

# Kazakhstan

## Country Profile

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### 1. Overview of Electricity Supply

Kazakhstan's total installed power-generating capacity is 18.7 gigawatts (GW), although actual capacity is substantially less due to poor maintenance and obsolete equipment. In 2006, Kazakh power generation was approximately 74.9 billion kilowatt-hours.

Around 85 percent of the country's power generation comes from coal-fired plants, mostly concentrated in the north of the country close to the coal-producing regions of Karaganda and Ekibastuz. The remainder is generated by hydroelectric plants, mainly on the Irtysh river in the north-eastern part of the country. In Kazakhstan, the centralization process during the 1980s led to the closure of more than 600 small hydro power plants.

Significant generation capacity exists in Kazakhstan. However, deterioration of the system throughout the 90's owing to a lack of economic growth and a lack of consistent maintenance has left the actual output far below the potential for the electric system.

Through the decline in demand throughout the 1990's the generation capacity was able to meet demand, at least in the latter part of the decade. However, the current structure of the electricity grid requires that Kazakhstan import power in some regions, while exporting in others. The electricity grid is divided into a northern half, linking the Russian and Central Asian Networks, and a southern half, with links to Kyrgyzstan and Uzbekistan.

In order to link the northern and southern grids, the World Bank began the North-South Electricity Transmission Project in 2005. The project will ensure businesses and households have adequate access to reliable and cost effective electricity. A 475 km 500 kV single circuit overhead line from the Ekibastuz substation to the Agadyr substation including a fiber optics cable will be constructed. The Ekibastuz and Agadyr substation are also being expanded (World Bank, 2005).

Kazakhstan has large reserves of exploitable coal, oil, and gas, and it therefore is expected that the energy sector will play a significant role in the economic development of the country. The size of Kazakhstan and its geography (the country is divided into north and south by a central desert region), together with the concentration of coal deposits in the north, means that the country must make large investments in its transmission systems, which is the source of high losses and low reliability. The power sector needs considerable rehabilitation and serious upgrading if the country is to decrease its heavy reliance on electricity imports.

The main motivating factors for renewable energy development in Kazakhstan include the need to:

- replace imports of electricity, especially in the southern region
- extend access to electricity to the country's remote and nomadic populations
- protect the country's delicate ecosystem by reducing the dependence of the electricity generation system on coal (presently at 85 percent)
- reduce line losses and improve stability and reliability by installing dispersed and end-of-line generation stations that use RE resources.

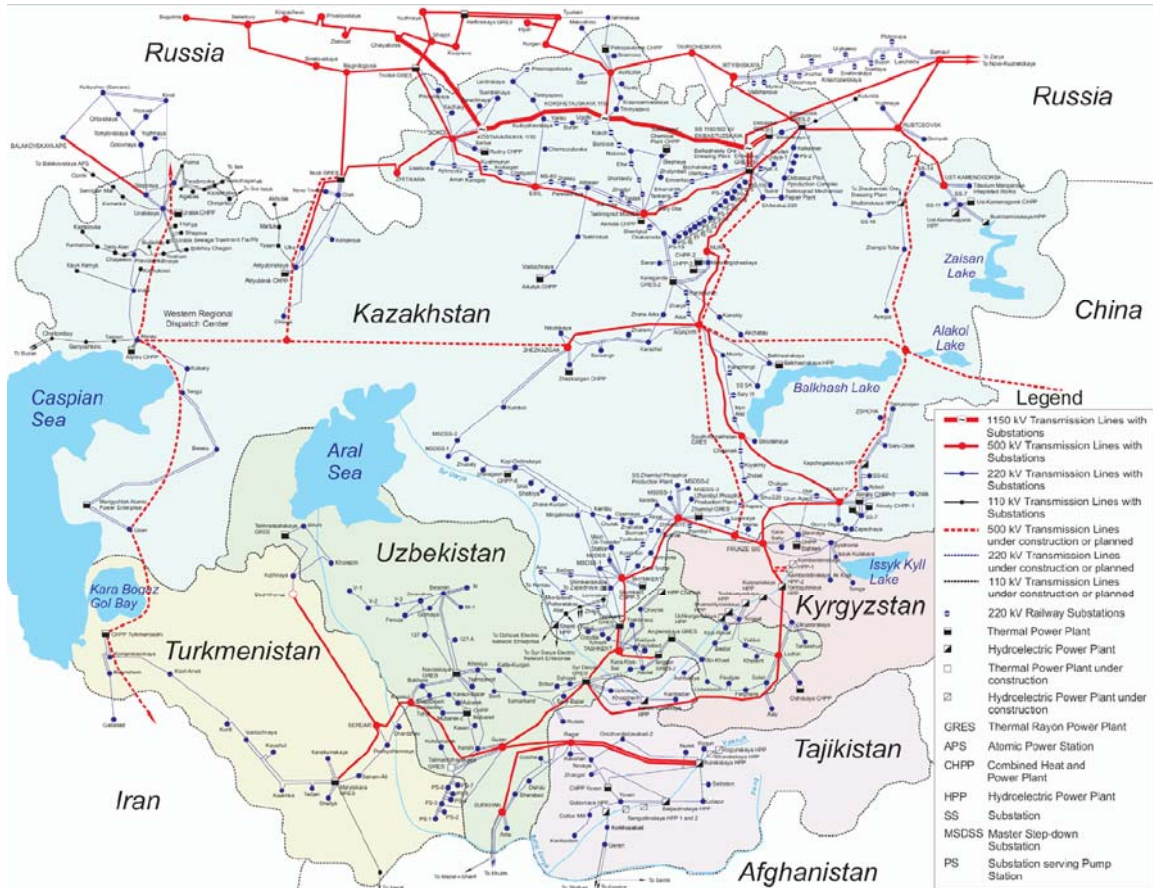
The table below displays summary information about Kazakhstan.

