

**Renewable Energy Country Profile
Version 0.6b**

These profiles are a work in progress. They are presented to the international community for review and comment. The profiles are undergoing continual updating for technical content, formatting, grammar, and other issues. Each country profile will be modified on a continuous basis as new information is made available.

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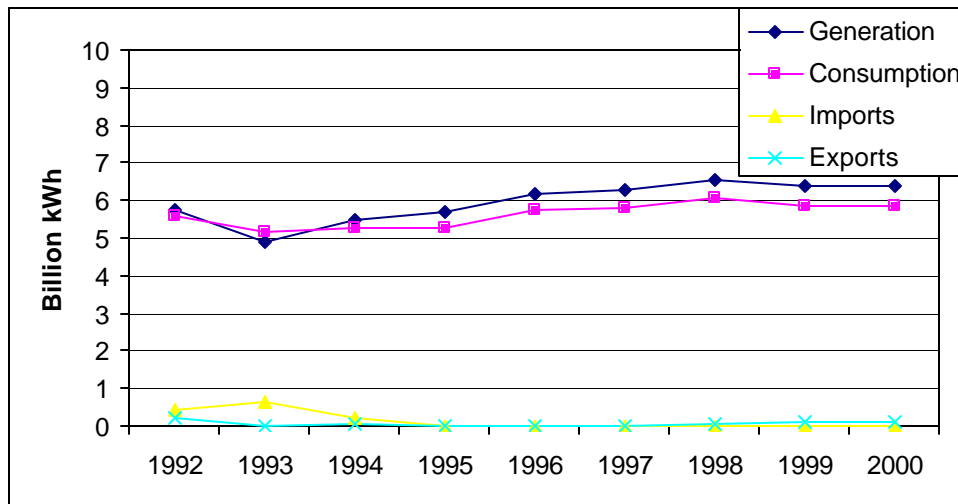
Interwind, Wind Energy Issues
Black & Veatch, Project Coordinator

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11.0 MYR Macedonia

11.1 Overview of Electricity Supply

| Fuel | Number of Units | Capacity (MWe) | Percent of Capacity |
|------------------|-----------------|----------------|---------------------|
| Nuclear | -- | -- | -- |
| Thermal | N/A | 1,010 | 69.9% |
| Hydro | N/A | 434 | 30.1% |
| Other Renewables | -- | -- | -- |
| Total | N/A | 1,444 | 100% |



1.1.1 Wind Resources

Current Status of Wind Energy¹⁾

There was no direct information on wind energy available in this country. However, in the neighboring Greece 336.7 MW of the licenses granted were for **Macedonia**-Thrace. Furthermore there is an interconnection between both countries and Greece would be interested to buy wind power from FYR of Macedonia.

A country wide wind-atlas is not available. No industry association was identified. No projects were identified.

Wind Energy Resource Potential

Due to lack of information it is not possible to make a statement on Macedonia's potential for wind energy.

Identification of Areas/Projects with High Potential for Wind Energy

Judging by the Greek wind energy sites, we would estimate that Lake Doiran, South east of the country would probably be the best, followed by the area along the Greek border, in the south of the country.

Barriers/Incentives for Wind Energy No information is available.

Table 1-3. Macedonia Wind Energy Profile.

| | |
|---|--|
| Current status of wind energy | |
| Installed capacity | None |
| Projects under construction | None |
| Supporting regulations? | None |
| Industry association? | No |
| Wind energy resource potential | |
| Level of information available | Insufficient |
| Highest wind class | Not known, but estimated as 3 - 4 |
| Country-level wind atlas available? | No |
| Estimated potential | Not known |
| Target established? | No |
| High wind speed locations | Lake Doiran, south, along the Greek border |
| Identification of areas/projects with high potential for wind energy | |
| Recommended strategic assessments | Study 1 : Country level appraisal of wind resources by state of the art measurements at 50 m. Study 2 : an appraisal of legal and economical frame work |
| Identified areas/projects | None |
| Incentives/barriers for wind energy | |
| Significant incentives | Not known |
| Significant barriers | Not known |
| Overall Prospects | Poor Total lack of information on wind energy, current political and economical problems would put Macedonia at the very end of the list of countries for wind energy development. |

