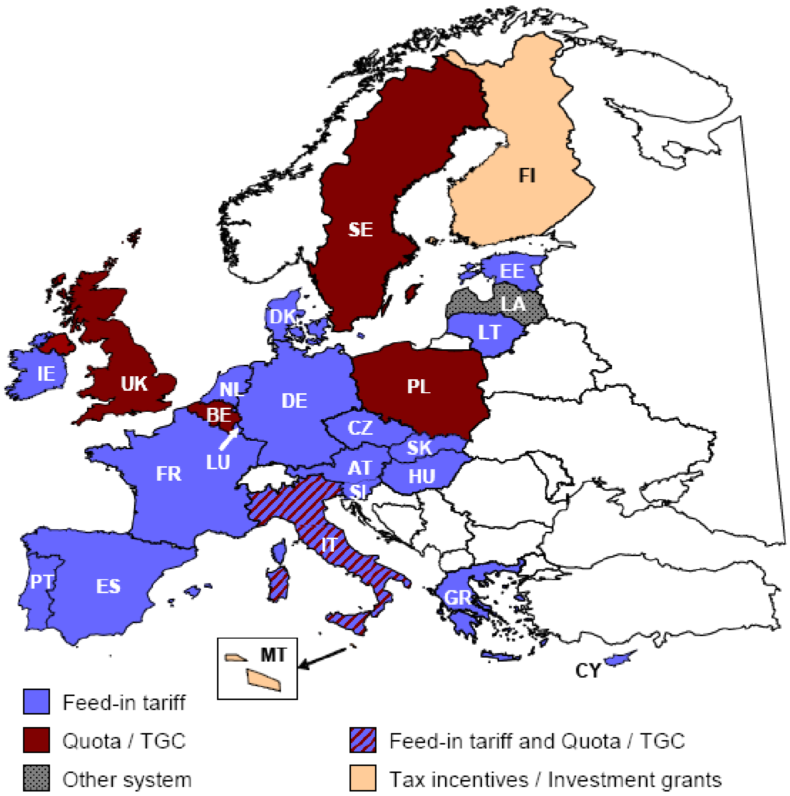

Figure A4.2.3.1. Overview of subsidies for electricity generation from RES, selection of European countries

Some countries have introduced so-called energy or environmental taxes, by means of which RES receive preferential treatment compared to conventional electricity sources. The Danish example was given above, but Denmark is not the single country to have introduced such taxes. United Kingdom has introduced the tax called Climate Change Levy, which is applied to electricity generated from coal,

[69] *EU Energy Portal, Bulgarian RES Strategy.*

natural gas, propane, butane and electricity in the industrial sector, but is not applied to generators using RES. Austria provides tax exemptions, but they are applied to electricity generated by SHPPs for own consumption and electricity generated by PVPPs. This group of measures also includes the so-called CO_2 and SO_2 taxes and tax exemptions.

A4.2.4. Overview of technologies

Below is the overview of subsidy limits for each technology established by most countries and related to total installed capacity and capacity per plant. At the same time overview is provided of tariffs applied by generators and the average duration of contracts on guaranteed electricity purchase.

Table A4.2.4.1 provides a comparison of HPP limits. It is important to have in mind that common is the practice to apply higher tariffs for HPPs with smaller installed capacity. HPPs with installed capacity above 10 MW, as already explained above, are usually not eligible for subsidies.

Table A4.2.4.1. HPPs

State	Upper limit for subsidies - total installed capacity [MW]	Upper limit for subsidies – individual plant [MW]	Subsidies [EUR/MWh]	Contract duration for preferential generator
Croatia		10	50 to 90*	12 years
Bulgaria		10	49.7	15 years
Greece		20	73 / 84.6**	20 years.
Slovenia		125***	82 to 105 / 24 to 50 ****	n/a

* Coefficient which on the basis of retail prices index and appropriate correction factors determines the tariff rate

** Systems connected to inland grids/isolated offshore systems

*** Upper limit for funding is 125 MW per plant for all RES technologies, under the notion that plants with installed capacity above 10 MW are eligible only for premiums

****Fixed tariffs/Premiums

Table 4.2.4.2. Wind mils [70]

