

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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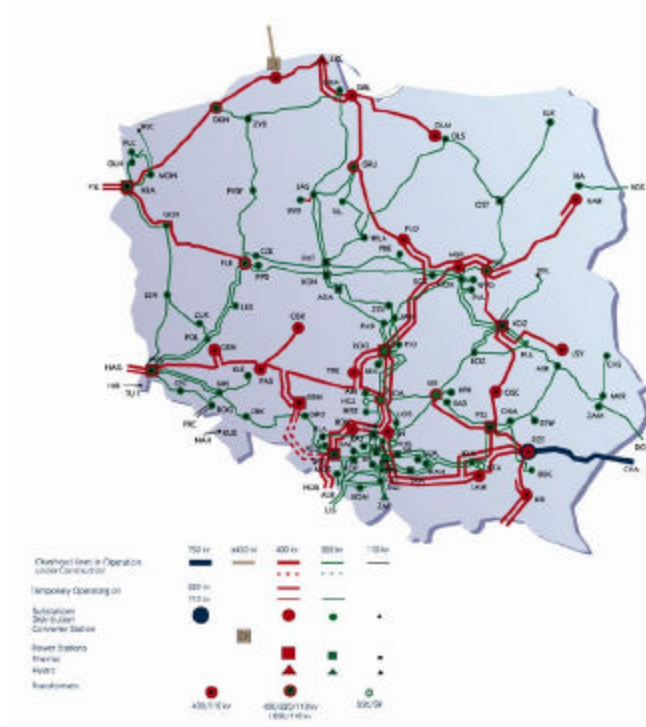
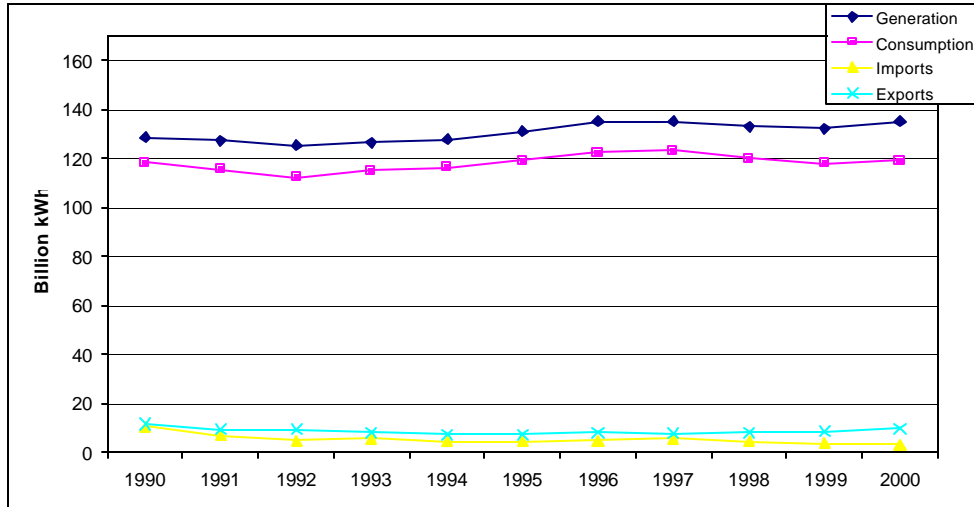
19.0 Poland

19.1 Overview of Electricity Supply

Coal-fired power and CHP plants dominate electricity generation in Poland. However, more than half of the capacity was built in the 1970's with 60% of generation at more than 15 years old, and 40% at more than 20 years old. Thus, significant investment in new generation and modernization of existing generation is required to make the Polish electricity industry competitive with western European markets. Additionally, there are plans in place to expand the existing transmission and distribution networks. These investments in the electricity industry are estimated to cost around \$50 billion over the next 15 years. Much of this cost, though, is proposed to be covered in the process of privatization.

Fuel	Number of Facilities	Capacity (MWe)	Percent of Total
Nuclear			
Coal			
Oil			
Natural Gas			
Major Hydro*			
Other Renewables			
Total			

The current generation assets have been more than capable of meeting the demand over the course of the 1990's. This has allowed Poland to become a net exporter of power. Continued investment in the system for modernization and expansion will, however, be required to maintain this position and expand the potential electricity export market.



Privatization has proceeded quickly as Poland has sought entrance in the EU since 1994 when it signed an Association Agreement. Poland began privatization by dividing the electricity sector into generation, transmission, and distribution companies. In 1999 the government began to privatize the companies by selling shares of the companies. Initially there was a limit by foreign investors of 20-30% in power plants, and 20-25% in distribution. However, these restriction were lifted in April 2001 with a new law that allows ownership of over 50% of these companies. Currently, many of these companies are in negotiation proceedings for privatization.

1.1.1 Wind Resources

Current Status of Wind Energy^{1, 2, 5, 6}

At present in Poland there are wind power plants of the total installed power of 28 MW.

In Poland where 95% of power is generated from 20-30 year old coal plant, the government is trying to stimulate renewables demand through a quota system where utilities will have to prove that in 2001 2.4% of the electricity sold is generated from renewable sources. This percentage rises each year to 7.5% in 2010. To date, however, the number of MW installed wind capacity is negligible and consists only of small stand-alone units.

A country wide wind-atlas is available. According to this atlas there is one area in the northwest with wind speeds above 6 m/s at 10m. The Baltic coast, one large central area and an area to the north show wind speeds of 5 m/s.

There is an industry association and there are two local companies which manufacture Polish wind turbines. These are the 160 kW unit, developed in 1993, and produced at present by the NOWOMAG Factory and the new approach of the KOMAG center aiming at a development of the prototype of state of the art wind turbine of 1MW according to the original technical concept, which is a compromise between present multi-gear and gearless solutions in wind turbines.

Two specific projects one for 100 MW and another dating back to 2000 with a total of 44 turbines of 600 kW unit capacity. This 26.4 MW project was awaiting approval of the Czech banks. Nothing was heard of it since then.