¹⁾ Wind Power Monthly, various issues

ENERGY COUNTRY RENEWABLE PROFILES

COUNTRY: FYR MACEDONIA

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RENEWABLE ENERGY PROFILE OF FYR MACEDONIA

1. GENERAL INFORMATION ON THE COUNTRY

The FYR Macedonia (Former Republic of Macedonia) declared its independence from FR Yugoslavia in 1991. It is a relatively small landlocked country with a population of about 2 million and an area of 25.713 km². It is bordering on four countries: FYR Yugoslavia to the north, South Albania to the west, Greece to the south and Bulgaria to the East.

The country is largely mountainous with 80% of high plateaus and mountains. There are 16 mountain peaks higher than 2000 m, 3 tectonic lakes, 15 artificial and 25 glacial lakes, dolling the country. The major rivers running through its territory are: Vardar, Crni Drim and Strumica.

The capital city Skopje is situated 245 m above sea level and has over 500.000 citizens, representing 25% of the total population.

Its “production-based” GDP declined from USD 4,51 bln 1991 to USD 3,49 bln in 1997. High inflation rates, which characterized previous years, were stabilized to about 4% in 1997.

2. ENERGY OVERVIEW OF FYR MACEDONIA

2.1 The Energy Policy of FYR Macedonia

The Government of FYR Macedonia, like most countries of Eastern Europe and the Balkans aspiring to join the EU in due course, has followed a policy of seeking compatibility or harmonization with the EU. Its reforms and National Development Strategy have focused on the following objectives:

- Speed up privatization, restructure the economy and the energy sector and open up to foreign investment
- Accelerate growth to about 5.7% p.a.
- Shift from heavy to light industry
- Promote energy conservation and efficiency
- Shift from electricity to gas heating: The target for 2000 has entailed adoption of natural gas as a medium of heating for 120.000 households
- Energy subsidies to be eliminated and prices to reflect costs.
- Establish a Regulatory Agency and Framework concerning the pricing system of purchases from independent power producers or the prices the independent power producers would pay for using the transmission network of ESM – the public Electricity Supply Company.

The specific targets laid down for the Energy Sector, has been based on the medium growth rate scenario of 2,9% p.a. for the period 2000-2010 and 3,7% p.a. for the period 2010-2020. It would entail an increase in peak demand from around 1.200 MW in 2000 to around 2.300 MW in 2020.

2.3 Immediate and Medium-term Priorities

FYR Macedonia's economy and energy infrastructure have suffered seriously by the fighting and the ethnic conflict that persisted for prolonged periods. Being dependent to a significant extent on imported energy but supplied through the country-wide energy infrastructure of the Former Federal Republic of Yugoslavia, it felt isolated and lacking security of supplies, when it declared itself independent and resolved its internal ethnic conflict especially between its Christian Macedonian and Moslem Albanian communities.

In consequence, the projects, which currently represent priority for the energy sector of the former Yugoslav Republic of Macedonia, are in the field of electricity, gas pipeline system and liquid fuels in particular.

In the electricity sector, the current possibilities are favourable for co-operation in the construction of big and small HPPs (Hydro-Power Plants) and rehabilitation of the existing ones. The further involvement in the "Vardar Valley" project is also a priority. Due to the high debt level of JP "Elektrostopanstvo na Makedonija" (the Electricity Company of the former Yugoslav Republic of Macedonia), all bigger HPPs will be built on concession basis, and the smaller PPs and other electricity facilities – by joint investment or loans from local interested entities. For the gas pipeline system, currently of priority interest is its extension and inclusion of households, while for the liquid fuels, an important project is the construction of an oil pipeline to OKTA-Crude Oil Refinery, Skopje.

FYR Macedonia considers itself a relatively clean country, "since the level of pollution of the environment remains within the limits of tolerable technical parameters". (Black Sea Energy Review May 2000). Yet no targets are spelled out for Renewable Energy Sources, except for hydro-power, presumably because of their concentration of shifting to natural gas.

The Ministry of Economy is responsible for coordinating the activities of the energy sector.