	Country	Feed-in tariff (€cents/kWh) –in the time of Rulebook preparation	Feed-in tariff (€cents/kWh) - 2008 Evaluating different feed-in tariff design options - Best Practice Paper for the International Feed-In Cooperation, 2nd edition	Feed-in tariff (€cents/kWh) - 2009 EREF Price Report on renewable electricity prices in Europe – EUROPEAN RENEWABLE ENERGIES FEDERATION	Duration (years)	Note
1	Macedonia	8,9	8,9	8,9	20	/
2	Austria	7,8	7,8	7,54 – 2009 (12 years) 9,70 – 2010 (13 years)	12	This feed in tariff is for 10 years from starting the operation of the plant. In the 11-th years hegets only 75 % from the feed in tariff, and in the 12-th years 50 % from the feed in tariff.
3	Bulgaria	8 - 8,9	8 - 9	With install capacity > 800 kW: - 9,663 (until 2250 effective working hours per year) - 8,794 (up 2250 effective working hours per year) With install capacity < 800 kWwith asinhron generator with cage rotor: 7,414	15	As additional measure special credit line is implemented for finacing the Project related to the RES. RES Project could get 20% grant.

[70]Resource: Energy Regulatory Commission of the Republic of Macedonia

4	Cyprus	/	9,2	16,6	20	With decreasing from 0,5 €cents/kWh на every 4 year. Grant: 15-55% from capital investments.
5	Germany	9	9,2	From 2004-2013 Starting feed in tariff (base tariff – premium for the first 5 years) 8,7 – 8,03 Base tariff : 5,50 – 5,07 Decreasing: 2% per year in accordance with starting year. In 2009 Starting tariff Почетна тарифа (base tariff – premium for the first 5 years): 9,2 Base tariff :: 5,02 Decreasing 1% per year	20	
6	Greece	7 – 7,8	7,3 – 8,5	8,014 (land) 9,714 (islands)	12-20	
7	Latvia	/	12,6 – 13,0	< 0,25 MW: from 16,650 – 18,261 > 0,25 MW: from 9,618 – 13,597	10	
8	Luxembourg	/	7,8 – 10,3	8,27	15	
9	Portugal	4,5 – 8,3	7,4 – 7,5	9,45	15	

10	Slovakia	/	5,1 – 8,8	Start with work before 1 st of January 2005: 8,677 New from 1 st of January 2005: 9,7 Older than tree (3) years, and start with work from 1 st of January 2005: 6,598 Older than tree (3) years, and start with work from 1 st of January 2008: 5,609	12	
11	Slovenia	8 – 8,4 (includes fix and variable part)	5,9 –8,3	9,538	10	The fix part is determinate on every 5 years, and variable part yearly depends from the electricity market price In the frame of measures for RES plants support, public tender are published for approving 2 types of credit lines with smaller interest rates.
12	United Kingdom	/	/	35,3 (< 1,5 kW) 26,6 (од 1,5 kW до 15 kW) 23,7 (од 15 kW до 50 kW) 20,8 (од 50 kW до 250 kW) 18,5 (од 250 kW до 500 kW) 5,2 (од 500 kW до 5 MW)	20	From 10.04.2010 feed in tariff are implemented.
13	Croatia	5,4 – 7,7	/	8,8	12	

14	Chez	9,6 (содржан е фиксен дел и премија)	7,1 – 12, 5	9,011 (put in operation after 01.01.2009) 9,820 (put in operation 01.01.2008 – 31.12.2008) 10,09 (put in operation 01.01.2007 – 31.12.2007) 10,28 (put in operation 01.01.2006 – 31.12.2006) 11,28 put in operation 01.01.2005 – 31.12.2005) 11,82 (put in operation 01.01.2004 – 31.12.2004) 13,132 (put in operation before 01.01.2004)	15	Also there is a premium system (price which is add to the electricity market price)
15	France	8,5	8,2	New installation For the first 10 years: 8,2 (копно) For the next 5 years : - 8,2 (2400 hours per year) - 6,8 (2800 hours per year) - 2,8 (3600 hours per year) Yeraly decreasing from 2%. 11 (island) for 15 years Existing installation : For the first 5 year : 8,38 For the next 10 years 3,05 - 8,38 depends of location	15	
16	Hungary	/	10,5	11,422		
17	Italy	/	22 (< 1 MW)	30 (< 0,2 MW)	20	

18	Holland	6,3 – 8,2	/	4,0 (2009)	15	Base tariff is 11,8 €cents/kWh, minus the correction which is 7,8 €cents/kWh for 2009, Every year correction and feed in tariffs are established in accordance with the electricity average price.
19	Spain	6,2 (includes fix and variable part)	7,1 – 8,5	7,568 for the first 20 years ,than : 6,325	20	
20	Litvania	7,5	6,4	8,69	10	

Table 4.2.4.3. Photovoltaic system [71]

