

Renewable Energy Country Profile Version 0.6b

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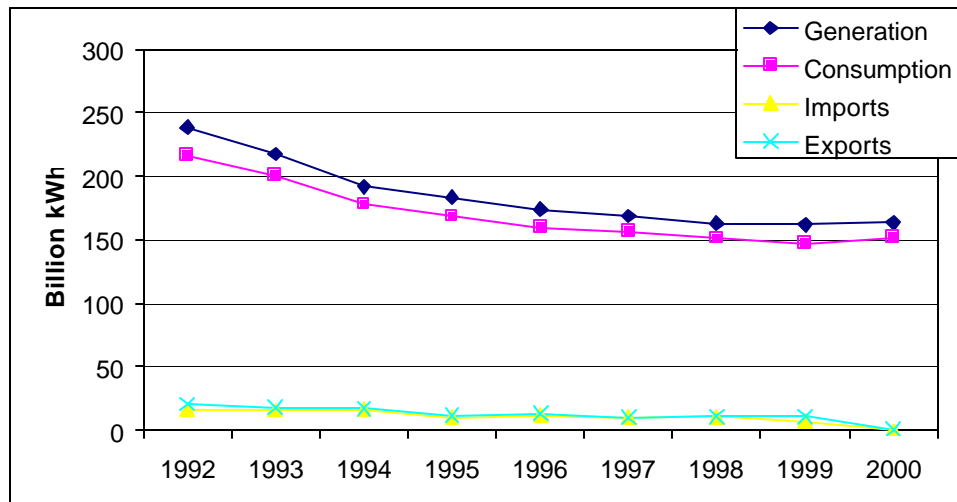
Interwind, Wind Energy Issues
Black & Veatch, Project Coordinator

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26.0 Ukraine

26.1 Overview of Electricity Supply

Fuel	Number of Facilities	Capacity (MWe)	Percent of Total
Nuclear	N/A	12,880	23.9%
Thermal	N/A	36,345	67.4%
Hydro	N/A	4,706	8.7%
Other Renewables	--	--	--
Total	N/A	53,931	100%



1.1.1 Wind Resources

Current Status of Wind Energy ¹

Early in 2002 Ukraine boasted 40 MW of installed wind power capacity, largest among the countries in this study.

This stands in contrast to the earlier studies which estimated a total capacity of to 40 MW at more than 10 sites of the Azov – Black Sea and Carpathian areas. The large Donuzlavskaya wind power plant and an experimental Ai-Petry one in the Crimea as well as Adjigolskaya wind power plant in the Nicolaev district were the main developments.

On March 2, 1996 the Ukraine President, Leonid Kuchma, issued a decree calling for the development of wind power plants. It was the first such decree in any former Soviet country and formed the basis for a national program of wind plant construction to 2010 and beyond.

A country wide wind-atlas is available, which indicates large areas wind speeds of 5-6 m/s at 30 m height and the area around Mariupol, with wind speeds more than 6 m/s.

No industry association was identified.

The company called Vetroen, or "The Wind", manufactures 250 kW turbines. Vetroen used to collaborate with the Ukrainian company Yzhnoe, before Yzhnoe before it developed its own 220 kW turbine. Vetroen has proposed several projects of 2-5 MW in different parts of Russia, including at Krasnodar and Komi, the latter expected to function as a test station for severe Arctic conditions. It is unclear what their status is now.

The leading manufacturer is WindEnergol Ltd. Their original design goes back to the units manufactured by now defunct US Wind Power (Kenetech). WindEnergol is negotiating with various CIS water ministry representatives in the hopes of selling turbines for water-pumping in the extensive canal systems of the Crimea and in the nation of Khazakhstan to the east. WindEnergol hopes the water pumping market is sizeable. Some 300 MW is currently used to power canals in the Crimea portion alone, which has a population of 3.5 million, notes the Ukrainian Water Irrigation Ministry.

With this manufacturing base Ukraine seems to be ready for advanced technology transfer and subsequent local manufacturing of most of their needs.

Several projects going back to early 90's were identified but their fate is unknown. It is likely that most of the long list of newer projects are revivals of the se.

Based on the available wind atlas Ukraine has a very good technical potential for wind energy development.