The main barrier seems to be the extremely low feed-in tariff. In 2000 the utility would pay 1.13 Zlotys / kWh, which is approximately 2.75 €Cents (2000), where as the average electricity price was 2.40 Zlotys or 5.9 €Cents/kWh. The government has introduced a tariff of 9.5 €Cents / kWh in November 2001, but the wind plant operators were given 3 days to lodge applications. It is may be because of this that the effect of this new tariff was not visible by September 2002. There is a grid obligation for renewables, but there are no consequences for non-compliance.

Poland has a good technical potential for wind energy development and local manufacturing.

Wind Energy Resource Potential^{1, 2 3,4, 5, 6}

In Poland 30% of the land surface is economically suitable for wind turbine applications, 5% very favorable. The best sites are in the southern mountainous region and along the Baltic coast. Poland has an area of 300.000 km² and extends from Baltic Sea in the north to the Carpathians and Sudetic mountains in the south, a range of some 600km. A large part of the country is rather flat, used for farming and forestry. The wind resources range from more than 1000 kW/m²/year near the Baltic coast to less than 400 kW/m²/year in the

center of the country. In the mountain range some sites are said to have high average wind velocities (10m/s) due to local conditions.

Most recently, Risoe National Laboratory from Denmark widened the geographical scope of wind estimates in the European Wind Atlas to now include Poland. Risoe's estimates indicate that wind conditions along the Pomeranian Coastline are similar to those in Denmark and the Netherlands. In Central Poland, wind resources are very similar to those found in Germany.

In spite of the data shown on the wind atlas some areas in the mountains, with wind speeds of 10 m/s at 50 m above ground level were identified. Based on available information today, we would rate the technical wind energy resource potential of Poland as very good.

Identification of Areas/Projects with High Potential for Wind Energy

Judging by the past and currently operational projects the most promising sites seem to be the western and the eastern parts of the country.



Wind Atlas of Poland

Table 1-2 Poland Areas/Projects with High Potential for Wind Energy

Project Name and Location	Size (MW)	Description
Gulf of Gdansk; Sulwaki		Baltic coast; Near Lithuanian border
Poznan, Wielkopolskie		West part of the country
Ciechanow, Mazowieckie		Center of the country
Silesian and Zywiec Beskids, Bieszczady and Dynowskie Plateaus.		

Barriers/Incentives for Wind Energy

Specific incentives for the implementation of wind projects in Poland include:

- Announced price for wind energy, DEM 0.10/kWh.
- Availability of funding by various national and international institutions
- The most promising development has been the legal grid obligation for renewables in the Poland.
- No government renewables support program exists, but low interest credits are available from the state environment fund and from normal banks when the money is used for environmental projects.
- Dutch utility NUON will be selling wind energy to a local energy company at a price of at least EUR 0.06/kWh.
- As part of its attempt to achieve a zero CO₂ balance by 2005, Dutch confectionery concern Van Melle is to build a wind farm in Poland. And also he is looking to sell the project's output to a local Polish power company and set the carbon credits generated by the wind turbines against its emissions in the Netherlands.
- Dutch utility NUON is to build a 60 MW plant in the same area under the Dutch government's Joint Implementation, emissions trading scheme ERUPT
- Wind energy is to be the focus of Poland's first renewable energy development program drawn up under a new regime aimed at increasing the percentage of renewables in the country's primary energy supply to 7.5% by 2010 and 14% by 2020.

Specific barriers to the implementation of wind projects in Poland include:

- Wind energy developers in Poland are also up against a powerful coal sector and miners trade union. As in the Czech Republic, the Polish parliament is heavily influenced by these lobbies.
- Utilities often neglect to fulfil their existing obligation to take fixed minimum amounts of renewables onto their grids because there are no effective penalties.
- At the time of writing this report following news were received:

However, the Polish national grid operator, Polskie Sieci Elektroenergetyczne (PSE), manifested ill will against alternative energy producers by imposing new internal regulations last July, which forces wind farms to set detailed production plans 48 hours in advance. For obvious reasons, a wind farm cannot set exact

production plans, but without them, no heat-and-power plant from the national grid will make deals with alternative energy producers.

Wind farm owners are desperate. "At the moment none of the power plants will buy energy from us", say owners, who are still operating, but supply energy to the grid for free. A few more months of the impasse, and all the wind farms will go bankrupt.

PSE blames bad legislation for the problem.

This situation emerging at this point in time implies that

- a- There is not enough know-how for drafting wind energy power purchase agreements
- b- There is also a lack of load dispatch know-how on part of the wind park developers / operators, respectively solutions to such problems
- c- The coal lobby is reacting to the planned 470 MW of wind power projects

Table 1-3. Poland Wind Energy Profile.

Current status of wind energy	
Installed capacity	0.55 MW, Energotel, Darlow 0.16 MW, Wojewodschaft in Lower Silesia 1.50 MW, Location ? 8.00 MW, Skrobotowo, near the shores of the Baltic, north west 4.40 MW, Noble III, at Stramnica on the Baltic Sea coast 10.20 MW, near Gdansk on a site known as Lieswo 1 4.90 MW, at Barzowice <u>2.00 MW, at Cisowo</u> 28 MW Total
Projects under construction	40 MW, 20 x Vestas V80 Turbines, construction autumn 2002
Supporting regulations?	Yes. Green Certificate and Joint Implementation.
Industry association?	Yes. Polish Wind Energy Association.
Wind energy resource potential	
Level of information available	Very Good
Highest wind class	Class 7 (in the Baltic Sea four kilometers north of Gdansk the wind speed average is 7-8 m/s, inland locations 10 m/s)
Country-level wind atlas available?	Yes
Estimated potential (BREC)	3'000 MW economical potential
Target established?	Yes. 1'600 MW by 2010
High wind speed locations	Baltic coast, some inland locations up to 10 m/s.
Identification of areas/projects with high potential for wind energy	
Recommended strategic assessments	Study 1, check feasibility of identified projects Study 2, appraisal of legal frame work and contract law
Identified areas/projects	30 MW, Wind 7 10 MW, Jacobs Energie, on the Baltic coast 10.2 MW, Lieswo 1, 17 x Enercon E-40, near Gdansk 37.5 MW, Add-on to Lieswo 1, 25 x 1.5 MW turbines 4.5 MW, Lagerwey, near the shores of the Baltic, north west 60 MW, Nuon (Dutch Utility) Project 100 MW, (Off shore), Wiatropol International, in the Baltic Sea four kilometers north of Gdansk 183 MW, Offshore Poland P&T & Friends Germany, in the Bialogora region of the Baltic Sea, off the coastal town of Slupsk