|   |              |
|---|--------------|
| <b>Demographical Information</b>  |              |
| Population, millions (2009)   | 15.4         |
| Land area, thousand sq km (2009)  | 2,720        |
| <b>Macroeconomic Information (2008)</b>   |              |
| GDP, billion US\$   | 176.9        |
| Real GDP growth rate, percent   | 3.0          |
| Foreign direct investment (net), million US\$ (2007)  | 7,098        |
| <b>Electricity disposition, billion kWh (2006)</b>  |              |
| Generation  | 74.93        |
| Consumption   | 61.81        |
| Exports   | 3.53         |
| Imports   | 3.67         |
| <b>Generation capacity, GW (2005)</b>   |              |
| Nuclear   | 0.00         |
| Thermal   | 16.52        |
| Hydro   | 2.22         |
| Other renewables  | 0.00         |
| <b>Total</b>  | <b>18.73</b> |
| <i>Sources: CIA World Factbook, U.S. Energy Information Administration, United Nations Conference on Trade and Development.</i> |              |

**Kazakhstan Country Summary Table**

The map below displays the transmission system throughout Kazakhstan.

## Kazakh Transmission System (Source: GENI)



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## 2. Energy Policy, Barriers and Incentives

In July 2004 Kazakhstan adopted its new Law on Electricity Energy. The law was created to encourage a fully competitive electricity market. In the region energy companies that own electricity networks and act as primary suppliers have to spin off their electricity supply business from their network operations business. If regional energy companies do not agree to voluntarily separate, it is presumed that reorganization would be mandated by a court order.

The law also stated that starting in October 2004, all power plants and guaranteed suppliers must sell/purchase a certain portion of their electricity output/demand at the electricity exchange. It was estimated that by January 2005, at least 50 percent of the electricity generated in Kazakhstan would be sold/purchased at the electricity exchange (Baker & McKenzie, 2004). No further information could be found about the electricity exchange.

In December 2006 Kazakhstan and the European Union signed a Memorandum of Understanding (MoU). The MoU outlined plans for further energy cooperation, with specific regard for energy security and industrial cooperation (EU, 2006).

Kazakhstan's first renewable energy law was passed in June 2009. The law establishes a full regulatory framework for renewables. The law was a result of a Renewable Energy & Energy Efficiency Partnership (REEEP) program funded by the United Nations Development Program. The law established a renewable energy target: 5 percent of Kazakhstan's energy balance must be renewable by 2024. The law also uses feed-in tariffs and renewable energy certificates to encourage renewable energy investment (REEEP, 2009).

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### 3. Wind

Kazakhstan possesses enormous potential of wind energy, especially in the Djungar Gates and Sheleksky Corridor in Almaty oblast. Proximity of existing energy-transmission lines, good correlation of wind season with energy demand, as well as the local market of energy demand, make the potential of developing these energy resources in the Djungar Gates and Sheleksky Corridor favorable. It should be noted that almost the entire territory of Kazakhstan is good for installation of wind-power stations. Despite the great potential, Kazakhstan has only 500 kW of installed capacity (UDI, 2009).