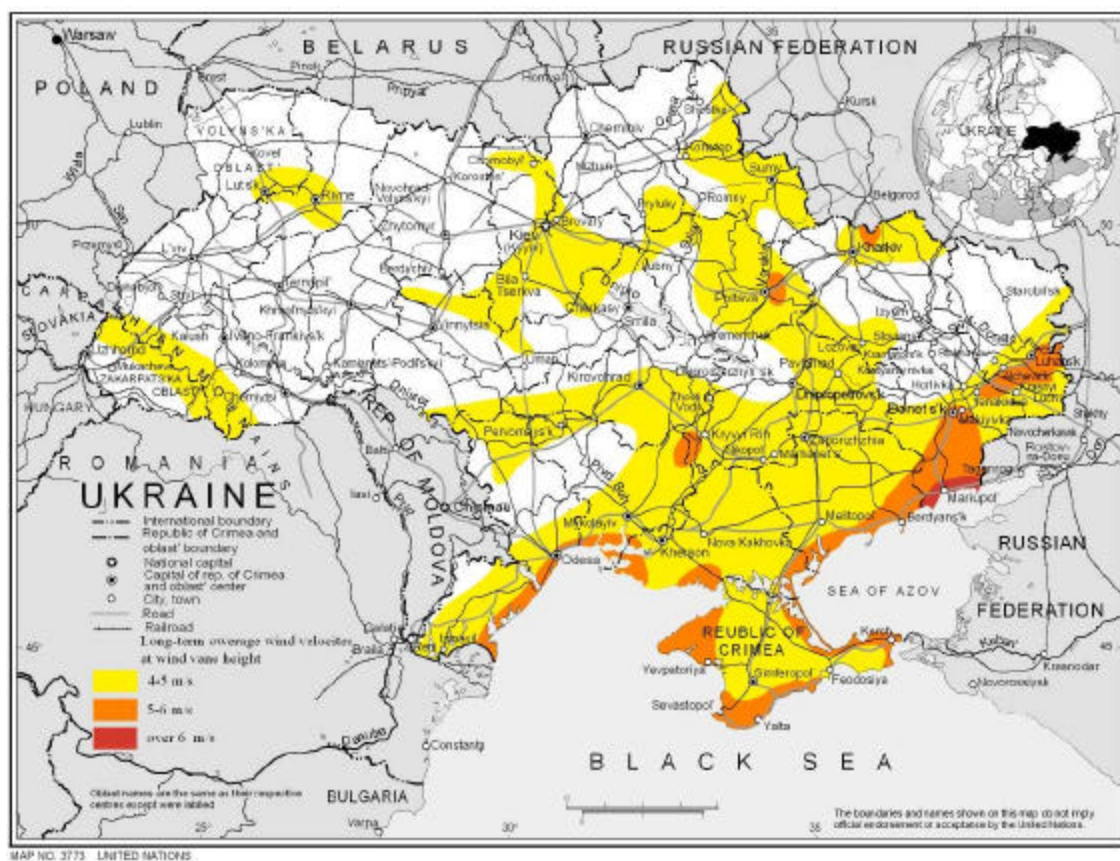
Wind Energy Resource Potential ^{2,3}

"Master Plan of Wind Power Development of the USSR till 2010", 1989 (MPWD) included a country-level wind map. The wind regime in the territory of the Ukraine is determined by the presence of mountains (the Carpathians, the Crimea) and the effect of the Black Sea and the Sea of Azov. The wind conditions are generally assessed as favorable for

wind power development – nearly in 40% of the territory the wind potential is suitable for development.

Identification of Areas/Projects with High Potential for Wind Energy ³

The most promising areas are found around the Azov Sea, around the Crimean peninsula and the southeast of the country along the Black Sea coast. Some inland locations, for example Poltava, may prove to have equally strong potential upon closer examination.



Wind atlas of Ukraine

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

Project Name and Location	Size (MW)	Description
Azov region		Coastal strip from the Perekop isthmus to the border with Russia. The highest density of wind potential – in the area of the town of Mariupol.
The Crimea		The eastern foothills of the Crimean mountains and Kerch peninsula. The western coast of the Crimea. Several points of the mountainous Crimea.
Near Black Sea region		A wide coastal strip from the Crimea to the border with Romania. The most high wind potential is concentrated in the South-East of Ukraine.
Other regions		Separate zones in the Donbass as well as near the town of Poltava and in the Carpathian mountains.
Chechen and Dagestan border		

Barriers/Incentives for Wind Energy

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

- Great interest in wind power development because of problems in fuel supply. The Authorities of the Crimea Autonomous Republic support the initiative of regional programs and investment projects.
- The legislative basis has been developed and the main regulatory documents has been elaborated on the Governmental level such as: “Electric energy tariffs for wind power stations”, “Financing the wind power developments”.
- There is a special regime of investment activities stipulating tax and customs privileges in the zones of locating the wind farms.
- Presidential Decree of 1996 to promote wind energy
- Established target of 200 MW by 2010
- Availability of a local industry

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

- Lack of low priced, long term capital
- Financial uncertainty
- Low domestic fuel and electricity prices
- Lack of information
- Corruption
- Lack of business expertise
- Weak legal institutions
- "Tremendous bureaucracy" (WindEnergO venture required 127 separate signatures for approval)

Table 1-3. Ukraine Wind Energy Profile.

Current status of wind energy	
Installed capacity	40 MW
Projects under construction	None
Supporting regulations?	Yes, Feed-In tariff, tax and customs privileges
Industry association?	No
Wind energy resource potential	
Level of information available	Very Good
Highest wind class	Class 6 (~550 W/m ²)
Country -level wind atlas available?	Yes
Estimated potential (PHARE Study)	100*10 ¹² kWh/y, gross (theoretical) potential 600*10 ⁹ kWh/y, technical potential 9*10 ⁹ kWh/y, economic potential
Estimated potential (Interwind)	5'000 MW
Target established?	Yes. 200 MW by 2010.
High wind speed locations	Eastern Crimea, Azov sea coast, 6.7-6.9m/s a.g.l. 20m Southwards Lugansk -Kishinev Line, 5.0m/s a.g.l. 20m Ivano-Frankovsk region (Pozhizhevskaya), 6.5m/s a.g.l. 20m Kharkov, 5.4m/s a.g.l. 20m Poltava, 5.3m/s a.g.l. 20m

Sumy, 5.1m/s a.g.l. 20m

Identification of areas/projects with high potential for wind energy

Recommended strategic assessments	Study 1 : an appraisal of legal and economical frame work Study 2 : an appraisal of country wide wind resources by state of the art measurements
Identified areas/projects	Early Projects (first half of 90's) with unknown status 500 MW, Donuzlavskaya, The Crimea, Soudak district 1.2 MW, Adjigolskaya, in Nikolaev district 0.8 MW, Ai-Petry pilot project, Crimea ~8 MW, WindEnergO, Crimea 15 MW, KrymEnergO, Near Kaliningrad on the eastern shore of the Baltic Sea <u>10-15 MW, US-based Alliance. In the Kaliningrad area</u> Newer Projects ? MW, Svitiazskaya, West Ukraine ? MW, Zapadnosivashskaya, Northern Crimea ? MW, Sudakovskaya, Eastern Crimea ? MW, Tchernomorskaya, Western Crimea ? MW, Sergeevskaya, Odessa region ? MW, Saksakaya, Western Crimea ? MW, Dzhankoyskaya, Northern Crimea ? MW, Akimovskaya, Zaporozhje region ? MW, Timofeevskaya, Kherson region ? MW, Tchaplinskaya, Kherson region 10 MW, Donuzlav

Incentives/barriers for wind energy

Significant incentives	<ul style="list-style-type: none"> • Presidential Decree to promote wind energy • Special feed-in tariff • Tax and customs privileges • Availability of skilled man -power and local manufacturing • Established Target
Significant barriers	<ul style="list-style-type: none"> • Lack of low priced, long term capital • Financial uncertainty and weak legal institutions • Low domestic fuel and electricity prices • Lack of information • Corruption - "Tremendous bureaucracy" • Lack of business expertise

Overall Prospects
Good

Although Ukraine has a lot for wind power, including proven resources and formal governmental support it will be difficult to mobilize foreign investment as long as the legal institutions are weak.