Incentives/barriers for wind energy

Significant incentives

- Green credit trading with Netherlands
- Availability of funding by various national and international institutions
- Fixed price for wind energy

Significant barriers

- Established target
- Inimical attitude of utilities
- Load dispatch issues
- Poor contracts

Overall Prospects**Good**

Poland has one of the best documented wind resources, areas up to 1'000 W/m², an existing industry, a lot of interested investors, almost everything needed to become one of the best wind countries in the world. The only problem seems to be the opposition by the powerful coal lobby and inadequate / fragile contracts.

¹ Wind Power Monthly, various issues

² WIND ENERGY IN POLAND, Market Report, EC Baltic Renewable Energy Centre, Gdansk - Warsaw, September 2000

³ The Wind Energy Resource Assessment of Poland, Pacific Northwest Laboratory, 1994

⁴ Wind resource contour map of Poland, Institute of Meteorology and Water Management (IMGW), 1996

⁵ Wind power industry and wind power plants technology in Poland, Andrzej Drwicga, KOMAG Mining Mechanizati Centre

⁶ Wind energy market study Eastern Europe, Poland, Thermie Action WE05, P. Skjerk Christensen

1.1.1 Solar Resources

1.1.1.1 Current Status of Solar Energy

It is extremely difficult to evaluate the volume of renewable energy utilized in Poland as information may only become available through special fact-finding research techniques. At the moment, solar energy is of lower significance. According to the EC Baltic Renewable Energy Center (ECBREC), utilisation of solar energy in Poland in 1999 is 0.01 PJ/yr making up of 0.01 % of the total amount of energy utilized from renewable energy sources (RES).

Solar energy is the least popular form of energy. Poland has a very uneven distribution of solar radiation throughout the year, with around 80% of the total annual insolation falling within six months in spring and summer. The distribution of density of a solar radiation flux and its structure show that opportunities of its utilisation are somewhat limited, especially in winter. However, liquid and air solar collectors are used in a few areas in Poland. Air collectors are most frequently used at farms for crop drying. The total number of air collectors is estimated at 50-60 units, and their surface area at 6,000 m². They are operated for 300-600 hours per year on average. Liquid collectors are mainly used for heating water in homes, camping and summer cottages, sports and recreation facilities, livestock buildings and fodder stores. Also, liquid solar collectors heat up water in tanks and swimming pools as well as process water in small industrial plants. To date, around 1,000 solar installations for the heating of usable water have been installed in Poland with the total surface area of the collectors exceeding 10,000 m².

Photovoltaic cells in which solar energy is directly converted to electricity are virtually not used in Poland.

1.1.1.2 Solar Energy Resource Potential

When renewable energy potentials of different sources are analyzed, it can be easily realized that one of the greatest technical potential is in solar radiation. Unfortunately, it is unrealistic to expect a considerable growth in the utilisation of solar energy in Poland in the nearest future. One advantage may be that the technologies which produce energy at costs higher than the national average price but may be competitive under the following conditions; least economically viable photovoltaic technologies in special niche areas (e.g. power supply to marine navigational marking).

The potential of solar energy in the country is estimated as 370 PJ/yr. The technical potential for solar energy according to the EC BREC's studies of the year 2000 give an annual

technical potential energy as 1340 PJ/yr. This number varies greatly in different studies. It is obvious that a country wide extensive research on the technical and economical feasibility of solar energy is needed.

1.1.1.3 Identification of Areas/Projects with High Potential for Solar Energy

There are **poor** opportunities for solar development in Poland.

1.1.1.4 Barriers/Incentives for Solar Energy

Specific incentives for the implementation of solar energy projects in Poland include:

- There are environmental funds on all level of administration supporting development of RES with grants or soft loans;
- There is also an organisation called ECOFUND, aimed at promotion of clean technologies, including RES, which provides organisations with grants for RES equipment.
- For water solar collectors (heat production cost PLN 147.3/GJ), photovoltaic systems (electricity production cost PLN 8.89/kWh), which are unable to compete with the highest prices of energy generated in Poland in fossil fuel installations even if 50% of the total investment cost is covered by grants.
- Specific barriers to the implementation of solar projects in Poland include:
 - Inadequate economical mechanisms, particularly fiscal ones, which would enable acquisition of relevant financial benefits with regard to induced investments for production of energy from renewable resources;
 - Relatively high investment costs of technologies utilising renewable energy;
 - Lack of general access to information about distribution of energy potential of particular kinds of renewable energy;
 - Lack of information about manufacturing companies and design engineers and consultants from that area;
 - Lack of generally accessible information about the procedures in entering such kind of investment, typical costs of investment and the economical, social and ecological benefits combined with utilization of renewable energy;
 - Lack of tax preferences in the area of imports and exports of equipment utilizing RES; Inadequate scope of educational curricula, including the renewable sources of energy, at all levels of education;
 - Lack of educational and training programs from the area of renewable sources of energy addressed to engineers, designers, architects, representatives of the power engineering sector, banks and local authorities;

- Lack of developed methods of refraining conflicts with the protection of environment and landscape

Table Error! No text of specified style in document. - 1. Poland Solar Energy Profile.

