

# Ukraine

## Country Profile

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### *1. Overview of Electricity Supply*

Ukraine is an emerging market economy at the crossroads of Eastern Europe, Russia, Central Asia, and the Middle East and holds great potential as a new market for trade and investment. Ukraine's resources and economic strengths include very rich agricultural land, strong scientific establishment, educated and skilled workforce, and significant coal and moderate oil and gas reserves. Ukraine has achieved significant progress in opening its market to exports and investment. However, prerequisites for sustained economic growth, such as improvements in rule of law and corporate governance, remain incomplete. Until these basic weaknesses are corrected, and an independent judiciary is established to support and protect them, Ukraine's economic development is likely to lag behind its eastern European neighbors and be unable to attract the volume of foreign or domestic investment that the country needs to raise living standards.

Two overarching themes in the Ukrainian energy sector are obsolete infrastructure and systemic debts. Aging, Soviet-designed power plants and corroding pipelines contribute to inefficiencies throughout the energy system, as well as increased production and transportation costs. All this considered, there is considerable overcapacity in the Ukrainian electricity sector, meaning no investment in new plants is necessary to ensure demand is met. While power shortages do occur during periods of peak demand, this is not due to lack of generating capacity, but rather fuel shortages, mismanagement, and poor maintenance of existing equipment.

A majority of the energy sector of Ukraine is still state-owned. As of 2006, the state owned 100 percent of the oil and gas transportation sector, electricity transmission, and district heating networks. The state also owned about 90 percent of the oil and gas production, electricity generation and coal production in 2006. Ukraine's energy sector is in urgent need

of capital investment, and private companies have the advantage of being able to raise financing on capital markets (IEA, 2006).

Foreign investors have been actively courted, and supporting legislation has been upgraded several times. Registered foreign investors are, in principle, guaranteed equal treatment with local companies. However, the Ukrainian courts' lack of true independence makes investors vulnerable to being ousted if they are investing in a strategic sector or company in which someone else more powerful is interested. This is especially true of the energy sector and other areas dependent on government relations or in which well-connected Ukrainian or Russian investors have a strong interest. Investors setting up in greenfield or niche areas are much less likely to have problems in this respect. There have been numerous examples of successful investment projects in Ukraine, but the uncertain political environment is likely to deter many others unless there are clear signs of a change. Signs of change include making significant improvements to fight corruption, develop capital markets, and improve the legislative framework (CIA, 2008).

Ukrainian dependence on Russian imports and lack of significant structural reform has made the country very vulnerable to external shock. Ukraine depends on imports for about 75 percent of their annual oil and gas requirements. In January 2006 Russia doubled the price Ukraine pays for Russian gas; disputes with Russia have caused periodic gas-cuts (CIA, 2008).

The use of renewable energy in Ukraine was one of the principal goals of the 1996 National Power Energy Program. As of 2005 Ukraine has about 9 percent of renewable generating capacity with a majority of the capacity coming from hydropower (EIA, 2005). The National Power Energy Program called for completion of new hydropower utilities—such as the Dnistrovska hydro pumping storage station—to reduce dependence on imported energy sources. At present the use of renewable energy in Ukraine (excluding large hydropower) is less than 0.5 percent of the total primary energy demand.

The Ukrainian parliament passed a bill in July 2001 that aims to develop alternative energy sources such as solar and geothermal. Additionally, through the Wind Power Development Project, Ukraine seeks to establish wind power as a significant source of electricity generation by 2020.