¹ Wind Power Monthly, various issues

² "Master Plan of Wind Power Development of the USSR till 2010"

³ Some aspects of wind energetics in Ukraine, Y. Zhabskiy, D. Resnitskiy, A. Pyrch, E. Trushkov. Joint stock company Vetroenergoprom.

5.25 Ukraine Renewable Energy Profile

5.25.3 Solar Resources

Current Status of Solar Energy

At present the using of solar energy is poorly developed at the Ukraine. The plants of solar hot water supply with using flat solar collector have some spreading. The production of solar collectors is carried out at six enterprises of Ukraine [1], however the volumes of production are small because of limited solvent demand.

Solar Energy Resource Potential

The solar energy resource potential for Ukraine is characterized by the maps of annual incidence of solar radiation on horizontal surface and direct solar radiation on a surface normal to beams, which are presented in Figs. 1 and 2. These maps are the part of corresponding maps compiled for the former USSR [2]. As follows from Figs.1 and 2 the Ukraine possesses solar energy potential that is satisfactory for using. On the whole the incidence of solar radiation on Ukraine territory is increased from Northwest to Southeast.

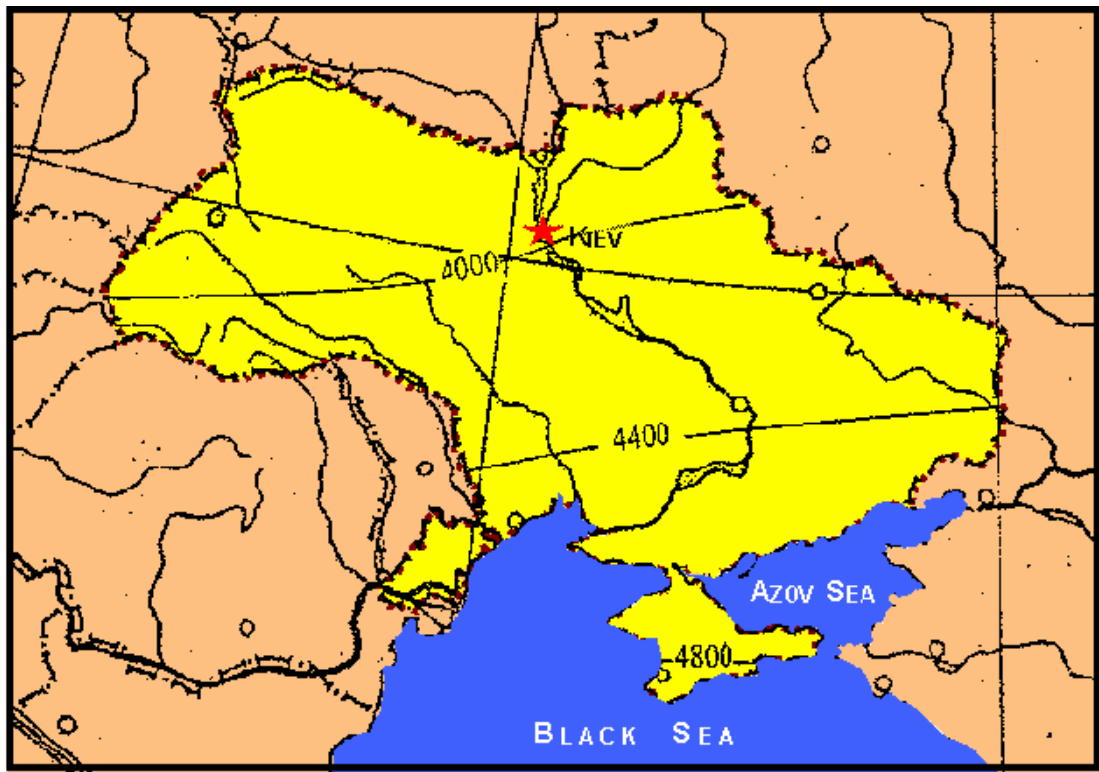


Fig.1 Annual incidence of total solar radiation on horizontal surface, MJ/m²

The change of incident solar radiation in a yearly cycle (the annual course of solar radiation) is shown in Tables 1 and 2 for three points: Borispol (near Kiev), Odessa and Yalta.

Table 1

Monthly and annual total solar radiation incident on horizontal surface, MJ/m²

Name of place	I	II	II	IY	Y	YI	YII	YII	IX	X	XI	XII	Yearly
Borispol	107	161	304	425	604	660	649	547	384	220	89	66	4216
Odessa	114	160	306	465	631	698	712	623	452	282	118	89	4650
Yalta	127	178	342	481	601	708	739	651	474	321	164	107	4862