Current status of solar energy	
Installed capacity	Air solar collectors for drying crops: 50 -60 collectors, total surface ca. 6000 m ² ; estimated primary energy production: 0,01 PJ
Projects under construction	NA
Supporting regulations?	There are four legal documents stimulating development of renewable energy in Poland: <ul style="list-style-type: none"> · Polish Energy Policy Foundations until 2020 issued by the Ministry of Economy, 2000 · Strategy of RES Development, Ministry of Environment, 1999 · Energy Law, 1997 · Decree on obligation of Purchase of Electricity produced from RES, Ministry of Economy, 2000
Industry association?	Yes. Polish Solar Energy Association
Solar energy resource potential	
Level of information available	Poor
High range of solar insolation	950 - 1250 kWh/m ² /year (BP Solarex map)
Country -level solar atlas available?	No
Target established?	Extra installed capacity by 2010: 100 MW air solar collectors, water solar collectors, 2 MW photo-voltaics
High solar insolation locations	NA
Identification of areas/projects with high potential for solar energy	
Recommended strategic assessments	Technical and economical feasibility of introducing highly advanced solar energy technologies.
Identified areas/projects	NA
Incentives/barriers for solar energy	
Significant incentives	Environmental funds on all level of administration and ECOFUND for Renewable Sources
Significant barriers	Inadequate economical mechanisms High investment costs Lack of access to technical and administrative information
Overall Prospects	Poor. Solar energy may be used for preparation of hot water during summer as well as for crop drying. Solar energy does not seem to be on the leading renewable energy source for the State unless feasible technology is introduced.

1.1.1 Geothermal Resources

Current Status of Geothermal Energy

Poland has a sizable reserve of geothermal energy that is rich in low enthalpy resources, although there is little in the form of naturally occurring thermal springs or outflows. The country is characterized by large-scale low enthalpy resources which are contained in 3 sedimentary provinces which cover approximately 80% of the total land area (PGA, 2002). Currently the country utilizes the resources mainly for space heating and balneology purposes, although there are experimental projects regarding fish farming, timber-drying and greenhouse heating. Current installed capacity is approximately 68,5 MWt, of which 26,2 MWt is from heat pumps, which collectively generate 274 TJ of energy on an annual basis (PGA, 2002).

It is only until recently that attempts have been made at exploiting the potential of the country's thermal resources. There are currently 3 sites that have been developed and are in commercial operation, providing mainly space heating for local residents as well as some experimental activities (i.e. fish farming, greenhouse heating, timber drying). The Podhale project was the first in development and in 2000 secured financing from the European Union and World Bank for further expansion of the plant to include district heating capabilities for nearby towns. The second project is located in Pyrzyce and provides district heating for approximately 14.000 residents. Finally the third project is the Mszczonow, which is the most recent and most advanced of the three. The site provides district heating and drinking water for approximately 6.000 residents. It should be noted that all of the above projects required the additional installations of natural gas boilers to supplement the systems with additional heat capacity during the colder months (Danish EPA, 2002).

In addition there are several heat pumps installed in many areas of Poland such as Sudetes, Kielce, as well as in the Polish Lowlands, where several individual villas and residences utilize the resources.

While country does have a local industry association, the Polish Geothermal Association (PGA), which has been pushing for an increase in the use and awareness of the country's resources, the sector is still underdeveloped. While the State has set aggressive goals concerning renewable energy to be met in 2010 and 2020 respectively, it is viewed that the majority of the RES development will be in biomass.

Geothermal Energy Resource Potential

Geothermal resources in Poland are of low enthalpy, typically ranging between 20° ; C - 120° ; C and as such would be better suited for heat generation rather than power. There are three main geothermal formations within the country that complete a section of the Central European Geothermal Province (INEEL):

- Polish Lowlands Geothermal Province;
- Fore-Carpathian Geothermal Province;
- Carpathian Geothermal Province.

It is estimated that the theoretical potential of energy that is extractable from the main formations to be approximately $7,75 \times 10^3$ PJ with annual technical potential to be 1.1512 PJ (BAPE, 2002).

While there has been much discussion in recent years regarding the further exploitation of the country's resources mainly in the Polish Lowlands and the Fore-Carpathian Geothermal Province. With over 7000 wells already drilled throughout the country at depths exceeding 2.000 – 3.000 m, it would seem appropriate that additional projects could be developed, albeit mainly for localized space and district heating purposes, and in which case an additional heat generating source especially during the colder months would most probably be required (S. Ostaficzuk, 2000).

Identification of Areas/Projects with High Potential for Geothermal Energy

There are fair-good opportunities for geothermal development in Poland especially for district heating purposes, although it is believed that additional opportunities will occur after further research and preliminary studies are completed. The Ministry of Environment has stated that there are 16 potential sites in where geothermal projects can be developed, of which can be seen in **Figure....**

Figure.... Potential Geothermal Project Locations (Ministry of Environment)



- | | |
|------------------------|--------------------------|
| 1. Czarnków | 9. Łódź |
| 2. Oborniki | 10. Zgierz |
| 3. Janikowo | 11. Piotrków Trybunalski |
| 4. Kruszwica | 12. Żyrardów |
| 5. Koło | 13. Stargard Szczeciński |
| 6. Poddębice | 14. Szczecin |
| 7. Aleksandrów Łódzki | 15. Police |
| 8. Konstantynów Łódzki | 16. Goleniów |

Barriers/Incentives for Geothermal Energy

Specific incentives for the implementation of geothermal projects in Poland include:

- Political / public push away from utilization of fossil fuels. Legislation in place calling for the increased use of RES;
- District heating infrastructure already present in many regions, requiring less capital cost for conversion / adaptation to geothermal.

Specific barriers to the implementation of geothermal projects in Poland include:

- Inadequate economic mechanisms for providing funding for RES projects;
- Lack of economic / financial incentives in the form of taxes and duty reductions on imported equipment technology;
- Lack of information regarding suppliers and education towards readily available proven technology;
- Lack of education and training programs regarding geothermal uses addressed to engineers, and the local municipalities.

Table Error! No text of specified style in document. - 1. Poland Geothermal Energy Profile.