<b>Demographical Information</b>	
Population, millions (2009)	45.7
Land area, thousand sq km (2009)	603.7
<b>Macroeconomic Information (2008)</b>	
GDP, billion US\$	337
Real GDP growth rate, percent	2.1
Foreign direct investment (net), million US\$ (2007)	9,218
<b>Electricity disposition, billion kWh (2006)</b>	
Generation	182.41
Consumption	148.09
Exports	12.52
Imports	2.08
<b>Generation capacity, GW (2005)</b>	
Nuclear	13.84
Thermal	34.92
Hydro	4.72
Other renewables	0.08
<b>Total</b>	<b>53.55</b>
<i>Sources: CIA World Factbook, U.S. Energy Information Administration, United Nations Conference on Trade and Development.</i>	

**Ukraine Country Summary Table**

The Ukrainian electricity transmission network needs substantial rehabilitation and upgrading due to a lack of investment over the years as well as an increase in demand patterns. The current network exhibits high technical losses and poor quality of power supply. The network as it stands is inconvenient, costly and potentially dangerous to customers. Improvements to the grid in southern Ukraine are planned and are being funded by EBRD (Mercados, 2009). The electricity market in Ukraine can be seen on the map below.

**Electricity Market in Ukraine**  
(Source: Centrenergy)



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## 2. Energy Policy, Barriers and Incentives

The Ministry of Fuel and Energy is the key administrative body for Ukraine's energy sector. It develops the energy sector's strategy and regulatory framework. The Ministry also has authority over the state-owned companies, Naftogaz of Ukraine and Energy Company of Ukraine and thus controls major assets in the oil, gas, electricity and district heating sectors. It also helps develop proposals that align Ukrainian legislation with EU directives.

The Ministry was founded by a presidential decree in April 2000 by merging the Ministry of Coal Industry, the Ministry of Energy, the State Committee for the Power Industry, the State Committee for Oil, Gas and Oil-refining Industries, and the State Committee for Nuclear Power.

Some Laws on renewable energy systems have been recently developed and accepted in Ukraine:

- Law of Ukraine "On power energy" (1997) was amended in 2000. The law envisages government subsidies for the construction of wind power plants. Further preferential tariffs for electricity generated at WPP are set.
- The Law of Ukraine "On alternative sources of energy" was passed in February 2003. The law provides the framework for defining the legislative, economic, ecological and organizational basis for the utilization and promotion of alternative sources of energy. No financial stimuli or other support mechanisms for the utilization of RES are mentioned.
- The Law of Ukraine "On combined heat and power production (co-generation) and utilization of dump energy potential" was passed in 2005. According to the Law, owners of CHP plants (independently of plant capacity) have unhampered access to local power grids and can sell produced power to individual consumers by contracts. Owners of qualified CHP plants have right to sell produced power to Wholesale Power Market of Ukraine and to consumers over all territory of Ukraine by direct contracts. Tariffs are set by the National Commission for Regulation of Power Industry of Ukraine.

The "Energy Strategy of Ukraine till 2030" was issued by decree in March 2006. The key policy objectives of the strategy include reducing import dependence and improving efficiency. The Strategy discusses the importance of pursuing renewable energy resources to help decrease their dependence on imported fuels (IEA, 2006).

In September 2008, the Ukrainian Parliament adopted a law on green tariffs, "On Amendments to Certain Laws of Ukraine Concerning the Introduction of a Green Tariff." The green tariff includes wind power, hydropower, biomass, biogas, and several methane capturing power producing activities. The National Electricity Regulatory Commission of Ukraine will approximately double the prices that energy producers in these sectors could normally charge for the next ten years (Fedorova, 2009).

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### 3. Wind

A great number of areas offering good wind power potential exist in Ukraine. The greatest wind energy potential is located in the vast areas adjacent to the Black Sea and the Azov Sea, as well as the Carpathian, Transcarpathian and Lower Carpathian areas. Additionally, there are areas with elevated wind potentials in the Donbass terrain and Dnepropetrovsk Region. If all of these areas were brought on-line, wind farms can account for 20 percent to 30 percent of Ukraine's demand for electric power.

The total installed capacity of Ukrainian wind farms is approximately 89 MW (UDI, 2009). Most of the installed capacity consists of old model turbines that have a capacity of 107.5 kW. Since 2003, the Turbowinds 600 kW turbines, built in Belgium, have been assembled in Ukraine, with the towers and blades manufactured locally (UWEA, 2008).