2.4 General Energy Summary

It is clear that the energy resources of FYR Macedonia are limited. The basic energy infrastructure consists of power plants and electricity networks, coal mines, a gas pipeline network, a crude oil refinery, firewood, heating systems and geothermal systems.

Its primary energy consumption, satisfied from indigenous and imported sources, over the past 2 decades by type of fuel are shown analytically in Table 1 below:

Table 1. Primary Energy Resources Consumption (Ktoe)

| Energy Resources | 1980 ^(a) Ktoe | 1990 ^(a) Ktoe | 1995 ^(a) Ktoe | 1997 ^(a) Ktoe | 2000 ^(b) Ktoe | 2000 ^(b) TJ |
|--------------------------|-----------------------------|-----------------------------|-----------------------------|-----------------------------|-----------------------------|---------------------------|
| Coal (lignite) | 125.33 | 1.288.98 | 1.324.11 | 1.405.44 | 136.617,5 | 57210 |
| • indigenous | 45.83 | 1,221.27 | 1.259.52 | 1,355.38 | 127.268,5 | 53295 |
| • imported | 79.50 | 67.71 | 64.59 | 50.06 | 9.349,0 | 3.915 |
| Coke, dry lignite | 120.39 | 77.39 | 55.77 | 51.13 | - | - |
| • indigenous | - | - | - | - | - | - |
| • imported | 120.39 | 77.39 | 55.77 | 51.13 | - | - |
| Firewood/Biomass | 149.81 | 184.75 | 177.02 | 181.66 | 21.372,6 | 8950 |
| • indigenous | 149.10 | 184.75 | 177.02 | 181.66 | 20.620,4 | 8635 |
| • imported | 0.71 | - | - | - | 752,2 | 315 |
| Liquid fuels | 1.078.39 | 1.038.93 | 794.27 | 750.17 | 116.395,9 | 48742 |
| • indigenous | - | - | - | - | - | - |
| • imported | 1,078.39 | 1,038.93 | 794.27 | 750.17 | 116.395,9 | 48742 |
| Natural gas | | | | 0.57 | 5.318,1 | 2227 |
| • indigenous | - | - | - | - | - | - |
| • imported | - | - | - | 0.57 | 5.318,1 | 2227 |
| Hydropower | 158.93 | 47.31 | 77.23 | 118.20 | 1005,8 | 4212 |

| | | | | | | |
|-----------------------------------|-----------------|-----------------|-----------------|-----------------|----------------|----------------|
| Electricity | | | | | | |
| • Net Imported | 191.93 | 22.39 | -24.25 | 5.89 | 964,8 | 404 |
| Other (included renewable) | 28.72 | 9.10 | 13.95 | 13.65 | 1.559,4 | 653 |
| • indigenous | 0.91 | 9.10 | 13.95 | 13.65 | 799,3 | 653 |
| • imported | 27.81 | - | - | - | - | - |
| TOTAL: | 1,853.24 | 2,668.85 | 2,418.10 | 2,526.71 | 2.922,9 | 122.398 |

Note: Primary Energy Resources Consumption was covered by indigenous production, net imports (import-export) and stocks from previous years

1 TJ = 238,8 Gcal
Mtoe = 2.383 X 10.⁵

Sources: (a) Black Sea Energy Review, May 2000
(b) Energy Balance Statistics 2000 by State Statistical Office

Evidently FYR Macedonia was self-sufficient through indigenous energy sources in 2002 only by about 55%. By far its biggest indigenous resource was coal/lignite (43,5%), followed by biomass/firewood (7,1%), hydropower (3,4%) and other, mainly geothermal, (0,5%).

In the future coal may have to be substituted by gas, hydropower and other RES on environmental considerations.

3. THE RENEWABLE ENERGY SOURCES (RES) AND RESOURCES FOR FYR MACEDONIA

3.1 Wind Energy

FYR Macedonia's potential wind resources have not been exploited so far, largely because of its recent political and ethnic problems, which diverted economic and energy resources to satisfying the basic needs of the economy and population.

The wider former Yugoslav area has been reported (Davor Skrlec, Enconet International) as having potential wind resources of about 15 PJ/year.

