

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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3.0 Azerbaijan

3.1 Overview of Electricity Supply

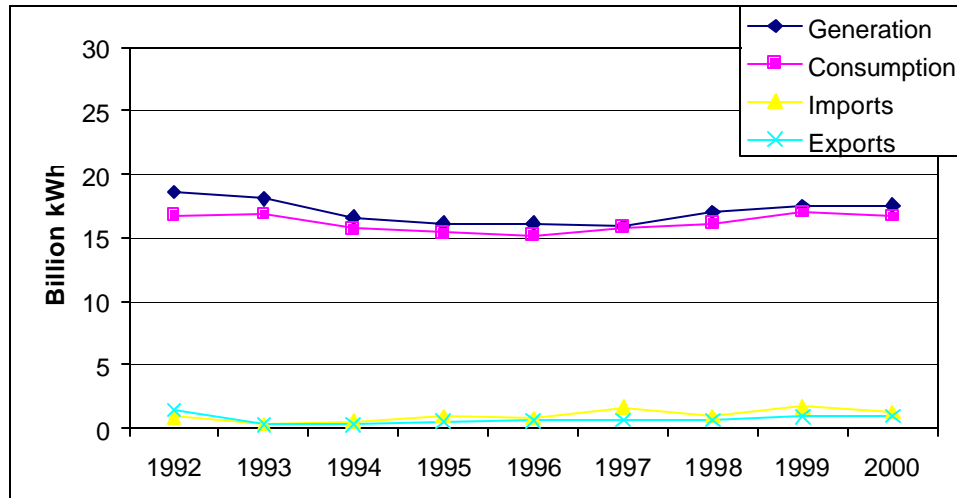
Azerbaijan achieved independence from the Soviet Union in 1991 while in the midst of a war with Armenia over Nagorno-Karabakh that began in 1988 and would last until 1994. This war would leave both countries' economies devastated, while Azerbaijan instituted an economic blockade on Armenia that remains in place today. This blockade also instituted a US restriction on aid to Azerbaijan that was only lifted in 2002 by President Bush as a concession to Azerbaijan's help in the War on Terrorism.

Throughout period between 1990 and 95 the GDP of Azerbaijan fell by 60%. After 1995 GDP began to increase steadily as foreign investment in the oil and natural gas sectors increased from \$15 million in 1993 to \$827 million in 1999. In 2001 Azerbaijan posted its 5th straight year of growth in GDP with at 5.2% increase. While GDP is forecasted to rise by an additional 5.7%, GDP is expected to reach 1991 levels, in real terms, 2007.

Electricity generation in Azerbaijan is primarily made up with thermal and hydroelectric generation resources.

Fuel	Number of Units	Capacity (MWe)	Percent of Capacity
Nuclear	--	--	--
Thermal	N/A	3,880	83.1%
Hydro	N/A	790	16.9%
Other Renewables	--	--	--
Total	N/A	4,670	100%

The power sector infrastructure is in a state of disrepair following the economic decline of the early 90's. Non-payment of electric bills by customers and power prices set below market rates has left the power sector without capital to make improvements to the system. However, with the advent of international aid, from the EBRD and other international banks, significant improvements to hydroelectric, thermal, and transmission and distribution systems are being made.



Privatization of the power sector has been met with difficulty. In 1996 President Aliyev issued a decree to transform the state-owned power company into a state-owned, closed, joint stock company and issued a program to privatize the transmission and distribution network in 5 years into 16 regions. This initial attempt met with failure as bids were only received for four of the regions. The privatization plan was redrawn into 5 transmission/distribution networks with investors owning and operating the networks. A new tender was issued for the first of these regions in November of 2000.

1.1.1 Wind Resources

Current Status of Wind Energy ¹⁾

There is no installed wind energy capacity in Azerbaijan, one of the oldest oil producing countries in the world. In the past years only small autonomous wind units were used for irrigation and lighting. The number and current operating conditions of these units are not known.

Built during the Soviet era, Azerbaijan's power infrastructure is generally in poor condition, with minimal public investment and maintenance since independence. The country's economic contraction during the mid-1990s, along with systemic problems--such as prices capped below the market rate and frequent non-payment by customers--have left Azerbaijan's power sector without sufficient capital to upgrade aging power-generation facilities.