Kazakhstan is the leader in the region in terms of wind energy resources per person. The wind potential of the mountain pass to China, the Jungar Gates, by itself can provide about 1.3 trillion kWh of electric energy per year. A country wide wind-atlas is available. More than 50 percent of the area of Kazakhstan is rated at 4 - 5 m/s at 30m, two very large areas show wind speeds between 4 - 5 m/s and some areas at the shores of Caspian see in excess of 6 m/s.

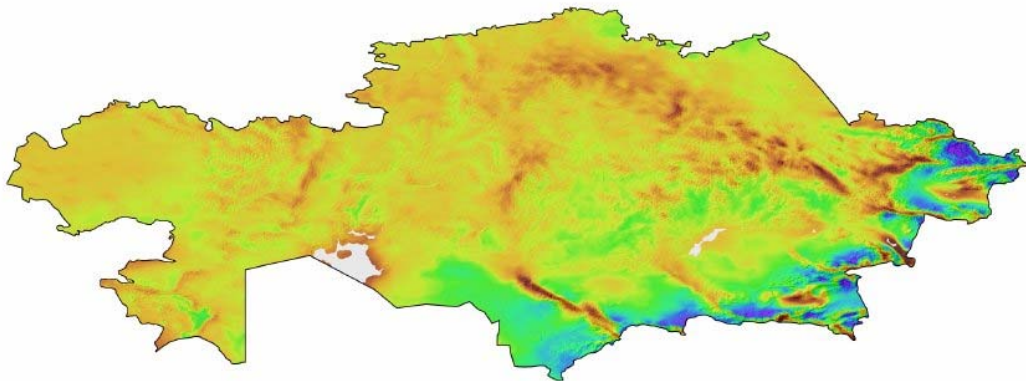
The Government of Kazakhstan has adopted "The Program of Wind Power Development till 2030" which defined non-conventional power development as one of the priority profiles. Japan's Electric Power Development Co (EPDC), has announced start of wind measurements.

Kazakhstan has very good potential for wind energy development. Additionally, Southern Kazakhstan is rapidly developing and short of power. Because of the oil and gas industry, the infrastructure also exists to export wind generated electricity to China, specifically to Xing Jiang in the Uigar Autonomous Region.

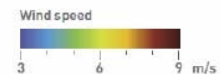
The most promising sites for wind power development are as follows:

- South-eastern part of the country; Djungar gate – a wide-gap south from the Alakol lake to the border with China, the Chu-Iliysky mountains in the area of the town of Astana, Tien-Shan off spurs (Karatau ridge) in the area of Jambul.
- Western part of the country- The Urals southern off spurs (Mugojar mountains). Caspian zone – Mangyshlak peninsula.
- Central part of the country, The Alytau mountains

# Kazakhstan Wind Map at 80m



5km Wind Map at 80m



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## 4. Biomass

The area of Kazakhstan occupied by forests constitutes more than 10 million hectares that represents 4 percent from the overall territory of country, from which 4.7 million hectares are covered by saxaul. In 1990 the volumes of logging in forests of the country made up about 3 million clear m<sup>3</sup> per year. The timber wastes at felling areas and wood processing at woodworking factories, as well as the wood, which is used as firewood, makes up almost 1.3 million clear m<sup>3</sup> or 1 million tons. Thus, the energy potential of timber waste comprises more than 200 thousand toe.

The straw of cereal crops is the most significant renewable energy resource of Kazakhstan. In 1990 the production of straw makes up almost 37 million tons. If 20 percent from this amount could be assumed for use in energy purposes, this amount will make up over 87 GWh.

The most prospective projects for using biomass for energy purposes are connected with straw. A bio-ethanol production facility has been discussed for northern Kazakhstan. The technology would process wheat (AgriMarket, 2006).