Although less windy than many northern European countries, wind energy appears to be a viable renewable energy technology in FYR Macedonia. Being characterised by high mountains (some of the highest in Europe), it is reported that there are locations which have annual average wind speeds exceeding 7 m/s.

However, the precise potential and specific locations will need to be determined and assessed, before techno-economic feasibility studies, business plans and investment programmes are prepared.

3.2 Solar Energy

Solar irradiation in FYR Macedonia (as well as in Serbia, Slovenia, Croatia and Bosnia/Herzegovina) are amongst the highest in Europe.

The most favourable areas record a large number of sunshine hours, the yearly ratio of actual irradiation to the total possible irradiation, reaching approximately 50% for former Yugoslavia as a whole, or 45% for the mountainous central regions, particularly in FYR Macedonia, due to the prevailing weather pattern.

The primary form of solar energy and technology used are flat plate collectors for heating houses and some commercial and public premises. But their contribution to the total energy consumption is insignificant, less than 1%. Nor is it expected that this figure will increase substantially in the near future, as new consumption could mainly come from new entrants to the market i.e. of new buildings or installations.

Likewise, electricity production from solar photovoltaic sources will be restricted to research or remote locations, primarily for telecommunications. PV solar energy is still 300-500% more expensive than alternative fossil-fuel derived sources.

3.3 Geothermal Energy

3.3.1 Characteristics and uses

FYR Macedonia derives useful energy in the form of heat from its geothermal wells. At present its geothermal water is used for heating greenhouses, residential houses, some commercial buildings, swimming pools and in balneology. No electricity is produced from geothermal energy in this country.

3.3.2 Geothermal zones and fields

The main hydrothermal systems are located in the East and North East of the country (see Fig. 1) in the crystalline rocks of Macedonian-Serbian massive and are characterized by low TDS and low corrosion activity. A number of geothermal areas composed by separate fields were discovered as a result of investigations from more than 50 prospecting and operating wells with a depth from 40 to 2100 m.

Fig. 1 Areas in FYR Macedonia where geothermal fields concentrate



According to the UNDP FinalRep on Geothermal Resources, the most productive fields are located in the following zones:-

- In geothermal zone *Gevgelia*:

- (a) **At the field *Smokvica*** 22 wells with a depth of 30-850 m were investigated. The most productive stratum was found in the range of 350-500 m. The total discharge of four wells was 180 l/s, the average wellhead temperature (WHT) was 65°C.
- (b) **The field *Negorska Banja*** was investigated by means of a few wells. The total discharge of thermal water of 80 l/s at 51°C was obtained by pumping from two wells at a depth of 600 m.

- In geothermal zone *Kotchany*:

- (c) **At the field *Podlog*** 22 wells with a depth of 70-350 m were investigated. The most productive stratum was discovered at a depth of 307 m. This well discharged 150 l/s of free flowing water with a wellhead temperature (WHT) of 79°C. 18 operating and prospecting wells were drilled during the last 20 years in this region. The total field productivity 600 l/s with temperatures from 57 to 79°C.
- (d) **At the field *Banja*** discharge of l/s was obtained at one successful well with temperature of 65°C.

- (e) **At the field Vinica** the total discharge of 60 l/s of thermal water with temperature of 60°C was obtained from a recently drilled operating well.

The total discharge of wells from the exploited fields in Macedonia constitutes 1000 l/s, the existing thermal capacity is 74.5 MWt. The proven thermal potential constitutes 220 MWt.

3.3.3 Geothermal projects - active or under construction

- (a) **Geothermal project Kotchany.** Since 1982 geothermal heat has supplied 18 hectare of greenhouses and a rice-drying plant. Due to the increasing of thermal water discharge up to 450 l/s from the new well, it is planned to connect it with a paper mill and automobile spare parts factory, as well as the heat supply of dwellings.
- (b) **Geothermal project Banjsko.** The thermal water is used for heating 2.2 hectare of glass covered greenhouses of out-of-date design and for heat supply of neighboring hotels.
- (c) **Geothermal project Gevgelia .** The project consists of two parts. The first part is the system of geothermal heating for 22.5 hectare of stationary greenhouses from the field Smokvica (15 MWh). The second part is a system of geothermal heat supply of a hotel complex that includes the heating of rooms, hot water supply and balneology. The thermal water is transmitted from the field Negorcy (10 km from Smokvica).