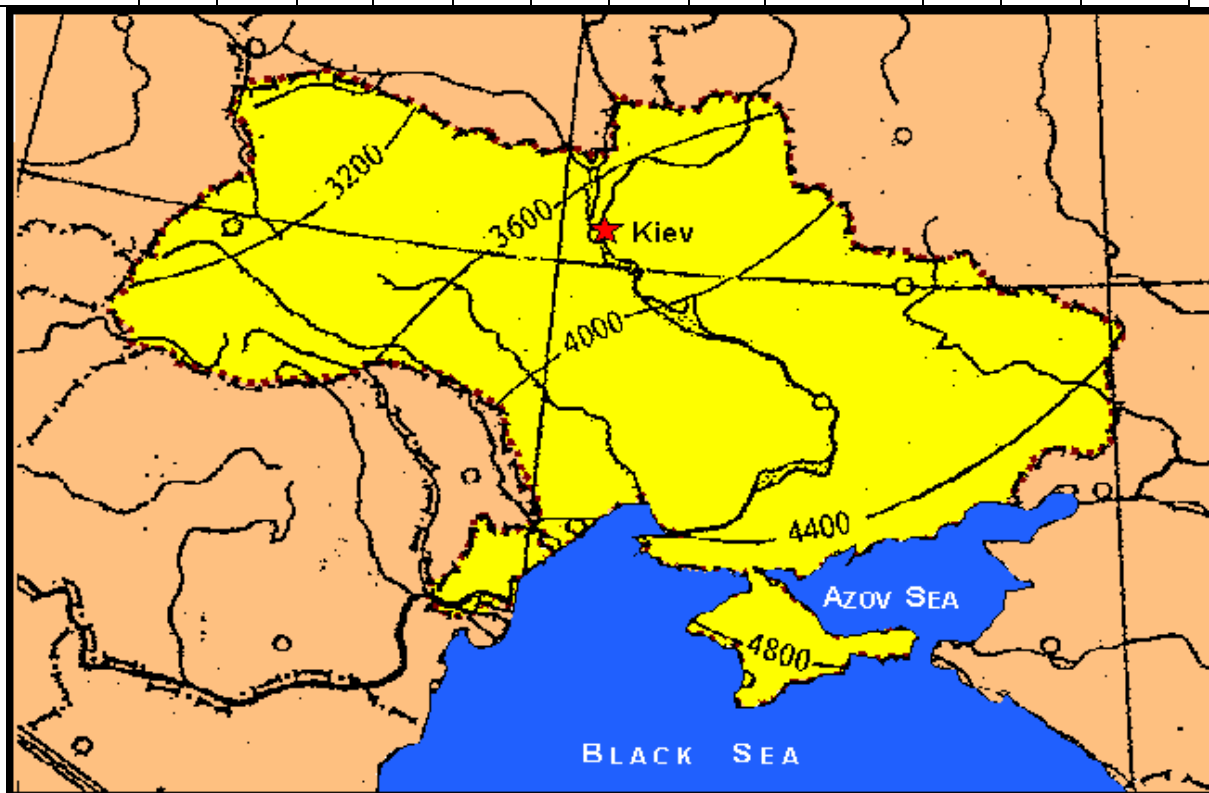


Fig.1 Annual incidence of direct solar radiation on the surface normal to beams, MJ/m²

Table 2

Monthly and annual direct solar radiation incident on surface normal to sunlight beams, MJ/m²

Name of place	I	II	II	IY	Y	YI	YII	YII	IX	X	XI	XII	Yearly
Borispol	119	143	249	332	478	547	499	472	380	232	94	65	3610
Odessa	95	153	281	428	591	663	725	656	572	323	137	103	4727
Yalta	163	179	304	415	500	650	709	649	524	407	219	147	4861

The data presented in Tables 1 and 2 were taken from [3] and are the averaged values in the period of observation for many years.

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

As it follows from the data presented in Figs.1 and 2 and Tables 1 and 2, the southern and southeast regions of Ukraine and especially Crimean peninsula possess the largest potential for

solar energy. In times of the former USSR Crimea was the all-Union test ground for using solar energy. In 1980s the solar steam-turbine power plant with capacity 5 MW and the large experimental complex of buildings with solar hot water supply, heating system and air-conditioning system in summer time as well as another objects with using solar energy were created in Crimea.

Crimea and especially its southern coast is the largest resort zone, for which the conservation of unique natural environment plays the most important meaning. Therefore the use of solar energy for generation of electricity and heat has in Crimea the largest prospects.

Barriers/Incentives for Solar Energy

The main barrier for using solar energy is an economic one. The Ukrainian economy being in a very weak state can't mobilize any considerable investments in some projects on using solar energy. At the same time there is a growth on the national level of understanding of the fact that under conditions of own resources shortage it is necessary to develop the alternative energy sources. The government of Ukraine developed and adopted "The program of state support for developing nontraditional and renewable energy sources and small hydro-thermal power engineering. The program foresees to carry the share of renewable energy sources in the fuel-energy balance of the country up to 10% by 2010 [4]. Along with it, the realization of this program requires the investments that meet the serious difficulties. A quite modest place is devoted in the mentioned program to solar energy. For the most part the increase of scales of using solar water-heating plants is foreseen.

Table 25-3. Ukraine Solar Energy Profile.

Current status of solar energy	
Installed capacity	Solar hot water supply plants with power about 5-8 MW (therm).
Projects under construction	Large projects are absent.
Supporting regulations	There is no legislation in the area of nontraditional energy.
Industry association?	There are 6 enterprises for producing flat solar collectors in Kiev, Odessa and Crimea with the total annual production no more than 0.8-1/0 thousand m ²
Solar energy resource potential	
Level of information available	Fair
High range of solar insolation	1.5 – 2.5 kWh/m ² /day [5] (worst month); up to 3.7 kWh/m ² /day (year average [3])
Country-level solar atlas available?	Yes, there is atlas of solar radiation as a part of solar atlas of the former USSR.
Target established?	No.
High solar insolation locations	Location 1 – peninsular Crimea and especially its southern coast Location 2 – southern regions – the coasts of Black Sea and Sea of Azov.
Identification of areas/projects with high potential for solar energy	
Recommended strategic assessments	Technical-and economic evaluation of competitiveness of solar energy in modern economic and ecological conditions
Identified areas/projects	Development of program and draft solutions on using the solar energy in resort zone on the Southern coast of Crimea for keeping the unique natural medium in this region.