| <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                          | 227,000                            | 8                                       |
| Permanent Crops                      | 1,000                              | 0                                       |
| Permanent Meadows and Pastures       | 1,850,980                          | 66                                      |
| Forest Area                          | 33,286                             | 1                                       |
| Other Land                           | 587,434                            | 22                                      |
| Inland Water                         | 25,200                             | 1                                       |
| <b>Primary crop production</b>       | (avg. 2006–2007, tonne)            | (tonne / 100 km <sup>2</sup> )          |
| Total primary crops (rank among COO) | 25,125,958 (24)                    | 922 (2)                                 |
| Top 10 primary crops                 |                                    |   |
| Wheat                                | 15,000,000                         | 550                                     |
| Potatoes                             | 2,388,200                          | 88                                      |
| Barley                               | 2,200,000                          | 81                                      |
| Watermelons                          | 656,500                            | 24                                      |
| Maize                                | 547,500                            | 20                                      |
| Tomatoes                             | 506,750                            | 19                                      |
| Seed cotton                          | 438,550                            | 16                                      |
| Rice, paddy                          | 355,000                            | 13                                      |
| Onions, dry                          | 339,000                            | 12                                      |
| Cabbages and other brassicas         | 331,500                            | 12                                      |
| <b>Animal units, number</b>          | (avg. 2006–2007, number)           | (number / 100 km <sup>2</sup> )         |
| Cattle                               | 5,558,900                          | 204                                     |
| Poultry                              | 27,200,000                         | 998                                     |
| Pigs                                 | 1,293,400                          | 47                                      |
| Equivalent animal units              | 6,348,260                          | 233                                     |
| <b>Annual roundwood production</b>   | (2006–2007, m <sup>3</sup> )       | (m <sup>3</sup> / 100 km <sup>2</sup> ) |
| Total                                | 852,000                            | 31                                      |
| Fuel                                 | 210,000                            | 7.7                                     |
| Industrial                           | 642,000                            | 24                                      |
| Wood-based panels                    | 10,045                             | 0.4                                     |
|                                      | (2006–2007, tonne)                 | (tonne / 100 km <sup>2</sup> )          |
| Paper and paperboard                 | 81,100                             | 3.0                                     |
| Recovered paper                      | 8                                  | 0.0                                     |

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

#### **Kazakhstan Biomass Resource Data**

Another preferred direction is the use of biogas produced from the wastes of agricultural livestock and poultry, at agricultural enterprises and with individual farm applications.

There is a large number of heads of agricultural livestock and poultry in Kazakhstan. Potential resources of methane produced from cattle waste constitute more than 85 thousand tonnes, or more than 52 thousand toe.

Potential resources of methane formed after the treatment of sewage of communal utilities make up about 3 thousand tonnes or almost 1.8 thousand toe.

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## 5. Solar

The solar energy resource potential is quite great for the vast territory of the largest Central Asian Republic. The number of sunny hours is 2,200-3,000 per year, and the energy of solar radiation is 1,300-1,800 kW/m<sup>2</sup>/year. Despite the very favorable conditions for solar energy, there is little use of the resource.

The tables include data on monthly and annual incidence of solar radiation in three points: Fort Shevchenko (at the coast of Caspian Sea), Aral Sea (near the Aral coast) and Alma-Ata (at Southeast of the country).

|               | Shevchenko | Aral Sea | Alma-Ata |
|---------------|------------|----------|----------|
| <b>Jan</b>    | 157        | 198      | 178      |
| <b>Feb</b>    | 230        | 307      | 234      |
| <b>Mar</b>    | 387        | 473      | 363      |
| <b>Apr</b>    | 551        | 616      | 491      |
| <b>May</b>    | 724        | 820      | 656      |
| <b>Jun</b>    | 749        | 850      | 716      |
| <b>Jul</b>    | 752        | 830      | 758      |
| <b>Aug</b>    | 675        | 736      | 668      |
| <b>Sep</b>    | 512        | 558      | 506      |
| <b>Oct</b>    | 328        | 343      | 328      |
| <b>Nov</b>    | 179        | 188      | 186      |
| <b>Dec</b>    | 124        | 139      | 134      |
| <b>Yearly</b> | 5368       | 6085     | 5218     |