3.3.4. Technologies used and strategy of development

Used technologies: The spouting (free flow) and pumping maintenance of fields, the direct use of geothermal water with discharge into surface water pools.

Strategy of development: It is planned to widen the existing heat supply system by connecting to industrial enterprises, hotels and dwelling houses. It is intended to improve the technology by means of creating two-loop heat supply systems and applying the reinjection of geothermal wastewater. The strategy of geothermal power engineering was developed in the framework of project "Evaluation of the reserves and technical feasibility of geothermal energy in Macedonia", 1997/1999, financed by the US Department of Energy and Ministry of Science of Macedonia.

3.3.5 Present and Potential Production / Utilization

The total discharge of wells from the fields being exploited in Macedonia constitutes 100 Vs and the existing thermal capacity is about 74,5 MWt.

The proven thermal potential is estimated to be 220 MWt. Its exploitation to the full could make a useful contribution to the environmental and renewable energy targets of FYR Macedonia.

3.4 Biomass Energy

3.4.1 Biomass Resources and Energy Use at present

Statistics on the biomass resources of FYR Macedonia are presented in Table 2. They show that in the period 1999-2001 a production of wood fuel and charcoal amounted to 787.000 cu.m. and wood residues 3.638 m³.

Table 2. FYR Macedonia Biomass Resource Data (FAO 2002a, FAO 2002b).

| Biomass resource type | Total production | Production density |
|---------------------------------------|----------------------------|---------------------------|
| Primary crop production, tonne | (avg. 1999-2001, tonne) | (tonne / 1000 Ha) |
| Total primary crops (rank among COO) | 2,354,688 (27) | 926 (18) |
| Top 10 primary crops | | |
| Alfalfa for Forage & Silage | 413,000 | 162 |
| Wheat | 307,606 | 121 |
| Grapes | 241,400 | 95 |
| Potatoes | 168,333 | 66 |
| Maize | 148,510 | 58 |
| Tomatoes | 129,800 | 51 |
| Watermelons | 120,000 | 47 |
| Barley | 109,167 | 43 |
| Chillies & Peppers, Green | 109,000 | 43 |
| Cabbages | 71,733 | 28 |
| Animal units, number | (number) | (number / 1000 Ha) |
| Cattle | 285,000 | 112 |
| Poultry | 3,344,000 | 1,315 |
| Pigs | 198,420 | 78 |
| Equivalent animal units | 397,808 | 156 |
| Forest products, cubic meters | (avg 1999-2000, cu meters) | (cubic meters / 1000 Ha) |
| Wood fuel and charcoal | 787,000 | 309 |
| Wood residues | 3,638 | 1 |

The country's official Energy Balances show that in the Year 2000 total primary production of wood amounted to 874.633 m³ having a gross energy value of 8.635.252 TJ. Gross inland consumption was slightly higher, about 896 000 m³ (8,9 million TJ) due to small quantities of imports.

Allowing for relatively small quantities of wood as energy input in heating plants etc. the net final energy consumption amounted to 860.901 m³ (8,55 million TJ). By far the biggest users were households with about 767.000 m³ (7.6 million TJ).

The final wood-derived energy consumption of 8,55 million TJ in the year 2002 comprised 12,7% of the country's total final energy consumption of 67.241.743

TJ. This turns out to be substantial larger than “the share of 7,3% of consumption of firewood in the consumption of primary energy resources” reported by the Black Sea Energy Review of May 2000.

The FYR Macedonian State Energy Agency is reported as “not anticipating any increase beyond the current use of wood as an energy carrier”. This does not necessarily mean that there are no further prospects for a better utilization of potential forest output for energy purposes. While ensuring sustainability of existing resources, better forest practices, re-forestation etc, as well as planting of deserted or marginal land could contribute to further development of this sector.