Incentives/barriers for solar energy	
Significant incentives	Favorable climate. Shortage of own traditional energy resources. Existence of “Program of state support of development of nontraditional and renewable energy sources and small hydro- and thermal power plants”.
Significant barriers	Existence of scientific-technical potential Absence of inside investment sources for solar energy. Low tariffs for electricity and heat. Absence of legislation in the field of nontraditional energy.
Overall Prospects	Poor because of barriers pointed out in item 4.2

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5.25.4 Geothermal Resources

Current Status of Geothermal Energy

Ukraine has considerable geothermal resources that can be used mainly for heat supply. Also there are prospects of binary GeoPP creation based on existing wells at abandoned oil and gas fields [1]. At present thermal water is used for municipal heat supply and in agriculture in the western and central part of Crimea (Iljinka, 1 MWt; Sizovka, 1 MWt; Kotelnikovo, 2 MWt; Novo-Alexeyevka, 3 MWt; Yantarnoye, 5 MWt). Separate wells are used in the Transcarpathian region for supplying thermal water in swimming pools or as an additional source of heat for the local boiler houses. Total installed capacity of heat supply systems 13 MWt. It is intended to increase the volumes of using thermal water by 2005 up to 200 MWt, by 2010 up to 250 MWt according to the State program of using renewable energy sources. There are also the plans for creating by 2005 a 1.5 MWe pilot binary GeoPP using a low-boiling working fluid [2].

Geothermal Energy Resource Potential

There are three geothermal areas with the heightened geothermal gradient at the territory of Ukraine [2]. They have different geological-geothermic and hydrogeological conditions (see Fig.1).



Fig.1. Geothermal areas of Ukraine: I – Crimea peninsula, II – Transcarpathian region, III – Poltava and Kharkiv regions (background map source: Lonely Planet)

The geothermal resources *at Crimea peninsula* are presented by thermal waters of artesian basins located in the sedimentary rocks of foothills' depressions along the northern slope of Crimean Mountains. The average- and low-temperature water-bearing reservoirs containing comparatively low and average salt waters are disposed in the upper part of sedimentary basins at the depth up to 2 km, and the deepest parts of the basins contain geothermal brines with tem-

perature up to 200⁰C. Medium temperature (60-90⁰C) water-bearing layers that are easy of access for mastering are located in the western part of Crimea near Yevpatoria at a depth of 1.5-2 km. The theoretical potential of medium temperature water in Crimea is estimated as 63.5 MWt with free flow maintenance, more than 1000 MWt using downhole pumps, and is in some times higher with full reinjection. High-temperature reservoirs were discovered by some oil-prospecting wells and are poorly studied. The inflows of geothermal brines were obtained from some wells; the maximum temperature 158 ⁰C was recorded at a depth of 2.5 km.

In the Transcarpathian region geothermal reservoirs were found in the terrigenous and volcanic rocks of intermountain valleys and in the flat western region adjacent to Pannonian basin. Small inflows of mineralized water with temperature up to 90 ⁰C were obtained from a separate well with a depth of 1-2.5 km. The maximum temperature 210⁰C was recorded at a depth of 4050 m in the parametric well Zaluzhskaya-3; however the obtained inflow of geothermal brine was small. On the whole the study of thermal water in this region is insufficient for the reliable evaluation of resources.

Inflows of geothermal brines with temperature 125 – 168 ⁰C were obtained in the flat part of Ukraine (*Kharkiv and Poltava regions*) from many oil-prospecting and operating wells at a depth of 3-4.5 km. The further investigations of hydrogeological characteristics of thermal water-bearing stratum are necessary for the evaluation of possible utilization of these wells for extracting the thermal water.

Identification of Areas/Projects with High Potential for Geothermal Energy

There are good opportunities for geothermal development in Crimea, Transcarpathia and Kharkiv-Poltava regions of Ukraine. Table 1 lists areas and projects in Ukraine with high potential for geothermal energy development.

Table 1. Ukraine Areas/Projects with High Potential for Geothermal Energy.

Project Name and Location	Size (MW)	Description
Upgrading of geothermal heat supply systems nearby Yevpatoria (Crimea Peninsula)	60 MWth	Upgrading of existing geothermal heat supply systems by transition to the modern technologies (full reinjection, multi-stage use of thermal water)
Creation of pilot binary GeOPP in Poltava region	1.5 MWe	Creation of experimental binary power plant using abandoned oil-prospecting wells for the new technologies development

Barriers/Incentives for Geothermal Energy

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

- The shortage of own fuel-energy resources at Ukraine results in the necessity to import large volumes of expensive natural gas. These difficulties are redoubled in Crimea due to the insufficient capacity of existing transmission lines and gas pipelines.
- The reduction of annual CO₂ emissions by 132.5 thd. t by 2005 and by 171.4 thd. t by 2010 (associated with projected thermal waters use growth correspondingly up to 200 MWt and 250 MWt). The reduction of harmful influence on the local environment is especially important for such regions as Crimea and Transcarpathia, where the development of the health-resort and tourist business is promising.

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

- Absence of modern geothermal equipment produced in Ukraine and experience in the application of modern technologies
- Low tariffs for electricity and heat
- Absence of legislative measures encouraging development of geothermal resources
- Shortage of budget funds and absence of investors