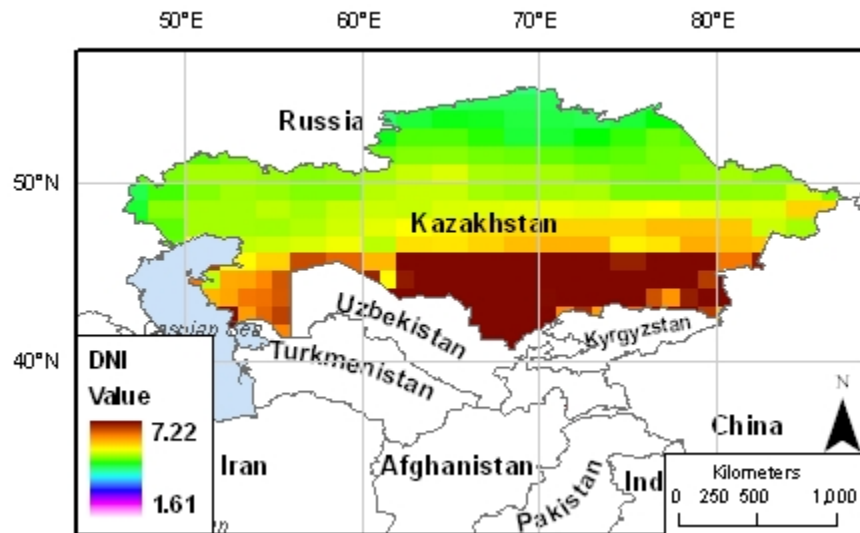
**Monthly and annual total solar radiation incident on horizontal surface, MJ/m<sup>2</sup>**

|               | Shevchenko | Aral Sea | Alma-Ata |
|---------------|------------|----------|----------|
| <b>Jan</b>    | 190        | 307      | 234      |
| <b>Feb</b>    | 249        | 396      | 226      |
| <b>Mar</b>    | 353        | 485      | 272      |
| <b>Apr</b>    | 492        | 611      | 400      |
| <b>May</b>    | 654        | 863      | 542      |
| <b>Jun</b>    | 729        | 890      | 680      |
| <b>Jul</b>    | 737        | 895      | 733      |
| <b>Aug</b>    | 705        | 881      | 686      |
| <b>Sep</b>    | 578        | 760      | 550      |
| <b>Oct</b>    | 395        | 510      | 396      |
| <b>Nov</b>    | 232        | 309      | 251      |
| <b>Dec</b>    | 137        | 238      | 175      |
| <b>Yearly</b> | 5451       | 7145     | 5145     |

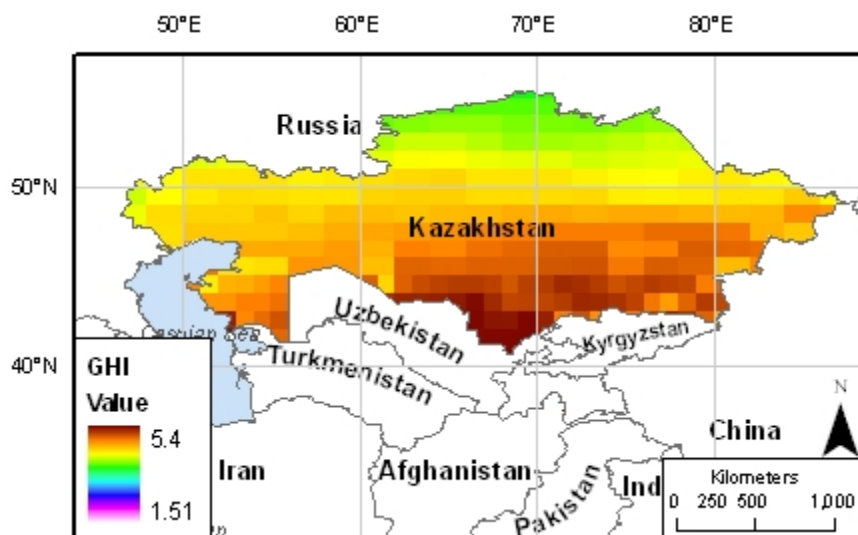
**Monthly and annual direct solar radiation incident on surface normal to sunlight beams, MJ/m<sup>2</sup>**

In 2002, a demonstration solar water heating system was installed at an infant orphanage in Kyzylorda, Kazakhstan. As of June 2009, no other solar systems have been planned or installed.