Current status of geothermal energy	
Installed capacity (electric)	There are no electric projects installed.
Installed capacity (thermal)	3 existing sites: Podhale; Pyrzyce; Mszczonow; Current installed thermal capacity is 68,5,2 MWt. Main uses are for space/ district heating purposes.
Projects under construction (electric)	There are no electric projects under construction.
Supporting regulations?	Yes. While actual legislation regarding geothermal exploitation does not exist there are numerous supporting regulations: <ul style="list-style-type: none"> • Polish Energy Policy Foundations until 2020 issued by the Ministry of Economy, 2000; • "The Polish National Strategy for the Utilization of RES", Ministry of Environment, 1999; • Energy Law, 1997; • Decree on obligation of Purchase of Electricity produced from RES, Ministry of Economy, 2000.
Industry association?	Yes. Polish Geothermal Association (PGA)
Geothermal energy resource potential	
Level of information available	Fair
Country geothermal atlas available?	No.
Estimated potential (electric)	No data available

Target established?	Yes. As part of The Polish National Strategy for the Utilization of RES, by 2010 total installed capacity 400MWt.
High enthalpy geothermal locations	No data available.
Identification of areas/projects with high potential for geothermal energy	
Recommended strategic assessments	Study 1 – Assessment of the existing situation of those wells in areas where energy development can exist and the steps necessary for upgrading for full exploitation; Study 2 – Assessment of the conversion / adaptation of district heating plants in regions where geothermal sources are present.
Identified areas/projects	16 Possible Project Locations: 1 - Czarnkow 2 - Oborniki 3 - Janikowo 4 - Kruszwica 5 - Kolo 6 - Poddebice 7 - AleksaandrowLodzki 8 - KonstantinowLodzki 9 - Lodz 10 - Zgierz 11 - Piotrkow Trybunalski 12 - Zyradow 13 - Stargard Szczecinski 14 - Szczecin 15 - Police 16 - Goleniow No additional information obtained.
Incentives/barriers for geothermal	
Significant incentives	1 - Political / public push away from utilization of fossil fuels. Legislation in place calling for the increased use of RES; 2 - District heating infrastructure already present in many regions where geothermal sources are known, requiring less capital cost for conversion / adaptation to geothermal.
Significant barriers	1 - Inadequate economic mechanisms for providing funding for RES projects; 2 - Lack of economic / financial incentives in the form of taxes and duty reductions on imported equipment technology; 3 - Lack of information regarding suppliers and education towards readily available proven

technology;

- 4 - Lack of education and training programs regarding geothermal uses addressed to engineers, and the local municipalities.

Overall Prospects

Fair - Good. While there does exist a potential for exploitation of the country's geothermal resources for space and district heating purposes, it appears that discussions are still occurring as to the overall technical and economical feasibility of these projects.

1.1.1 Biomass Resources

Current Status of Biomass Energy

Poland, occupying a total land area of approximately 304,465 km² ; , of which some 14.310.000 ha, or approximately 47% of the overall land area, consists of arable and agriculture lands, and 8.800.000 ha, or approximately 28%, being forest cover, biomass not only is beginning to play an important role in fulfilling Poland's energy needs, but will continue to do so easily until 2020 (Central Intelligence Agency, 2002). In addition with afforestation protocols already in place it is estimated that total forest cover to reach 32% by the year 2020.

The areas in which there appears to be the most development in recent years has been energy generation from fuelwood, forestry residues, agricultural residues and surpluses. These have taken the form of individual and industrial heating plants, district heating and even CHP plants, in where biomass is replacing or reducing the use of coal. Considering the age and the decreased efficiency of many of the existing plants due to age or lack of maintenance, rehabilitation and conversion to a biomass boiler may be a possible alternative.

Another alternative has been the expanded use of biogas. Energy production projects from biogas generated from wastewater treatment plants, agricultural and livestock activities and landfills are currently being implemented. **Figure...**, identifies the extent of the current use of biomass / biogas in Poland.

In addition, bio-fuels is also an area that appears to be developing, especially for the agriculture community. It has been a political priority of the Polish government to develop the use of bio-fuels. Bio-fuel (i.e. bio-ethanol, bio-diesel) has recently been utilized in conjunction with #2 fuel oil, for heating purposes. A 1997 bio-fuels law provides tax incentives for the use of #2 fuel oil / bio-fuel mixtures. In 2001, approximately 209 tons of bio-fuel was utilized for heating (Gierulski K., 2002a).

Under the auspices of Poland's probable succession to the EU, as well as through legislative actions dating back to the early 1990's, the State has developed protocols for the introduction of renewable energy sources (RES), most notably biomass, into commercial use. As part of *"The Polish National Strategy for the Utilization of RES"* by 2020, which was officially adopted on August 23, 2001, the State has set specific targets for the development and implementation of renewable energy sources. The basic aim of this aggressive policy is to increase the share of RES for energy production from the current 2,5% to 7,5% by the year 2010 and 14% by 2020 (Council of Ministries, 2000).

Figure ... Installed Biomass Capacity of Poland (BSREC, 2002)

Type of installation	Number of installations	Total capacity [MW]	Electricity [GWh]	Heat [TJ]
CHP (waste from pulp & paper industry, furniture industry)	50	1000	90	12500
Automatic wood -fired heating plants	70	350	-	4200
Small and medium boilers using wood chips saw dust and shavings, incl. multi-fuel	100,000	5,000	-	80000
Straw -fired direct heating	10	13	-	130
Small and medium straw-fired boilers	75	7	-	49
Sewage sludge		38.9	72.5	250
Animal manure/ agricultural residues	10	0.15	-	N/A
Landfill gas	15	15.3	49.8	110

The biomass / biogas sector is maturing quite rapidly with many local private sector organizations such as FUWI Elbag, ZAR, Energoinvest, Uniwex-AJ, ABM-Solid, and Skanska-Budexpol, supplying a variety of biomass boilers and turn-key installations. In addition the Polish Biomass Association (POLBIOM) has been actively performing research as to the feasibility of such projects as well as new possible uses for biomass. However, most notable in the field of RES for Poland is the EC Baltic Renewable Energy Center, which has performed extensive research on the topic.