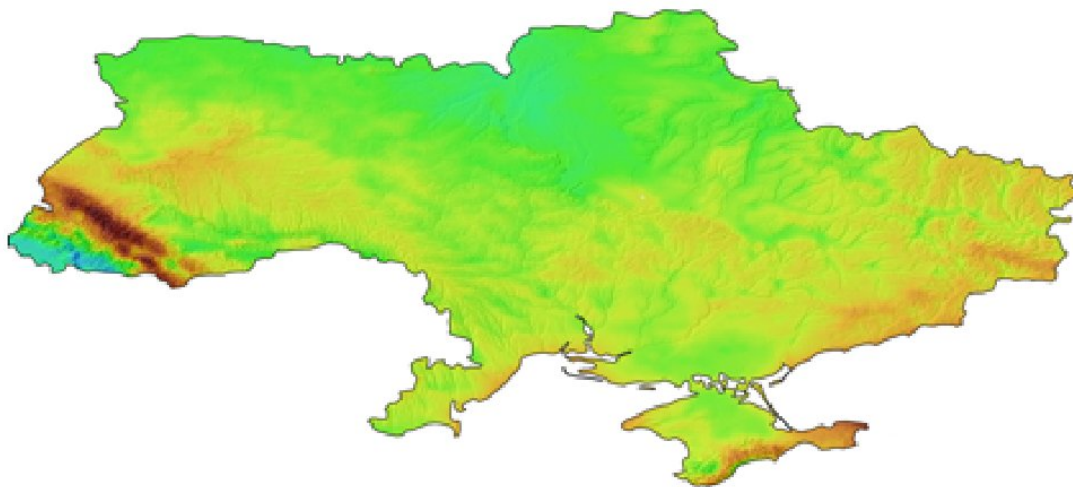
Ukraine's wind program is governed by the "Complex Program for Wind Farms Construction," which was adopted by the Ukrainian government in 1997. According to the program, 1,990 MW of wind capacity is to be installed by 2010, and by 2030, 20-30 percent of the country's electricity production is to be produced by wind power (UWEA, 2008). However, as of June 2009, only 300 MW of capacity have been planned (UDI, 2009).

The wind capacity has been postponed due to a lack of financing. The wind program was to be financed with a 0.75% tariff on electricity rates, but the non-payments and debts in the energy sector prohibited the program from being fully financed. In 2006, the government approved a fixed annual budget; however, this change has not had any significant influence on recent wind projects (UWEA, 2008).

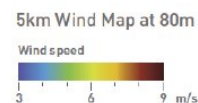
The following figure displays the wind velocities at a height of 80 m throughout Ukraine. As shown, the most significant resource is in the southeastern and southwestern regions of the country.

**Ukraine Wind Resource Map (Source: 3Tier)**

## Ukraine Wind Map at 80m



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## 4. Biomass

Ukraine currently gets under one half of one percent of its energy from biomass resources and biofuels; however, it is estimated that Ukraine could produce more than ten times its current level. The government is committed to focusing on biomass as a renewable energy. In fact, a number of biofuel facilities and stations that sell biofuels have been established in the country in the past few years (Austin, 2008).

The total potential for biomass was estimated at 86,300 GWh per year in 2003. A majority of the potential came from cereal crops straw (wheat, barley, oat, etc.) at 29,500 GWh annually.

Approximately 12,800 GWh per year came from animal manure, and another 29,500 GWh per year came from wood wastes (Geletukha, 2006).

There are a few modern wood-fired boilers in operation in Ukraine. A number of boilers originally designed for coal and oil combustion have also been converted for wood combustion. As a rule these boilers have fixed grates, batch fuel loading, low efficiency, and high emission. There is also one 980 kW straw-fired boiler in operation.