	Country	**Feed-in tariff (€cents/kWh) –in the time of Rulebook and Decision preparation (adopted on 04.09.2008)**	**Feed-in tariff (€cents/kWh) - 2008** Evaluating different feed-in tariff design options - Best Practice Paper for the International Feed-In Cooperation, 2nd edition	**Feed-in tariff (€cents/kWh) - 2009** EREF Price Report on renewable electricity prices in Europe – EUROPEAN RENEWABLE ENERGIES FEDERATION	**Duration (years)**	**Note**
1	Macedonia	46 (≤ 50 kW) 41 (> 50 kW)			20 **(15 години од 31.03.2010 година)**	ERC prescribes the feed in tariffs with the Decision adopted on 04.09.2008 year, with 20 years duration. - 46 (≤ 50 kW)

[71]Resource: Energy Regulatory Commission of the Republic of Macedonia

						- 41 (> 50 kW) **From 27.07 2010 year, the following tariffs are in force with the 15 years g duration:** **- 30 €cents/kWh (≤ 50 kW);** **- 26 €cents/kWh (од 50 kW до 1 MW)**
2	Austria	60 (≤ 20 kWp) 47 (> 20 kWp)	32,0 - 49,0	45,98 (< 5 kWp) 39,98 (од 5 до 10 kWp) 29,98 (> 10 kWp)	12	This tariff duration is 10 years from putting in to operations of the plants. In the 11 –th years is 75 % from the tariff, and in the 12-th years is 50 % from tariff.
3	Bulgaria	39,1 (≤ 5 kWp) 35,9 (> 5 kWp)	36,7 - 40,0	42,079(≤ 5 kWp) 38,603 (> 5 kWp)	25	Not includes the WAT. There are in force from April 2009 Every year new tariffs are determinates, where the income for the following year can not be less than 95% from the income from previous year.
4	Cyprus	/	20,4 - 38,6	36,0 (≤ 20 kWp) 34,0 (од 21до 150 kWp)	20	Also there is Grant: 15-55% from capital investments

5	Germany	49,2	31,94 – 43,01	Base tariff: 31,94 Open installations: 31,94 Roof and installations for protecting from the noise: - 43,01(до 30 kW) - 40,91 (од 30 kW до 100 kW) - 39,58 (од 100 kW до 1 MW) - 33,00 (над 1 MW)	20	
6	Greece	45 (≤ 100 kWp) 40 (> 100 kWp)	40,0 – 50,0	45 (≤ 100 kWp) 40 (> 100 kWp)	20	
7	Latvia	/	/	42,765		
8	Luxembourg	/	28,0 – 56,0	42 (≤ 30 kW) – with the yearly decreasing rates from 3 % 37 (од 31 до 1000 kW)	15	
9	Portugal	45 (≤ 5 kW) 31 (> 5 kW)	31 - 47	42 (≤ 5 kW) 32 (> 5 kW)	15	
10	Slovakia	/	25,1	27,746	12	

11	Slovenia	38 (≤ 36 kW) 38 (> 36 kW)	6,5 – 37,5 (fix) 8,7 – 39,7 (premium)	<u>On buildings and other constructions:</u> - 41,546 (< 50 kW) - 38,002 (< 1 MW) - 31,536 (до 5 MW) <u>as a part of the buildings and elements that can be changed:</u> - 47,778 (< 50 kW) - 43,703 (< 1 MW) - 36,267 (до 5 MW) <u>Independent structures:</u> - 39,042 (< 50 kW) - 35,971 (< 1 MW) - 28,998 (до 5 MW)	10	Fix part is determinated on every 5 years , and variable part yearly depends of the electricity market price.
12	United Kingdom	/	/	42,2 (< 4 kW) 35,8 (from 4 kW to 10 kW) 32,4 (from 10 kW to 100 kW) 30,1 (from 100 kW to 5 MW) 30,1 (to independent system)	20	The mentioned feed in tarioff are proposed from 10.04.2010. Decreasing rates from 7 %.
13	Croatia	46 (≤ 10 kW) 40,5 (10-30 kW) 28,38 (> 30 kW)	/	/	12	

14	Chez	/	25,1 – 51,5 (fix) 22,0 – 48,4 (premium)	49,632 (< 30 kW) 49,254 (> 30 kW)	15	Also there is a premium system (price which is add to the electricity market price)
15	France	/	30,0 – 55,0	30 (land) 40 (island)	20	
16	Hungary	/	10,5	11,422		
17	Italy	44,5 - 49	44,5 - 49	<u>From 1 kW too 3 kW:</u> - 39,2 (which are not integrated in the buildings) - 43,1 (which are partially integrated in the buildings) - 48,0 (completely integrated in the buildings) <u>Од 3 kW до 20 kW:</u> - 37,2 (which are not integrated in the buildings) - 41,2 (which are partially integrated in the buildings) - 45,1 (completely integrated in the buildings <u>Над 20 kW:</u> - 35,3 (не интегрирани во згради) - 39,2 (делумно интегрирани во згради) - 43,1 (целосно интегрирани во згради)	20	