Table 25-4. Ukraine Geothermal Energy Profile

Current status of geothermal energy	
Installed capacity (electric)	0
Installed capacity (thermal)	13 MWt Total
Projects under construction (electric)	0
Supporting regulations?	No
Industry association?	No
Geothermal energy resource potential	
Level of information available	Fair
Country geothermal atlas available?	Yes. Atlas of Thermal Water Resources of the USSR describes only theoretical (regional) resources.
Estimated potential (electric)	~50 MWe, gross (theoretical) potential 3 MWe, technical potential (based on proven resources) economic potential is not studied
Target established?	Yes. The State program of using renewable energy sources.
High enthalpy geothermal locations	Three abandoned oil fields containing hot geothermal brines in Kharkiv-Poltava regions
Identification of areas/projects with high potential for geothermal energy	
Recommended strategic assessments	Feasibility Study on Creation of Binary GeoPP in Kharkiv-Poltava regions
Identified areas/projects (electric)	1.5 MWe, Pilot Binary GeoPP, Kharkiv -Poltava region (location should be specified after feasibility study completion)
Incentives/barriers for geothermal	
Significant incentives	1. Shortage of own fuel-energy resources at Ukraine 2. Reduction of GHG emissions to atmosphere
Significant barriers	1. Low tariffs for electricity and heat 2. Shortage of budget funds and absence of investors
Overall Prospects	Fair in general. There are good opportunities for geothermal development in Crimea, Transcarpathia and Kharkiv -Poltava regions of Ukraine (upgrading of existing heat supply systems by transition to the modern technologies (full reinjection, multi-stage use of thermal water) and creation of binary GeoPP)

References

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5.25.5 Biomass Resources

Current Status of Biomass Energy

At present the utilization of renewable energy sources (excluding the large hydropower plants) constitutes less than 0.5% from the general consumption of primarily energy carriers. Now only a few modern boilers for burning wood are operating in Ukraine. In addition a considerable amount of boilers initially designed for combustion of coal and oil and then reequipped for wood combustion are operating in the forestry districts and at woodworking enterprises. Such boilers have, as a rule, the low efficiency and a high emission of pollutants in atmosphere. A few boilers that were converted for the combustion of sunflower seeds' husk are maintained at oil-extraction plants. The combustion of husk is an economically efficient technology, which is developed in Ukraine. Now there is only one straw-fired boiler with power 980 kW, there are no examples of mini-CHP plants using biomass; the large biogas plants for treatment of manure sewage and sewage of food industry as well as the gasifiers for biomass processing are absent in Ukraine.

Recently some demonstration projects in the area of biomass energy were fulfilled in Ukraine. The plants that were implemented within the frameworks of these projects are the first large-scale biomass energy equipment working in Ukraine. First of all, that is a project of technical assistance of Kingdom of Netherlands to Ukraine, within the frameworks of which two steam combustion wood boilers were installed: one with power 5 MW – at the enterprises of plywood “ODEK Ukraine” in city Orzhev (Rovno region), and the second one with 1.5 MW - in Malinsk district forestry's secondary technical school (Zhitomir region). The boilers were intended for combustion of wood chips, bark and sawdust with moisture content up to 60%.

The Danish-Ukrainian project of technical assistance was also successfully fulfilled. Within the frameworks of this project the boiler with power 980 kW was installed and commissioned in village Drozdi of Kiev region for burning the large straw bales.

Within the frameworks of a project of technical assistance of Kingdom of Netherlands to Ukraine the biogas plant is erected at the hog-raising farm for 15000 pigs in village Helenovka of Dnepr opetrovsk region. The plant has reactors with volume 2000 m³ for treatment of 80 t/day manure sewage using the biogas in the plants of combined production of heat and electricity with power 160 kW_e + 300 kW_{th}.

Overall Biomass Energy Resource Potential

Table shows the overall biomass resource data for Ukraine

Ukraine 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)	218,671,693 (2)	3,774 (2)
Top 10 primary crops		
Mixed Grasses, Legumes	78,900,000	1,362
Maize for Forage & Silage	52,583,333	908
Vegetables and Roots, Fodder	16,000,000	276
Potatoes	15,353,667	265
Wheat	15,026,100	259

Sugar Beets	14,250,667	246
Barley	7,817,867	135
Maize	2,961,633	51
Sunflower Seed	2,832,000	49
Forage Products (misc)	1,400,000	24
Animal units, number	(number)	(number / 1000 Ha)
Cattle	11,174,050	193
Poultry	113,500,000	1,959
Pigs	10,078,150	174
Equivalent animal units	16,340,310	282
Forest products, cubic meters	(avg 1999-2000, cu meters)	(cubic meters /1000 Ha)
Wood fuel and charcoal	1,775,000	31
Wood residues	930,000	16

A technical potential of straw accessible for obtaining energy makes up about 2.5 million toe.

According to data of 1999 the total amount of biogas, which could be obtained from manure of cattle, pigs and poultry constituted 2.2 billion m³ that was equivalent to about 1.6 million toe.

In 1999 the total volume of stored wood in Ukraine makes up 10.3 million clear m³. The normative residue of wood at felling areas constitutes 12%, i.e. the residues constituted 1.406 million clear m³ during the storing of above-mentioned volume of wood materials. When the timber in the round is first treated, the output of lumbers constitutes 65% from the total volume, and 35% are the waste. The waste of primary treatment of timber in the round, which is not used, can be considered as a potential for energy production. This potential constitutes 0.452 m³. Another source of wood wastes are the wastes at the woodworking factories with manufacturing of ready products. Accordingly to statistic data 1.108 million m³ of clear wastes (the wastes of primary processing of timber of the round plus the wastes of woodworking factories) were formed on the whole during the manufacturing of products in the woodworking industry of Ukraine in 1999. If the already estimated volume of wastes during the sawing of timber of the round (0.452 million clear m³) is subtracted from the total amount of wastes, we obtain the wastes at the woodworking factories with manufacturing of ready products as 0.656 million clear m³. In addition 3.853 million clear m³ were removed from forest as firewood. Thus the overall wood energy potential in Ukraine constituted in 1999 about 6.37 million clear m³ or 1.58 million toe.

Identification of Areas/Projects with High Technical Potential for Biomass Energy

The following technologies can be considered as most prospective in Ukraine for a commercial using in the nearest years:

- Industrial combustion wood boilers with power 0.1-5 MW for installation in forestry districts and at woodworking factories;
- Combustion wood district heating system stations with power 1-10 MW;
- Combustion straw farm boilers and boilers for small district heating systems with power 0.1-1 MW;
- Combustion straw district heating stations with power 1-10 MW;

- Biogas plants for the large farm cattle raising, pigstry and poultry plants and the enterprises of food industry.