Cost levels of liquid fuels produced from biomass could end up around 6 Euro/GJ, which is about competitive with production costs of diesel and gasoline from mineral oil. The amount that could be produced would surpass the national demand for transport fuels and would allow for significant exports. Given the growing demand for biofuels in particular in the EU, biofuels could prove an extremely valuable export commodity for the Ukraine. In the longer term, after 2015-2020, introduction of state-of-the-art agricultural techniques could increase this potential further. Specific opportunities may emerge from the Chernobyl Exclusion Zone, covering over 4 million hectares of land, which may be restored again by introducing short rotation coppice crops to remove radioactive elements from the soil.

In addition, Ukrainian industry is capable of producing many of the required components for advanced conversion technology such as biomass gasification-Fischer-Tropsch plants (pretreatment, gas cleaning equipment, combined cycle technology, etc.), which may allow for lower capital costs than observed in Western European countries.

<b>Biomass resource type</b>	<b>Total production</b>	<b>Production density</b>
<b>Total land area covered by</b>	(avg. 2006–2007, km <sup>2</sup> )	(avg. 2006–2007, %)
Arable Land	324,400	54
Permanent Crops	8,990	1
Permanent Meadows and Pastures	79,360	13
Forest Area	95,945	16
Other Land	70,650	12
Inland Water	24,205	4
<b>Primary crop production</b>	(avg. 2006–2007, tonne)	(tonne / 100 km <sup>2</sup> )
Total primary crops (rank among COO)	86,712,920 (26)	14,366 (25)
<b>Top 10 primary crops</b>		
Sugar beet	19,699,350	3,254
Potatoes	19,284,800	3,195
Wheat	13,873,650	2,298
Barley	8,670,660	1,436
Maize	6,562,800	1,087
Sunflower seed	4,749,000	787
Tomatoes	1,635,500	271
Cabbages and other brassicas	1,395,300	231
Vegetables fresh nes	1,259,900	209
Soybeans	862,800	143
<b>Animal units, number</b>	(avg. 2006–2007, number)	(number / 100 km <sup>2</sup> )
Cattle	6,344,750	1,051
Poultry	16,397,500	27,166
Pigs	7,553,900	1,251
Equivalent animal units	11,006,060	1,823
<b>Annual roundwood production</b>	(2006–2007, m <sup>3</sup> )	(m <sup>3</sup> / 100 km <sup>2</sup> )
Total	16,366,450	2,711
Fuel	9,230,900	1,529
Industrial	7,135,550	1,182
Wood-based panels	1,852,000	307
	(2006–2007, tonne)	(tonne / 100 km <sup>2</sup> )
Paper and paperboard	870,501	144
Recovered paper	339,000	56

*Source: Food and Agriculture Organization of the United Nations*

### **Ukraine Biomass Resource Data**

The technology of straw combustion is a very strong opportunity in Ukraine. However, increased use of the technology requires a solution to a series of problems such as the organization of collection, baling, transportation and storage of straw. First and foremost, the best prospect for implementing at agricultural enterprises has been farm boilers and the boilers for small district heating systems with power 0.1-1 MW. After the demonstration of advantages of these boilers, large district heating stations also have opportunities for commercialization.

The large biogas plants play an important role in this concept. Their introduction is possible at pig farms (with amount more than 5 thousand pigs), poultry plants and enterprises of food

industry. It is possible to construct in Ukraine about 3,000 biogas plants with the average volume of methane tank 1,000 m<sup>3</sup> including 300 biogas plants at hog raising plants, 130 biogas plants at poultry plants and 2,500 biogas plants at cattle-raising farms and enterprises of food industry.

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## 5. Solar

Solar radiation in Ukraine is of middling intensity. The average amount of solar energy received annually in Ukraine is about 1,200 kWh/m<sup>2</sup> (4300 MJ/m<sup>2</sup>). Even so, the current use of solar energy in Ukraine is minimal.

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 figures below. The incidence of solar radiation is lowest in the northwestern region of the country and highest in the southeast. The monthly and total yearly solar radiation is shown in tables below for three locations: Borispol (near Kiev), Odessa, and Yalta.