18	Holland	/	/	25,3 (from 0,6 to 15 kWp) 38,3 (from 15 to 100 kWp)	15	Base tariff is 52,6 (45,9) €cents/kWh, minus correction from 2009 which is 27,3 (7,6) €cents/kWh Every year correction and feed in tariffs are established in accordance with the electricity average price.
19	Spain	44	23,0 – 44,0	Up to 100 kW: 45,513 for the first 25 years, than 36,41 From 100 kW to 10 MW: 43,148 for the first 25 years, than : 34,518 From 10 MW to 50 MW: 23,746 for the first 25 years, than : 18,996	No limitation	

Specific are the examples of Italy and Spain. Italy anticipated feed-in tariffs for installed capacity above 1 kW and the tariff rate is lower for plants with installed capacity above 3 kW. In the case of Spain, feed-in tariffs for PVPPs are set every three months with the ultimate goal to achieve the previously defined total installed capacity for PVPPs for the given year.

Table A4.2.4.4 Plants using biomass

State	Upper limit for subsidies - total installed capacity [MW]	Upper limit for subsidies – individual plant [MW]	Subsidies [EUR/MWh]	Contract duration for preferential generator
Croatia			93.6 to 163.2*	12 years
Bulgaria			82.8 to 109.9	15 years
Greece			73/ 84.6 **	n/a
Slovenia		125***	167 (1 to 10 MW) and 224 below 1MW / 108 (1 to 10 MW) and 165 below 1 MW****	n/a

* * Coefficient which on the basis of retail prices index and appropriate correction factors determines the tariff rate
** Systems connected to inland grids/isolated offshore systems
*** Upper limit for funding is 125 MW per plant for all RES technologies, under the notion that plants with installed capacity above 10 MW are eligible only for premiums
****Fixed tariffs/Premiums

Table A4.2.4.5 Plants using biogas

State	Upper limit for subsidies - total installed capacity [MW]	Upper limit for subsidies – individual plant [MW]	Subsidies [EUR/MWh]	Contract duration for preferential generator
Croatia			From 48.9 to 163.2*	12 years
Bulgaria				
Greece			73/ 84.6 **	n/a
Slovenia		125***	from 62 to 159/ from 3 to 102****	n/a

* * Coefficient which on the basis of retail prices index and appropriate correction factors determines the tariff rate
** Systems connected to inland grids/isolated offshore systems
*** Upper limit for funding is 125 MW per plant for all RES technologies, under the notion that plants with installed capacity above 10 MW are eligible only for premiums
****Fixed tariffs/Premiums

ANNEX 5: RES SUBSIDIES IN THE NEIGHBORING COUNTRIES

Almost all countries in the region apply feed-in tariffs, i.e., they have adopted preferential prices for electricity from RES, with the exception of Romania where green certificates have been introduced.

Croatia

The Croatian legislation stipulates preferential prices for electricity generated from RES and for TPPs (cogeneration). Feed-in tariffs are applicable to PVPPs, HPPs, WPPs, plants using biomass (solid biomass from forestry and agriculture and separately, solid biomass from the wood-processing industry), GPPs, plants using biogas obtained from agricultural crops and organic waste from agriculture and food industry, plants using bioliquids, plants using biogas from landfills and waste water treatment plants and other power plants. Two groups are defined for the application of relevant tariffs :

1. plants with installed capacity up to 1 MW (including those with installed capacity of 1MW), connected to the distribution grid.
2. plants with installed capacity above 1MW, connected to the distribution and transmission grid.

Table A5.1 and A5.2 below show the tariffs and relevant procedures on technology-based tariff-setting. [72]

Table A5.1 Tariffs for plants with installed capacity below 1 MW applied in Croatia

Technology		Coefficient S kn/kWh
WPPs		0.64
HPPs		0.69
PVPPs with installed capacity	up to 10 kW	3.40
	10 kW to 30 kW	3.00
	above 30 kW	2.10
Power plants using biomass obtained from forestry and agricultural activities		1.20
Power plants using biomass obtained from the wood industry		0.95
GPPs		1.26
Power plants using biogas from agriculture and organic residue from agricultural waste and food industry		1.20
Power plants using bioliquids		0.36
Power plants using biogas from landfills and waste water treatment plants		0.36
Power plants using other RES		0.60

[72] Government of the Republic of Croatia: Tariff Systems for electricity generation from RES and cogeneration.