The technologies of direct wood combustion and primarily for production of heat and process steam require the preferred development. It is connected with a rather low cost of electricity, which exists in Ukraine, and in the same time – with sufficiently high prices of fuel and heat. The introduction of mini-electric power stations and mini-CHP plants burning the solid biomass (wood, straw, hull) will be profitable in the case of considerable increase of electricity price or in the case of subsidizing. The obtaining of heat from biomass is economically profitable already now, even in the case of using the imported equipment. The Ukraine has as well the sufficient technical potential for beginning the own production of combustion wood and straw boilers.

The technologies of straw combustion are also very prospective for Ukraine. However the wide spreading of these technologies requires the solution of a series of problems such as the organization of collection, baling, transportation and storage of straw. First and foremost the best prospects for implementation at agricultural enterprises have the farm boilers and the boilers for small district heating systems with power 0.1-1 MW. After the demonstration of advantages of these boilers, the large district heating stations also have the good opportunities for commercialization.

The large biogas plants play also the important role in this concept. Their wide introduction is possible at pig farms (with amount more than 5 ths. pigs), poultry plants and enterprises of food industry. It is possible to construct in Ukraine about 3000 biogas plants with the average volume of methane tank 1000 m³ including 300 biogas plants at hog raising plants, 130 biogas plants – at poultry plants and 2500 biogas plants – at cattle-raising farms and enterprises of food industry.

Areas in Ukraine with high technical potential for biomass energy

1. Energy potential of straw after cereals (data for 1999)

Name of region	Amount of straw accessible for energy production, ths. t	Energy potential of straw accessible for energy production, million toe
Poltava	342.6	0.17
Vinnitsa	342.2	0.17
Dnepropetrovsk	304.4	0.15
Kharkiv	302.4	0.15
Cherkassy	282.2	0.14

2. Energy potential of manure (data for the beginning of 2000)

Name of region	Amount of biogas, which can be obtained, million m ³ /year	Energy potential of biogas, thousand toe
Kharkiv	140.5	101.4
Poltava	139.9	100.9
Kiev	136.2	99.0
Chernigiv	129.5	93.4

Vinnitsa	128.5	92.7
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3. Energy potential of wood (data for 1999)

Name of region	Amount of wood accessible for energy production, ths. t	Energy potential of wood accessible for energy production, thousand toe
Zhitomir	623.1	202.0
Chernigiv	425.6	138.0
Rovno	401.1	130.1
Kiev	381.9	123.8
Lviv	314.3	101.9

One project has been proposed by a private Ukrainian agribusiness Agro-Soyuz, located in Dnipropetrovsk: "Integrated Farm Energy and Feed Systems". In Ukraine, the 5,000 milking Holstein dairy operation is in the first stage of completion. Currently, 880 Holsteins are being milked. A state-of-the-art dairy barn for 2,500 milking cows will be completed by the end of 2002 and the additional 2,500 milking cow barn by 2004. Now in the process is selecting of an appropriate design for the anaerobic digester which will be required to handle 400 tons of dairy manure daily for processing into biogas which will supply the heat for the boiler in the ethanol facility. The manure, rather than being a problem will become a profit center. The final stage will be the construction of the ethanol facility for which it is intended to seek financing from an international financial institution.

Barriers/Incentives for Biomass Energy

There are in Ukraine a few *technological barriers* preventing to development of biomass energy. For today the mass production of combustion wood and straw boilers and biogas plants is absent. The imported equipment is also absent in the market of Ukraine. It should be noted that at the market there are the combustion wood domestic boilers with power 15-50 kW, mainly of foreign production, as well as the combustion wood boilers with power up to 200 kW. Maximum power of steam boilers, which are produced in Ukraine, makes up 10 t/h (6.5 MW) with pressure up to 13 bars.

At present the most spreading in Ukraine system of gathering in of straw is a collection of grinded down straw in haystacks, which are kept in fields. The technology of straw baling has yet not a wide spreading. It makes not profitable to transport the straw at long distances and prevents to create the large combustion straw stations as well as to spreading the boilers burning the straw in bales.

The large amount of hog raising plants in Ukraine is equipped with the systems of manure wash out. In this case the moisture content of manure (about 98%) substantially exceeds this content permissible for obtaining the positive economic effect from anaerobic fermentation of manure (88-90%). In these cases the implementation of biogas plants requires the reconstruction of existing system of manure wash off.

Economic barrier of development of biomass energy in Ukraine consists of absence of any economic incentives in forms of subsidizing, exemption from taxes etc. Even for the most profitable technologies (such as industrial combustion wood boilers or the plants for extraction and using of landfill gas), the financial incentives are necessary both for the producers and customers of equipment at least in the initial period of development and mastering of production.

Legislative barrier is connected with the absence of state policy with respect to biomass combustion, obtaining of biogas and other biomass energy technologies. Any laws stimulating the usage of timber and straw as a fuel are absent.

Ecological barrier is connected with a currently existing and rather “soft” ecological legislation that doesn’t allow to include the economic component in the economic effect from using biomass energy technologies. So, if the main effect from construction of biogas plants in the developed countries is considered as the main one, the biogas technologies in Ukraine should compete with other technologies only due to the energy effect and the effect from production the qualitative organic fertilizers.

In addition almost the full **information** vacuum on biomass energy technologies is typical for Ukraine that forms the information barrier on the way of biomass energy development. It is impossible to find in the Ukrainian libraries the periodic publications from the developed countries on these technologies. The Ukrainian specialists practically have no possibility to participate in the specialized foreign conferences and exhibitions.

Organizational barrier is determined by a coordinated policy in the field of developing biomass energy technologies in Ukraine and an absence of State organ, which could form this policy.

Administrative barrier can include the considerable problems, with which the independent producers of electricity are faced, when they sell this electricity in network.