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



## Kazakhstan Solar Global Horizontal Irradiation (Source: NASA)



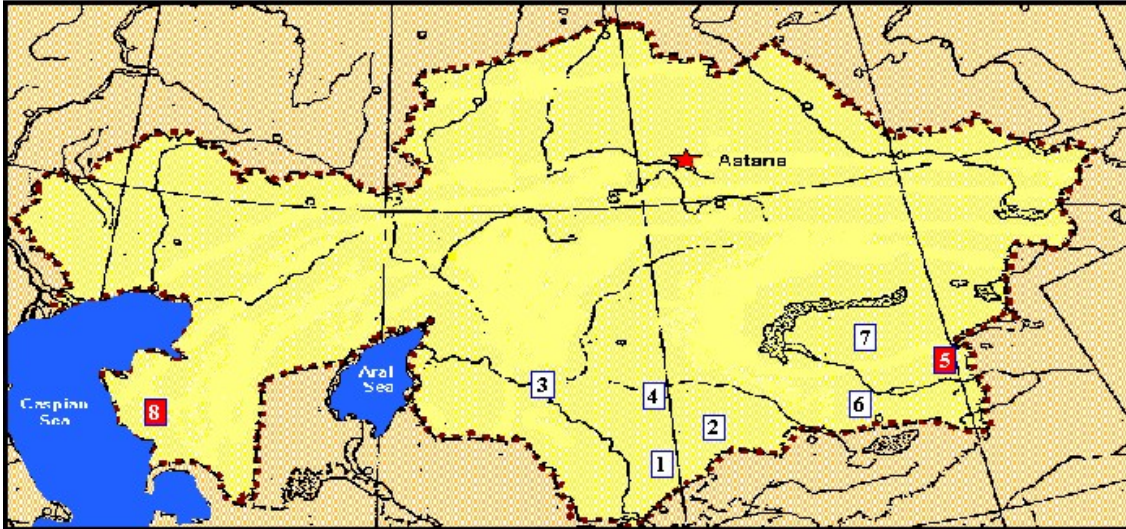
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## 6. Geothermal

Kazakhstan possesses a large resource of middle and low temperature thermal water. The geothermal field Kaplanbek (near the city of Chimkent), with thermal water of temperature 80 °C, is used for heat supply of residential buildings. Near the city of Almaty thermal water with temperature 80-120 °C is used for heating the green houses in winter and for air conditioning in summer. As of 2007, Kazakhstan is not producing power from their geothermal resources.

The evaluation of geothermal resources was carried out in accordance with the testing results for numerous wells drilled for oil and gas exploration and production. The most prospective geothermal reservoirs were found in Cretaceous formations in the South and South west of Kazakhstan. Main thermal water areas include

- The vicinity of cities Chimkent, Dzhambul, Kyzyl-Orda; a depth is 1200-2100 m, temperature 45-80 °C, TDS 1g/l.
- Chu river valley and North of Kyzyl-Kum desert; geothermal gradient 35 °/km, temperature 80-90 °C, TDS 1.5g/l
- High valley of Ily river (Panfilov field); Cretaceous aquifers – depth 2000-3500 m, temperature 90-115 °C, TDS 1.5 g/l, flowrates 20-90 l/s; deeper (4500 m) aquifer has been identified with brine temperature 170 °C
- City Almaty neighborhood; depth 2500-3500 m, temperature 80-120 °C
- Taldy Kurgan Region; large resources of hot (90 °C) water has been identified.
- At Ust-Urt plateau (nearby Caspian Sea coast) large hot water(>120 °C) resources are expected from data provided from oil wells.



### Main thermal water areas in Kazakhstan

Total thermal water resources are estimated as 520 MWt (free flow operation) or 4300 MWt (pumping operation). Proven resources for electricity production (Panfilov field) 12 MWe for Cretaceous aquifer, for deeper aquifer further investigation is necessary.

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## 7. Hydroelectric

Hydropower accounts for approximately 12 percent of Kazakhstan's total generating capacity. Average annual hydropower generation in Kazakhstan amounts to 7.78 billion kWh. By absolute indices of potential hydro resources Kazakhstan is third amongst CIS countries.

Kazakhstan hydro resources are spread throughout the country, but there are three major districts: the Irtysh River basin with main tributaries (Bukhtarma, Uba, Ulba, Kurchum, Kardzhil, South-Eastern zone with the Ili River basin, and the Southern zone – basins of Syrdaria, Talas and Chu rivers.

Programs of small hydropower development in Kazakhstan 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, and construction of new small HPPs for power supply of users in the outlying districts of the power system.

Favorable Factors for Development of Hydro Potential:

- Interest of regional authorities in small hydro;
- Private investors of small hydro are provided with state short-term credits;
- There are some privileges (tax holidays) in realization of investment projects

Despite the interest in promoting mainly small hydropower plants, Kazakhstan currently has several hundred MW of capacity under construction in the form of large hydroelectric power plants. A few small hydropower plants are under construction and planned for Kazakhstan as well.

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## 8. Relevant Links

Please see webpage for relevant links.

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## 9. References

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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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