Table A5.2 Tariffs for plants with installed capacity above 1 MW applied in Croatia

Technology		Coefficient S kn/kWh
WPPs		0.65
HPPs with installed capacity up to 10 MW and generated electricity within the range	up to 5000 MWh	0.69
	5000 MWh to 15000 MWh	0.55
	above 15000 MWh	0.42
Power plants using biomass obtained from forestry and agricultural activities		1.04
Power plants using biomass obtained from the wood industry		0.83
GPPs		1.26
Power plants using biogas from agriculture and organic residue from agricultural waste and food industry		1.04
Power plants using bioliquids		0.36
Power plants using biogas from landfills and waste water treatment plants		0.36
Power plants using other RES		0.50

Coefficients are multiplied with the correction factor depending on the domestic component's share in the project, expressed in percentages. The correction factor is in the range of up to 1.0 for projects with more than 60% in-country contribution and up to 0.93 for projects with in-country contribution of less than 45%. The domestic component contribution is determined by the competent ministry. Then, it is corrected every year pursuant to the retail prices index, i.e.,: $C_{god} = C_{god-1} \cdot KIM_{god}$. Similar corrections are applied to feed-in tariffs for energy obtained from cogeneration TPPs.

Several important provisions from the Croatian legislation on feed-in tariffs for electricity from RES can be emphasized, as given below.

Namely, feed-in tariffs are applied to electricity generators using RES or electricity generators from (cogeneration) TPPs which have obtained the decision on obtaining the status of preferential generator and provided they have signed electricity purchase contracts with the Market Operator (MO). Obtaining the status of preferential generator is regulated under the separate Rulebook on obtaining the status of preferential generation adopted by the Government of Croatia, while the status is awarded by the Energy Agency. The Rulebook stipulates the entire procedure on obtaining the status (type of application and where to submit it, etc.). The status of preferential generator can be obtained by the above given two groups and several groups of (cogeneration) TPPs.[73]

Preferential generators exercise their right to apply feed-in tariffs provided they have proved the electricity origin. The electricity purchase contracts for electricity from RES and (cogeneration) TPPs under feed-in tariffs are signed for a period of 12 years. When the generators have signed contracts prior to the entry into effect of this law, the duration of the electricity purchase contract is reduced by the period passed from the contract signing date (12-x, x=duration of previous contract). Purchase contracts are not signed with existing generators when they generate electricity from RES for a period longer than 12 years.

[73] Government of the Republic of Croatia: Regulation on subsidies to promote electricity generation from renewable sources and cogeneration, 2007.

The Market Operator signs electricity purchase contracts with preferential generators under feed-in tariffs until the total planned generation of electricity from RES and (cogeneration) attains the minimum share of electricity as stipulated under the relevant legislation. The manner of setting feed-in tariffs and tariff rates for RES and (cogeneration) TPPs applicable at the time when the contract is signed are not change for the entire contract duration. Purchase of electricity from RES and (congeneration) TPPs made under contracts and performed by the MO is not considered electricity trade.

In Croatia there is a regulation setting the minimum share of electricity from RES and (cogeneration) TPPs.[74] The aim of this regulation is to define the minimum share of electricity from RES and (cogeneration) TPPs whose generation is promoted and to set targets for Croatia as regards the electricity generation from RES and (cogeneration) TPPs. This does not apply to electricity generated from HPPs with installed capacity above 10 MW.

The regulation indicates that electricity generation from RES and (cogeneration) TPPs shall be promoted until sufficient development of equipment and electricity market is reached, meaning until the required conditions are secured for these technologies to become competitive. Minimum share set under this regulation should be the basis for setting the dynamics of putting into operation preferential electricity producers and signing electricity purchase contracts with the MO. By 31 December 2010, the minimum share of electricity from RES (whose generation is promoted) will account for 5.8% of total electricity consumption. [for cogeneration plants this share is set at 2% and should be achieved by 31 December 2010]

MO determines the share of electricity from RES which is to be transferred to each supplier. The share is expressed in percentages and all suppliers have equal shares in the total electricity supply in Croatia. Other rights and liabilities of suppliers are stipulated under Article 7 and Article 8 of the Regulation.

Despite the Rulebooks and Regulations on setting feed-in tariffs for electricity from RES, Croatia has also introduced a separate charge to promote generation from RES and cogeneration.

This charge is aimed at:

- reimbursement of prices for preferential generators pursuant to tariffs set forth;
- financing activities to promote electricity generation from RES and (cogeneration) TPPs undertaken by the Market Operator. The amount of these funds is determined by the Ministry competent to monitor calculations, payment and spending of these funds;
- reimbursement of costs incurred by the balancing system due to difference between electricity planned and generated by preferential generators entitled to apply the feed-in tariff. Amount of these funds and their payment falls under the obligations of the Market Operator, pursuant to the Balancing Rules for the electric power system.