Table 25-5. Ukraine Biomass Energy Profile.

Current status of biomass energy	
Installed capacity	Project, within the frameworks of which two combustion- wood steam boilers with power 5 MW were installed at the enterprise for production of plywood “ODEK of Ukraine” in city Orzhev (Rovno region) as well as the boiler with power 1,5 MW – in Malinsk state logging-lumbering school (Zhitomir region). Project, within the frameworks of which the boiler with power 980 kW for combustion of large straw bales was installed and commissioned in village Drozdi of Kiev regions. Project, within the frameworks of which the biogas plant with using biogas in CHP plant with power 160 kWe + 300 kWt is under construction at the hog raising farm in village Elenovka of Dnipropetrovsk region
Projects under construction	No data.
Supporting regulations?	No
Industry association?	Yes
	Scientific-technical center "Biomass"
Biomass energy resource potential	
Level of information available	Good
Relative biomass potential (total / density)	Total: 41%; Density: 61%
Country-level biomass investigations available?	Yes

Estimated potential	<p>Technical potential of straw that is accessible for energy production constitutes about 1.8 million toe.</p> <p>Overall amount of biogas, which can be obtained from the manure of cattle, pigs and poultry, constitutes 2,2 billion m³ that is equivalent to more than 1,1 million toe.</p> <p>Overall energy timber potential in Ukraine is equal to about 6,37 million clear m³ or about 1,1 million toe</p>
Target established?	Yes
High density biomass areas	There are no data on the concrete territories
Identification of areas/projects with high potential for biomass energy	
Recommended strategic assessments	<p>Study 1 Preparation of Feasibility Studied for investment projects</p> <p>Study 2 Realization of investment projects</p>
Identified areas/projects	'Integrated Farm Energy and Feed Systems'
Incentives/barriers for biomass energy	
Significant incentives	<p>The restricted reserves of organic fuel.</p> <p>Considerable volumes of agricultural wastes</p>
Significant barriers	<ol style="list-style-type: none"> 1. Absence of Federal and regional legislation on using nontraditional energy in economy and everyday life as well as of laws regulating the relationships between centralized energy production and local nontraditional energy. 2. Absence at market of wide assortment of reliable and accessible power plants using the nontraditional renewable energy sources and of the network of mounting and servicing stations.
Overall Prospects	Good

References

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Renewable Energy Profile (draft)

REPUBLIC OF UKRAINE

HYDRO POWER POTENTIAL FOR DEVELOPMENT OF SMALL AND MEDIUM SIZE HYDRO

According to the adopted classification, small HPPs are of capacity up to 30 MW, medium-size HPPs are of capacity up to 100 MW.

1. Current State of Hydro Power

Average annual hydropower generation in Ukraine amounts to 10.7 billion kWh, meeting 7% of the power system demand in electricity.

Hydro installed capacity totals 4.4 million kWh. At present 235MW Kiev PSP is operating.

Existing Hydro Power Plants in Ukraine

Hydro power plants	Installed capacity, MW	Share of HPPs in hydro power, %
Large HPPs:		97
Dnieper	1538	
Dniester	702	
Kremenchug	625	
Kanev	440	
Kiev	361	
Dneprodzerzhynsk	352	
Kakhovka	351	
Small HPPs	14	3

2. Hydro Power Resources of Ukraine

By potential hydro resources Ukraine is not on the leading place among the CIS countries, but the extent of developed hydropower economical potential is rather high.

Hydro Power Resources of Ukraine

Characteristics	Indices		Share of HPPs, % from the total
	Total	Including small HPPs of capacity up to 30 MW	
Gross theoretical hydropower potential, - Billion kWh/year - concentration of power resources on the territory, thou.kWh/km ²	44.7 73.4	18.3	41
Technically feasible hydropower capability, Billion kWh/year	22	5.7	26
Economically feasible hydropower capability, Billion kWh/year	17	Not determined	
Power generated by existing HPPs, - Billion kWh/year - per cent of economic potential, %	10.8 63	0.20	2

Major part of hydro resources (including small HPPs) is concentrated in the Central and Western Ukraine on the Dnieper, Dniester, Yuzhny Bug and Tisa Rivers. The Dnieper river basin is the most developed.

3. Plans for Development of Hydropower Potential

The main trends of further development of power sector with the leading role of hydro are stated in the National Power Program of Ukraine.

First Priority Potential Hydro Power Projects

Projects	Installed capacity, MW	Location
New construction Cascade of 5 HPPs on the Tisa River	220 (3x40+2x50)	Ukrainian stretch of the Tisa River, Transcarpathian obl.

Programs of small hydropower development in Ukraine include reconstruction and renovation of previously constructed small HPPs, adding small HPPs to water management projects with already existing water-retaining structures with the aim of utilizing waste releases.

Proposed Program of Small Hydro Development

Type of construction	Quantity	Installed capacity, MW	Average overyear power output, Million kWh	Note	Region
Reconstruction	51	94	380	HPPs of capacity within 0.2-27 MW commissioned in 50-60s last century	Spread on the whole territory of Ukraine
Rehabilitation of previously constructed HPPs	74	19	70	HPPs of capacity within 0.05-0.9MW commissioned in 50-60s last century	
Adding to water management projects	38	280	1250	Small HPPs of capacity within 0.5-7 MW	Dnieper and Dniester River basins
Total	163	393	1700		

First Priority Potential Small Hydro Power Projects

Projects	Installed capacity, MW/No. of units	Location
Reconstruction of existing small HPPs	10/16	
New construction of small HPPs	30/4	Tisa River, Transcarpathian oblast

4. Unfavorable Factors for Development of Hydro Potential

- permanent deficit of energy sources;
- lack of investments

5. Favorable Factors for Development of Hydro Potential

- National Power Program of Ukraine supported by state financing

Bibliography

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3. Periodicals: Hydraulic Construction, Power Stations, etc

Zones of location of planned small HPSs