	Borispol	Odessa	Yalta
<b>Jan</b>	107	114	127
<b>Feb</b>	161	160	178
<b>Mar</b>	304	306	342
<b>Apr</b>	425	465	481
<b>May</b>	604	631	601
<b>Jun</b>	660	698	708
<b>Jul</b>	649	712	739
<b>Aug</b>	547	623	651
<b>Sep</b>	384	452	474
<b>Oct</b>	220	282	321
<b>Nov</b>	89	118	164
<b>Dec</b>	66	89	107
<b>Yearly</b>	4216	4650	4862

**Monthly and annual total solar radiation incident on horizontal surface, MJ/m<sup>2</sup>**

	Borispol	Odessa	Yalta
<b>Jan</b>	119	95	163
<b>Feb</b>	143	153	179
<b>Mar</b>	249	281	304
<b>Apr</b>	332	428	415
<b>May</b>	478	591	500
<b>Jun</b>	547	663	650
<b>Jul</b>	499	725	709
<b>Aug</b>	472	656	649
<b>Sep</b>	380	572	524
<b>Oct</b>	232	323	407
<b>Nov</b>	94	137	219
<b>Dec</b>	65	103	147
<b>Yearly</b>	3610	4727	4861

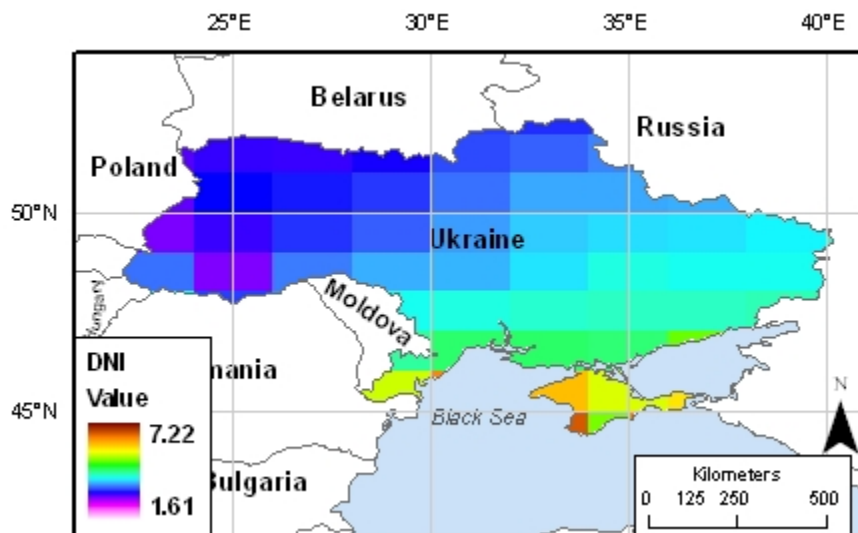
**Monthly and annual direct solar radiation incident on surface normal to sunlight beams, MJ/m<sup>2</sup>**

As the data shows, the southern and southeast regions of Ukraine, especially Crimea, possess the largest potential for solar energy. In times of the former USSR, Crimea was the all-Union test ground for solar energy. In the 1980s several projects were created in Crimea, including a solar steam-turbine power plant with a 5 MW capacity, and a large experimental complex of buildings with solar hot water and a heating and air-conditioning system.