[74] Government of the Republic of Croatia: Regulation on the minimum share of electricity from RES and congeneration whose generation is promoted.

Table A5.3 Charges (without VAT)

Year	2007	2008	2009	2010
kn/kWh	0.0089	0.0198	0.0271	0.0350

The charge is subject to reviews if the collected funds are insufficient to cover the above referred costs.

The charge is levied to captive and eligible consumers and represents an addition to the electricity price. Total amount of charge paid by consumers (in Croatian currency – KN) is the multiplication result of the charge rate (kn/kWh) from Table A5.3 and electricity consumed (kWh). The bill clearly indicates the charge and the total amount to be paid to promote generation from RES.

MO collects the charges from the suppliers to captive and eligible consumers (as stipulated under the Law on Electricity Market). MO signs contracts with all suppliers that stipulate mutual rights and liabilities of MO and the supplier as concerns the charge collection. MO calculates and allocates funds collected from the charge to promote generation from RES and cogeneration TPP. These funds are considered MO's income, except for the portion intended to finance activities performed by the MO and concerning the promotion of generation from RES and cogeneration TPPs.

Bulgaria

In Bulgaria, feed-in tariffs were adopted in 2007 and guarantee the purchase price of electricity generated from RES (under prices anticipated with the tariffs). By 2010, the electricity generators using RES will be able to sign electricity purchase contracts with the National Electricity Company with a duration of 12 years. Suppliers who refuse to purchase the electricity from RES are subject to fines in the amount of up to 500,000 EUR. Tariffs are not applied to HPPs with capacity above 10 MW. By 2012, the Ministry of Economy and Energy is obliged to propose new market-based mechanisms to promote use of RES. According to existing plans, the system on green certificates trade should enter into effect. Table A5.4 provides overview of feed-in tariffs applied in Bugaria[75].

Table A5.4 Feed-in tariffs adopted in Bulgaria

<table>
<tr><td colspan="2" rowspan="2">Technology</td><td colspan="2">Feed-in tariff</td></tr>
<tr><td>Lv/MWh</td><td>€/MWh</td></tr>
<tr><td colspan="2">WPP with installed capacity below 800 kW</td><td>139.96</td><td>71.6</td></tr>
<tr><td rowspan="2">All new WPPs, connected from 01.01.2006 with installed capacity</td><td>above 800 kW and less than 2250 working hours</td><td>185.95</td><td>95.1</td></tr>
<tr><td>above 800 kW and more than 2250 working hours</td><td>167.90</td><td>85.8</td></tr>
<tr><td rowspan="2">PVPPs with installed capacity</td><td>below 5 kW</td><td>782.0</td><td>399.8</td></tr>
<tr><td>above 5 kW</td><td>718.0</td><td>367.1</td></tr>
<tr><td colspan="2">HPPs with installed capacity below 10 MW</td><td>97.12</td><td>49.7</td></tr>
<tr><td colspan="2">Power plants using biomass</td><td>between 162 and 215*</td><td>between 82.8 and 109.9</td></tr>
</table>

* Depending on the manner in which biomass is used.

[75] Bulgaria-RES policy review, *EREC*

Feed-in tariffs are applicable for a period of 15 years, except for PVPPs for which they are applicable for a period of 25 years. Moreover, feed-in tariffs for PVPPs are set based on electricity market prices and are reviewed every year by 31st March. Due to their dependence on electricity market prices, feed-in tariffs for PVPPs can increase or decrease.

In addition, Bulgaria also implements a separate credit line intended for RES-related and energy efficiency projects (Bulgarian Energy Efficiency and Renewable Energy Credit Line – BEERECL). RES projects can be awarded grants in the amount of up to 20% of the project's cost. Insofar, loans have disbursed in the amount of 12.8 million EUR. The Bulgarian Energy Strategy also lists the credit line secured by the International Fund Kozloduj, supported by the European Investment Bank and applicable for RES projects (electricity generation and decentralized electricity generation). Investment support for RES projects can also be provided from EU funded programs, those being: „Developing the Competitiveness of the Bulgarian Economy“, „Regional Development Fund“, as well as programs targeting development of rural areas. Under the Multi-Annual National Program on Supporting Use of RES 2005-2015, the list of funding sources for RES projects also include loans from commercial banks, non-refundable assistance from environmental funds, interest-free credits, loans under special conditions from the specialized RES Fund, loans from international banks as additional funds, etc.