Biomass Energy Resource Potential

There exists a large potential to utilize biomass and biogas as an energy source. Readily available information regarding the use and potential use of biomass and biogas is well documented and detailed. Numerous demonstration and pilot projects either have been completed or are close to completion, which, when in full operation, should provide the necessary confidence to those industrialist and end users who are now skeptical. Two projects worth mentioning are a recently completed 29 MW biomass CHP plant in Ostroleka,

which was engineered and constructed by Foster Wheeler, and a 1 MWh / 800 kWe agriculture biogas CHP located in Northern Poland in the town of Koczala, which is still in the preparation / construction phase. In addition, there are potential opportunities in district and direct heating plants, especially in the rural areas. Estimates have put the number of rural DHP's at approximately 1.000, which currently utilize coal as a fuel source. It is thought that the condition and efficiency of these units to be in poor condition which may make way for possible rehabilitation and conversion over to a biomass fuel source (Gierulski K., 2002).

Table Error! No text of specified style in document.-1 shows agricultural and forestry statistics for Poland.

Table Error! No text of specified style in document. - 1. Poland 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)	83,836,385 (3)	2,754 (6)
Top 10 primary crops		
Potatoes	21,520,127	707
Sugar Beets	12,899,332	424
Wheat	8,982,393	295
Maize for Forage & Silage	6,333,333	208
Vegetables and Roots, Fodder	5,193,333	171
Rye	4,701,436	154
Mixed Grain	3,689,795	121
Barley	3,174,738	104
Leguminous (misc), Forage & Silage	3,064,000	101
Triticale	2,243,369	74
Animal units, number	(number)	(number / 1000 Ha)
Cattle	6,273,900	206
Poultry	49,772,000	1,635
Pigs	18,380,802	604
Equivalent animal units	14,123,941	464
Forest products, cubic meters	(avg 1999 - 2000, cu meters)	(cubic meters /1000 Ha)
Wood fuel and charcoal	1,505,000	49
Wood residues	1,356,000	45

Annually, wood production is 23,5 million m³ ; , whereas fuelwood production is 1,5 million m³ ; , of which 70% is being utilized. It is estimated that there is another 2 – 2,5 million m³ ; of fuelwood that could be harvested per year. Wood and wood wastes from processing is estimated to be 2 – 3,5 million m³ ; , of which currently 40% is being utilized. Waste wood from recycling and construction and demolition (C&D) activities amount to approximately an additional 2-3 million m³ ; . Utilization data from such wastes are not well documented (BSREC, 2002).

The country is also home to some 12.000 km² ; of peatland. While emphasis has not been placed on peat, there are approximately 40 million tons of calculated peat in place, with another 17 billion m³ ; or 5.4 billion tons as an estimated additional amount in place. Current consumption of peat is virtually all for agricultural or horticultural purposes.(POLBIOM) In addition, the State has initiated plantations of approximately 200 ha of coppice (*Salix Viminalis*), a fast growing tree species, which will be utilized for energy purposes when mature (Gierulski K., 2002). When considering the feasibility of utilizing energy crops as a possible renewable fuel source, the extent of heavy metal contaminated land should also be considered. Placing energy crops on contaminated land may not only create a beneficial fuel source but will also allow the potential for revenue generation from land that would otherwise be rendered non-usable.

Potentials for utilization of generated biogas are also high. With approximately 1.500 municipal wastewater treatment plants, the use of biogas generated from anaerobic processes for creating a self-sufficient treatment plant is a feasible option. However, expanded use of biogas generated from treatment plants into heat or electricity that can be sold for commercial purposes does not appear to be possible.

In farms with over 1000 LSU (live stock units), energy from biogas resulting from gasification of manure is also feasible, although due to the lack of experience and know-how on this subject forward progression is rather slow.

One last area that deserves mentioning is landfill biogas projects. With over 720 organized landfills, of which approximately 70-100 sites have extractable methane (CH₄) in concentrations greater than 240 million m³ ; , the potential for utilization for energy purposes is very good (BSREC, 2002).

In addition to the figures mentioned above, **Table ...** provides an overview and identification of various sectors and the estimated technical potentials of each:

Table.... Bulgaria Biomass Potentials

Sector	Technical Energy Potential, PJ (TWh)	Remarks
1. BIOMASS FROM WOOD		
Existing energy potential	~ 110 PJ (31 TWh)	35 PJ – forest 15 PJ – afforestation efforts 30 PJ – wood industry 30 PJ – Recycling, C&D waste
2. BIOMASS FROM AGRICULTURE (SOLIDS)		
Existing energy potential	~ 110 PJ (31 TWh)	Consists mainly of surpluses of hay, straw, cereals, and rape.
2. BIOMASS FROM ENERGY CROPS		
Existing energy potential	N/A	Sufficient studies have not been completed
3. BIOMASS FROM LANDFILL BIOGAS		

Existing energy potential	N/A	Sufficient studies have not been completed
4. BIOGAS FROM WASTES		
Existing energy potential	~ 136 PJ (38 TWh)	36 PJ – livestock & farming activities 100 PJ – wastewater treatment plants
Notes:		
1 - Data courtesy of Baltic Energy Conservation Agency; Gdansk, Poland		
2 -The above calculations are estimated potentials. It is necessary to further evaluate the true potential through more detailed studies.		

Identification of Areas/Projects with High Potential for Biomass Energy

There are very good opportunities for biomass development in Poland, and through governmental policies and the willingness of the public to veer away from the dependence of fossil fuel sources much can be accomplished. The areas with the most potential for biomass / biogas projects are those in the northern and western regions, rural and mountainous regions, as well as the eastern border of Belarus.