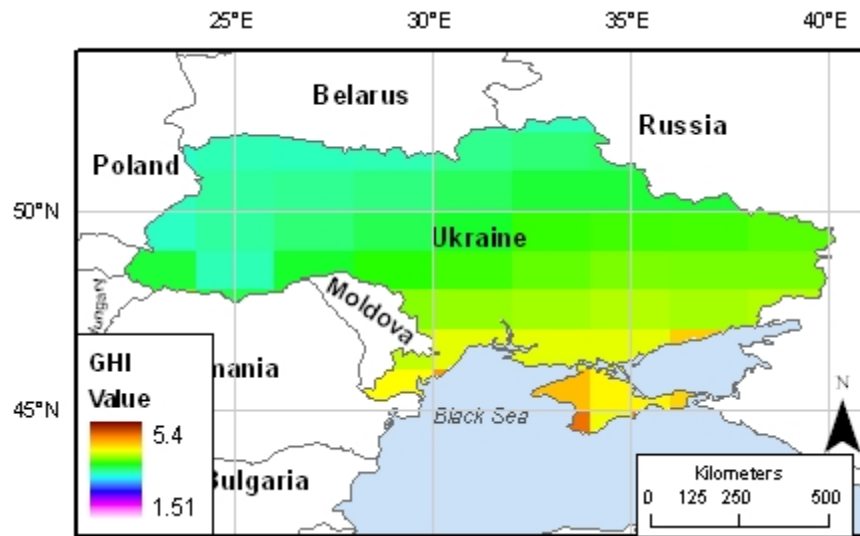
Additionally, Crimea—especially its southern coast—is the largest resort zone in Ukraine, and the conservation of the unique natural environment is important. Therefore the use of solar energy for generation of electricity and heat has in Crimea the largest prospects in the country.

The following figures display the direct normal insolation and global horizontal irradiation values for Ukraine. As previously mentioned, Crimea has the most significant solar potential.

**Ukraine Solar Direct Normal Insolation (Source: NASA)**



### Ukraine Solar Global Horizontal Irradiance (Source: NASA)



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## 6. Geothermal

Ukraine has considerable geothermal resources that can be used mainly for heat supply. There are also prospects for binary geothermal power plant creation based on existing wells at abandoned oil and gas fields. At present thermal water is used for municipal heat supply and in agriculture in the western and central part of Crimea. Separate wells are used in the Transcarpathian region to supply thermal water in swimming pools or as an additional source of heat for the local boiler houses. The total thermal installed capacity of Ukraine is 10.9 MWt, which generates 119 TJ of energy per year. Currently, the geothermal energy is supplied to nine different systems. Two of the systems are associated with power plant co-generation producing 0.16 MWe and 1.8 MWe. The heat flux of Ukraine can be seen in the figure below.

### Heat Flux ( $\text{mW}/\text{m}^2$ ) of Ukraine (Source: Energie-Atlas GmbH)



There are three geothermal areas with the heightened geothermal gradient at the territory of Ukraine. They have different geological-geothermic and hydro geological conditions.

The geothermal resources in Crimea are represented by thermal waters of artesian basins located in the sedimentary rocks of foothills' depressions along the northern slope of the 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 temperature up to 200 °C. Medium temperature (60-90 °C) water-bearing layers that are easy to access 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 at 63.5 MWt with free flow maintenance, more than 1000 MWt using down hole pumps, and possibly 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 °C 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 the Pannonian basin. Small inflows of mineralized water with temperatures up to 90 °C were obtained from a separate well with a depth of 1-2.5 km. The maximum temperature 210 °C 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 °C 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.

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## 7. Hydroelectric

The average annual hydropower production in Ukraine is around 10.2 billion kWh (EIA, 2007). The estimated total potential of the Ukrainian hydropower generation is close to 20 billion kWh of electricity per year. For small hydro alone, the estimated potential is about 2,500 million kWh of which only 170 million kWh is currently being utilized (Winkler, 2009).

Ukraine has a current operating capacity of approximately 4,880 MW. About 3,170 MW of capacity has been delayed after construction, and another 675 MW is planned (UDI, 2009).

Major equipment of many of the hydroelectric power plants (HPPs) has been operating for about 40 years and needs upgrading. Construction of the Dniester and Tashlytsky hydro power complexes has been delayed due to shortage of finance and the negative attitude of local authorities. The Dniester was delayed after the start of construction, while the Tashlytsky was delayed before the start of construction (UDI, 2009).

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

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.

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## 8. Relevant Links

Please see webpage for relevant links.

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## ***10. Country Contacts***

Contacts made in the preparation of this assessment are gratefully thanked for their contribution to this report. Please see webpage for contacts listing.

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