The Bulgarian Energy Strategy identifies certain shortcomings in the use of energy from renewable sources. Namely, the relatively high investment costs decrease investors interest in such projects, but on the other hand create additional public costs in the form of higher feed-in tariffs applicable for these technologies. The text above already indicated the unwarranted consequences of inappropriate promotion of biomass and biofuels affecting the reduction of the forestry stock and land for food production. Bulgaria does not have mechanisms to promote heating and cooling by use of RES. Existing support mechanisms will have to be adjusted to the market-based mechanisms. This will enable the promotion of cost-effective technologies that are more easily supported by the public. It has also been recommended to simplify the administrative procedures on the use of RES, but taking into account the environmental norms and standards.

According to the Energy Law in Bulgaria, the purchase of electricity generated from RES and holding certificate of origin is mandatory and eligible for the application of law-stipulated feed-in tariffs. At the same time, priority is given to connection of electricity plants using RES to the transmission and distribution grid, including HPPs with installed capacity of up to 10 MW. Due to the promotion of TPPs, electricity purchase from these plants is also guaranteed under feed-in tariffs but it is limited to 50 MWh, while the remaining electricity generated is purchased under prices set by means of special contracts or under prices applicable for system balancing. [76]

The Multi-Annual National Program on Supporting Use of RES 2005- 2015 also insists on regional approach in the development of this sector, which of course makes sense due to the country's size and individual regions' specifics.

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[76] National Multi-Annual Program on Supporting Use of RES *2005 -2015*, prepared by the Ministry of Economy and Energy and the Energy Efficiency Agency of Bulgaria.

Greece

The Law on Market Liberalization was adopted in 1999 and is in line with previous legislation, but its adoption enables the priority access to the grid for plants using RES.[77] At the same time, Greece introduced a charge in the amount of 2% of RES-related activities, which is intended for local governmental bodies. An important facilitation of procedures on construction of plants using RES was introduced by means of the Law on Simplifying Procedures on Establishing Companies, Licensing RES Plants, Regulation of Operation of the Company Greek Shipyards S. A. And Other Activities adopted in 2001. According to this Law, RES plants are exempted from general limitations listed under the legislation governing forests and applicable to public interest infrastructure projects in forests and under-afforested areas, construction permits are not required for the construction of PVPPs and WPPs, lines to connect these plants to the electric power system can be financed by any interested investor, but under terms and conditions set forth by the electric power system Operator – all for the purpose to facilitate construction of these plants outside densely populated areas, to provide a one-stop-shop system for permitting installations and operation, etc. Table A5.5 provides an overview of feed-in tariffs applicable in Greece.

Table A5.5 Feed-in tariffs adopted in Greece

Technology		Feed-in tariffs	
		Systems connected to the inland grid **€/MWh**	Isolated offshore systems **€/MWh**
Inland WPPs		73	84.6
Offshore WPPs		90	90
HPPs with installed capacity up to 20 MW		73	84,6
PVPPs with installed capacity	up to 100 kWp	450	500
	above 100 kWp	400	450
|Solar TPPs with installed capacity	up to 5 MWp	250	270
	above 5 MWp	230	250
GPPs		73	84.6
Power plants using biomass and biogas		73	84.6
Other		73	84.6

The Greek legislation stipulates the participation of several governmental institutions and companies in the use of RES. Thus, according to Greek laws, in order to obtain the approval for the construction of new RES plant, the application is submitted to the Energy Regulatory Commission with a description of the entire project. The Commission provides its opinion to the Minister of Development, who approves the construction in question. The Commission then moitors the construction process. The RES Centre works on promotion of the use of energy from renewable sources, energy efficiency and rational use of electricity, i.e., it represents a national coordination centre for RES-related activities. This centre disposes with laboratories

[77] *Greek National Report on Article 3 from Directive 2001/77/EC*

to verify RES technologies and prepares studies on determining RES potential and participates in evaluation and monitoring of investments made in this sector.

In the last years, Greece used different funds to subsidize RES projects. By the end of 2002, the Ministry of Development managed the Energy Program funded under the 2nd Community Support Framework and awarded assistance to energy projects. Portion of funds 33.8% were obtained from the European Regional Development Fund, 45.2% were state provided funds and 21% from private capital. Portion of program funds were used to promote the use of RES. Therefore, around 20 million EUR were spent on installation of WPPs with total capacity of 116 MW, HPPs with 11.5 MW, PVPPs with 0.737 MW and biomass power plants with 8.74 MW. On the other hand, the Ministry of Economy and Finance enabled financing of RES plants by means of several legal provisions. It is estimated that by 2003 one third of RES plants in Greece were constructed with state funds.