Barriers/Incentives for Biomass Energy

Specific incentives for the implementation of biomass projects in Bulgaria include:

- Biomass fuel is currently available at relatively low prices;
- Political / public push away from utilization of fossil fuels. Legislation in place calling for the increased use of RES;
- Tightening of environmental legislation from point source and industrial furnaces and boilers;
- Decree on the obligation of the *Purchase of Electricity Produced from RES*, Ministry of Economy, 2000;
- Large number of established local and international suppliers with proven and efficient technologies;
- A small number of grants that provide organizations with funds for the promotion of clean technologies (ie. ECOFUND).

Specific barriers to the implementation of biomass projects in Bulgaria include:

- Relatively high investment costs of RES technology;
- Inadequate economic mechanisms for providing funding for RES projects;
- Lack of economic / financial incentives in the form of taxes and duty reductions;
- Lack of information regarding suppliers and education towards readily available proven technology;
- Lack of education and training programs regarding RES addressed to engineers, designers, architects, and representatives of the power engineering sector.

Table Error! No text of specified style in document. - 2. Poland Biomass Energy Profile.

Current status of biomass energy	
Installed capacity	<ul style="list-style-type: none"> - CHP (waste from pulp & paper industry, furniture industry) -1000 MW; - Automatic wood-fired heating plants - 350 MW; - Small and medium boilers (wood chips, saw dust and shavings , incl. multi-fuel) - 5000 MW; - Straw-fired direct heating- 13 MW; - Small and medium straw -fired boilers- 7 MW; - Sewage sludge - 38,9 WM; - Animal manure/ agricultural residues - 0,15 MW; - Landfill gas - 15,3 MW.
Projects under construction	1 MWh / 800 kWe, agriculture biogas CHP, village of Koczala
Supporting regulations	<p>Yes:</p> <ul style="list-style-type: none"> · Polish Energy Policy Foundations until 2020 issued by the Ministry of Economy, 2000; · "The Polish National Strategy for the Utilization of RES", Ministry of Environment, 1999; · Energy Law, 1997; · Decree on obligation of Purchase of Electricity produced from RES, Ministry of Economy, 2000.
Industry association	POLBIOM- Polish Biomass Association
Biomass energy resource potential	
Level of information available	Very Good
Relative biomass potential (total / density)	Total: 40-60; Density: 40-60.
Country -level biomass investigations available?	Yes. There has been extensive research done by POLBIOM, EC Baltic Renewable Energy Center (EC BREC), Baltic Energy Conservation Agency (BAPE).
Estimated potential	<ul style="list-style-type: none"> 1 - Biomass from wood - ~ 110 PJ (31 TWh); 2 - Biomass from agriculture - ~ 110 PJ (31 TWh); 3 - Biogas from wastes - ~ 136 PJ (38 TWh) ; 4 - Biogas from landfills - N/A 5 - Biomass from energy crops - N/A
Targets established?	<p>Yes ; established in "The Polish National Strategy for the Utilization of RES " by the Ministry of Environment.</p> <ul style="list-style-type: none"> • 7,5% RES use by 2010; • 14% RES use by 2020; • Biomass from wood: 4.700MW installed capacity by 2010; • Biomass from straw boilers: 2.200MW installed capacity by 2010; • Biomass from individual small boilers: 8.900MW installed capacity by 2010; • Biomass from wood (CHP Plants): 1.200 – 1.900MW installed capacity by 2010; • Biogas from WWTP: 500MW installed capacity by 2010;

<p>High density biomass areas</p>	<ul style="list-style-type: none"> • Biogas from agriculture/livestock: 30 - 50MW installed capacity by 2010; • Biogas from landfills: 60 - 120MW installed capacity by 2010; • Biogas from communal plants: 500 - 700MW installed capacity by 2010. <ol style="list-style-type: none"> 1 - northern and western regions; 2 - rural and mountainous regions; 3 - eastern border of Belarus.
<p>Identification of areas/projects with high potential for biomass energy</p>	
<p>Recommended strategic assessments</p>	<p>Study 1 - Assessment of rural DHP's for rehabilitation and conversion to biomass;</p> <p>Study 2 - Identification and assessment of areas in where CHP's utilization of biomass may be feasible;</p> <p>Study 3 - Identification and assessment of contaminated land areas and appropriate energy crops for rotation farming ;</p> <p>Study 4 - Identification of specific areas and evaluation of livestock waste for energy;</p> <p>Study 5 - Feasibility studies for Landfill biogas of selected larger landfills;</p>
<p>Identified areas/projects</p>	<ol style="list-style-type: none"> 1 - Rehabilitation and conversions of DHP's - rural areas; 2 - Installation of biomass CHP's- country wide; 3 - Landfill biogas- approximately 70-100 potential locations;
<p>Incentives/barriers for biomass energy</p>	
<p>Significant incentives</p>	<ol style="list-style-type: none"> 1- Biomass fuel is currently available at relatively low prices; 2- Political / public push away from utilization of fossil fuels. Legislation in place calling for the increased use of RES; 3- Tightening of environmental legislation from point source and industrial furnaces and boilers; 4- Decree on the obligation of the <i>Purchase of Electricity Produced from RES</i>, Ministry of Economy, 2000; 5- Large number of established local and international suppliers with proven and efficient technologies; 6- A small number of grants that provide organizations with funds for the promotion of clean technologies (ie. ECOFUND).
<p>Significant barriers</p>	<ol style="list-style-type: none"> 1 - Relatively high investment costs of RES technology and length of time for return ;

- 2 - Inadequate economic mechanisms for providing funding for RES projects;
- 3 - Lack of economic / financial incentives in the form of taxes and duty reductions;
- 4 - Lack of information regarding suppliers and education towards readily available proven technology;
- 5 - Lack of education and training programs regarding RES addressed to engineers, designers, architects, and representatives of the power engineering sector.

Overall Prospects

Very Good. Both liquid and solid biomass is considered to be the main renewable energy source in Poland, for electricity and thermal energy production. This seems to be the case as technologies and supply sources are relatively mature, as well as the investment costs are much lower than in case of wind power. For these regions, biomass/biogas appear to be the preferred and most economical RES.