3.4.2 Biomass energy potential

While it is not expected to increase use of wood as a fire fuel in the traditional form, it does not necessarily mean that there are no margins and prospects for a better utilization of forest output for energy purposes. Better forest practices, reforestation, planting of deserted or marginal land could make a contribution, be it relatively small, to the further development of this sector. Moreover, as burning wood in the traditional way is quite polluting, there will be pressures for switching to other cleaner sources of energy, which would release fuel wood resources. This however, will be a slow process.

As far as exploitation of the residues of field crops, fruit tree plantations and livestock activities are concerned, there ought to be a significant potential for their collection and utilization, along with waste (incl. manures from intensive farms). This could be done through incineration or anaerobic digestion technologies. But special studies and surveys will have to be carried out to determine location, logistics, size of units, economics and viability.

Likewise with MSW (Municipal Solid Waste) and the waste of sewage (sewage sludge).

3.5 Hydroelectric Energy

3.5.1 Past and present

As Table 1 shows, production of electricity from hydro-power has fluctuated widely during 1980-2000. From about 159 ktoe in 1980 to 47 ktoe in 1990 and 118 in 1997. By the year 2000 it reached 1006 ktoe (4212 TJ), representing 3,4% of the total primary energy production.

Table 3 . Hydro Power Plants in FYR Macedonia

| Power Plant | Number of units | Installed capacity [MW] | Production 1998 [GWh] | Year of commissioning | Plant type | Reservoir volume [10 ⁶ m ³] |
|-----------------------------|-----------------|-------------------------|-----------------------|-----------------------|-----------------|--|
| Vrutok | 4 | 150 | 264.9 | 1957/1973 | reservoir | 277 |
| Raven | 3 | 19.2 | 31.1 | 1959/1973 | run of river | |
| Vrben | 2 | 12.8 | 40.4 | 1959 | run of river | |
| Globocica | 2 | 42 | 182.0 | 1965 | reservoir | 15 |
| Tikvesh | 4 | 92 | 153.3 | 1968/1981 | reservoir | 272 |
| Shpilje | 3 | 84 | 283.9 | 1970 | reservoir | 212 |
| Small HPP's | 22 | 35.8 | 121.9 | 1938-1993 | river/reservoir | 115 |
| Kozjak (under construction) | 2 | 80 | 0 | | reservoir | 260 |

The installed capacity of FYR Macedonia in January 1, 1999, was 1445,8 MW of which 1010 MW (70%) was in TPP's (Thermal Power Plants) and 435,8 MW (30%) in HPPs (Hydro-Power Plants).

To meet growing demand and partly substitute imports, over the long term (Year 2020) the country is planning new capacity amounting to 1.968 MW of which 207 MW in hydro power plants and 1.761 MW in new thermal generation units.

For the period 200-2005 two projects were planned: HPP Kozjak (80,5 MW) was due to be completed in 2001 and a new cogeneration plant (174 MW) in the capital city Skopje. This co-generation plant will satisfy the heat demand for residential district heating during winter, and also provide electricity generation during the whole year.

In the period 2005-2010, a gas turbine will come on line (122 MW) that would mostly serve the purpose of providing the necessary peaking capacity and system reserve. Also, two hydro projects are envisaged to be accomplished. These projects are the storage facility in Lukovo Pole and an additional reservoir for the three existing downstream power plants in the Mavrovo system (HPP Vrben, HPP Vrutok and HPP Raven) and HPP Spilje 2 (72.8 MW), a new generating unit added to the existing HP Spilje.

It should be explained that FYR Macedonia is divided into 3 separate drainage units/areas which are identified by their major rives:

- (a) The Vardar River water basin/drainage area of 20.535 km²
- (b) The Crni Drim River drainage area of 3.350 km²; and
- (c) The Strumica River drainage area of 1.535 km²

According to a Master Plan prepared as long ago as 1976 and other studies made at a subsequent time, “the technically usable” hydropower potential of the rives in the country are about 5.483 Gwh.

4. OVERALL ASSESSMENT/CONCLUSIONS

Evidently the renewable energy resource which stands to make by far the biggest contribution in meeting FYR Macedonia’s requirements is hydropower and plans are already proceeding towards this direction.

However, greater attention should also be given, along with incentives and financial facilities, to wind, as its high mountains permit that; as well to its solid and liquid wastes (from municipal and agro-industrial activity).

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