Today Greece envisages special incentives for investments that are within the range of 35-55% from the total investments (they vary depending on the region and the company type, SMEs are eligible to benefit from the upper limit of subsidies) and will be disbursed in the period 2007-2013.

Slovenia

Slovenia adopted feed-in tariffs with premiums and provides the possibility for generators to chose from the fixed feed-in tariffs or premiums. Feed-in tariffs are revised every year, i.e., they are adjusted according to the retail price growth. In the period of 5 years adopted tariffs will be reduced by 5%, while in the period of 10 years by 10%. [78]

According to the 2008 Energy Law, support measures are applied to plants using Res with installed capacity below 125 MW and constructed in the last 15 years, as well as to high-efficiency cogeneration plants with installed capacity of up to 200 MW and constructed in the last 10 years.

Support measures are applied in two different manners:

1. electricity purchase from RES plants with installed capacity of up to 5 MW and from cogeneration plants with installed capacity of up to 1 MW is guaranteed under government-set price (i.e., feed-in tariff); and
2. other generators as given in the Law are entitled only to premiums, i.e., the difference between the market and guaranteed (feed-in) price.

The Support Centre established as part of Borzen Ltd., i.e., the Slovenian Energy Stock Market is responsible for the implementation of support measures. The support system is implemented in the following manner:

1. the Support Centre must purchase the entire electricity generated by RES plants and cogeneration plants under government-set prices (i.e., the feed-in tariffs);
2. when the generator sells the electricity on the market, the Support Centre pays only the premium, which is otherwise included as portion of the tariff set by the Government.

Generators should be eligible to apply these feed-in tariffs and premiums, i.e., they must prove the origin of electricity generated by providing the special guarantee of origin issued by the Energy Agency. For all transactions guarantees should be

[78] Slovenia-RES policy review, *EREC*

submitted to the Support Centre, which then effectuates the payment. The eligibility of generators can also be determined by means of generation costs, where the assessment includes a market profit within a reasonable margin. If costs are higher than the market price, the generator is considered eligible for support measures.

Table A5.6 provides an overview of fixed and premium tariffs applicable in Slovenia.

Table A5.6 New draft feed-in tariffs and premiums in Slovenia

Technology		Tariffs	
		Fixed **€/MWh**	Premiums **€/MWh**
WPPs with installed capacity	below 50 kW	98	46
	below 1 MW	94	42
	1 to 10 MW	87	31
HPPs with installed capacity	up to 50 kW	105	50
	up to 1 MW	93	37
	1 to 10 MW	82	24
Building-incorporated PVPPs with installed capacity	up to 50 kW	401	343
	up to 1 MW	390	332
	1 to 10 MW	370	311
Independent PVPPs, with installed capacity	up to 50 kW	351	294
	up to 1 MW	330	273
	1 to 10 MW	301	242
GPPs with installed capacity	up to 50 kW	*	
	up to 1 MW	152	93
	1 to 10 MW	152	93
Power plants using biomass with installed capacity	up to 50 kW	*	
	up to 1 MW	224	165
	1 to 10 MW	167	108
Power plants using biogas with installed capacity	up to 50 kW	159	102
	up to 1 MW	155	96
	1 to 10 MW	140	80
Power plants using biogas obtained from industry and waste water with installed capacity	up to 50 kW	86	26
	up to 1 MW	74	15
	1 to 10 MW	66	7
Power plants using biogas obtained from waste with installed capacity	up to 50 kW	99	40
	up to 1 MW	67	8
	1 to 10 MW	62	3
Power plants using biogas obtained from biodegradable waste with installed capacity	up to 50 kW	/	/
	up to 1 MW	77	18
	1 to 10 MW	74	15

* Price is calculated for each power plant of this type separately.

As part of support for plants using RES, public tenders have been announced on awarding two types of loans under lower interest rates. The first tender provides loans to companies, municipalities and other natural persons, where loans were approved in total amount of 12 million EUR. These loans cover up to 90% of total investments in the facility, but usually they were approved to cover around 50% of investments. Deadline for loan repayment is maximum 15 years. The second type of loans was intended for legal entities and a total of 10 million EUR were disbursed. The purpose of these loans is to promote investments in small plants using RES with capacity of up to 50 kW. The fixed interest rate for these loans accounted for 3.9%, while the repayment deadline was 10 years. These loans cover up to 90 % of total investments in the facility, but usually they were disbursed to cover around 50% of investments, but not exceeding the amount of 40,000 EUR for PV installations. As for other plants, the upper limit for loan disbursement was set at 20,000 EUR.

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