1.1.1 Small Hydro Resources

1.1.1.1 Current Status of Small Hydro Energy

Very little renewable energy has been developed in Poland with the exception of hydropower and forestry residues. After the second World War about 30 % of primary energy demand was provided by hydro energy. From the use of water energy 1.9 PJ is produced in Poland which makes up only 1.83 % of the energy gained from renewable energy sources. (EC Baltic Renewable Energy Centre,1999)

Although hydro power has a long tradition in Poland, Polish hydro power resource is small due to the limited and unfavorably distributed precipitation, high soil permeability and relative flatness of the country. The total installed capacity of large hydro-electric power stations is around 630 MW, and of the small ones 160 MW.

In accordance with the relatively dynamic development of small hydro-electric power stations, a number of plant manufacturers, in particular of turbines and their components, operate at the market. There are also a number of companies specializing in the manufacture of control systems and hydraulic engineering constructions as well as a few consulting firms able to assist the investor in project management, from the obtaining of the necessary permits, loans etc, to the commissioning of a 'turn-key' installation.

1.1.1.2 Hydro Energy Resource Potential

According to forecasts prepared within the European Union, biomass will have the greatest contribution to the development of renewable energy, and next will come wind energy. On the other hand, hydro power will probably remain the second largest renewable energy source though with limited possibilities of further growth.

The technical potential for small hydropower production in a year is estimated to be 1,6 TWh/a. It is estimated that the dispersed hydro potential of 0.3÷0.4 Mtoe/year can be exploited this indicates the field for small hydro power further development. The strategic objective of Poland is to increase of the share of energy from renewable sources in primary energy balance to 7.5% in 2010 and to 14% in 2020.

The power output of existing hydro-electric power stations may be increased by 20-30% through the modernization of their generators. Due to limited water resources in Poland, the installed power of a considerable part of small hydro plants is below 100 kW. Such power

stations offer a chance of improving a very poor runoff coefficient, particularly on small rivers.

Estimates of the technical potential of renewable energy sources in Poland vary considerably. According to EC BREC , 2000 and World Bank, 1996 , annual technical potential of renewable energy in Poland is stated as 43 PJ and 30 PJ , respectively. Different sources increase this number up to 50 PJ.

1.1.1.3 Identification of Areas/Projects with High Potential for Small Hydro Energy

There are good opportunities for solar development in Poland.

1.1.1.4 Barriers/Incentives for Hydro Energy

Specific incentives for the implementation of hydro projects in Poland include:

- There are environmental funds on all level of administration supporting development of RES with grants or soft loans;
- There is also an organization called ECOFUND, aimed at promotion of clean technologies, including RES, which provides organizations with grants for RES equipment.

Specific barriers to the implementation of hydro projects in Poland include:

- Inadequate economical mechanisms, particularly fiscal ones, which would enable acquisition of relevant financial benefits with regard to induced investments for production of energy from renewable resources;
- Relatively high investment costs of technologies utilizing renewable energy;
- Lack of general access to information about distribution of energy potential of particular kinds of renewable energy;
- Lack of information about manufacturing companies and design engineers and consultants from that area;
- Lack of generally accessible information about the procedures in entering such kind of investment, typical costs of investment and the economical, social and ecological benefits combined with utilization of renewable energy;
- Lack of tax preferences in the area of imports and exports of equipment utilizing RES; Inadequate scope of educational curricula, including the renewable sources of energy, at all levels of education;
- Lack of educational and training programs from the area of renewable sources of energy addressed to engineers, designers, architects, representatives of the power engineering sector, banks and local authorities;
- Lack of developed methods of refraining conflicts with the protection of environment and landscape

Table 0-1. Poland Hydro Energy Profile.

Current status of small to medium hydro	
Installed capacity (small < 30 MW)	160 MW
Installed capacity (medium 30-100 MW)	630 MW
Projects under construction (small < 30 MW)	NA
Projects under construction (medium 30-100 MW)	NA
Supporting regulations?	<p>Yes: There are four legal documents stimulating development of renewable energy in Poland:</p> <ul style="list-style-type: none"> · Polish Energy Policy Foundations until 2020 issued by the Ministry of Economy, 2000 · Strategy of RES Development, Ministry of Environment, 1999 · Energy Law, 1997 · Decree on obligation of Purchase of Electricity produced from RES, Ministry of Economy, 2000
Industry association?	Yes. Society for Development of Small Hydro Power Plants
Hydro energy resource potential	
Level of information available	Fair
Country -level hydro atlas available?	No.
Estimated potential	43 PJ/yr 1,6 TWh//yr gross (theoretical) potential
Target established?	<p>Yes. 200-300 MW small hydro power plants.</p> <p>Official target for 2010 aims at 7.5 % of electricity from RES which is well below the EU target. The strategic objective is the increase of the share of energy from renewable sources in Poland's primary energy balance to 7.5% in 2010 and to 14% in 2020.</p> <p>According to reach the target of 7.5% of RES in the energy market, 200 MW 's of additional power will need to installed, leading into a Total annual production of electricity of 800 GWh in 2010. Total energy production from Small hydropower plants in Poland in 2010 will be 2880 TJ, presenting a share of 1.2 % in the energy produced.</p>
Identification of areas/projects with high potential for hydro energy	
Recommended strategic assessments	Economical Feasibility study on a wider use
Identified areas/projects	NA
Incentives/barriers for hydro energy	
Significant incentives	Environmental funds on all level of administration and ECOFUND for Renewable Sources
Significant barriers	<p>Inadequate economical mechanisms</p> <p>High investment costs</p> <p>Lack of access to technical and administrative information</p>

Overall Prospects

Good. Polish hydro power has chances for development as neither the big hydro power plants are fully used (due to antiquated equipment) nor small plants. Small hydro power plants are being developed by private investors who reconstruct the existing water sheds. Officials state that hydro power is the second most significant source for RES in the country and in the national plan measures /incentives are expected accordingly.

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