A country wide wind-atlas is available, where one main area with annual average wind speeds of more than 6 m/s were identified.

Azerbaijan law has no provisions for renewable energy sources.

No industry association or manufacturer was identified.

No specific projects were identified except for the 250 kW pilot project planned at Sumgait.

Wind Energy Resource Potential ²⁾

“Master Plan of Wind Power Development of the USSR till 2010”, 1989 (MPWD) included a country-level wind map. The resource potential was estimated for 30m above ground. The wind map identifies areas above "6 m/s", but there is no indication of the actual value. This value could be anywhere between 6 and 10 m/s!.

In spite of this the wind energy resource potential of 110×10^9 kWh/y estimated in above mentioned study is quite probably accurate. At an average capacity factor of 25 percent, this would mean a total installed wind power capacity of 3'000 MW.

Under these circumstances we would rate the technical wind energy resource potential of Azerbaijan as good.

Identification of Areas/Projects with High Potential for Wind Energy

The most promising sites are on the Apsheron Peninsula in the east along the Caspian Sea. Caspian Sea zone and the Kura River lower reaches and Nakhichevan Autonomous Republic also seem to have a good potential.



Wind atlas of Azerbaijan

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

Project Name and Location	Size * (MW)	Description
Apsheiron peninsula	1500 MW	All the territory of the peninsula including the towns of Baku and Sumgait and adjoining islands. Wind regime is exceptionally intensive.
Caspian Sea zone and the Kura River lower reaches	500 MW	From the Kura spit in the South to the border with Dagestan in the North.
Nakhichevan Autonomous Republic	70 MW	Separate localities on the Zangezur ridge (wind potential is at lower limit).

* Here size refers to estimated potential for the area

Barriers/Incentives for Wind Energy

There are no specific incentives for the implementation of wind projects in Azerbaijan.

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

- Lack of interest and governmental support of wind power development due to favorable status of the power lobby in the country
- Poor condition of electrical infrastructure

Table 1-3. Azerbaijan Wind Energy Profile.

Current status of wind energy	
Installed capacity	N/A
Projects under construction	N/A
Supporting regulations?	None
Industry association?	None
Wind energy resource potential	
Level of information available	Good
Highest wind class	Class 3 (> 300 W/m ²)
Country-level wind atlas available?	Yes
Estimated potential (MPWD)	7.7*10 ¹² kWh/y, gross (theoretical) potential 110*10 ⁹ kWh/y, technical potential 500 MW, economic potential
Estimated potential (Interwind)	3'000 MW, technical potential
Target established?	No
High wind speed locations	<ul style="list-style-type: none"> • Eastern region of the country, particularly Apsheron peninsula, Caspian Sea zone and the Kura River lower reaches • Nakhichevan Autonomous Republic
Identification of areas/projects with high potential for wind energy	
Recommended strategic assessments	Study 1 : state of the art wind measurements on Apsheron peninsula for the purpose of identifying at least one project above 50 MW installed capacity
Identified areas/projects	Study 2 : an appraisal of legal and economical frame work 250kW, Pilot Project, Sumgait in the vicinity of the Northern steam power plant ¹⁾
Incentives/barriers for wind energy	
Significant incentives	None.
Significant barriers	<ul style="list-style-type: none"> • Lack of interest and governmental support of wind power development due to favorable status of the power budget in the country. • Poor condition of electrical infrastructure
Overall Prospects	
	Fair Azerbaijan has a good and large technical potential, but the current condition of the electrical infrastructure and the economical conditions are not favorable potential for wind energy development.

¹⁾ Wind Power Monthly Various issues

²⁾ "Master Plan of Wind Power Development of the USSR till 2010", 1989

5.3 Azerbaijan Renewable Energy Profile

5.3.3 Solar Resources

Current Status of Solar Energy

Unlike Armenia and Georgia - two other neighboring Transcaucasian republics, Azerbaijan possesses the considerable resources of hydrocarbon fuel (oil). Probably that is a reason why the noticeable interest for using solar energy is absent, and the solar energy has practically no application here.

Solar Energy Resource Potential

Solar energy potential in Azerbaijan is very high due to the favorable climatic conditions. It is characterized by the data presented in Tables 1 and 2 for three points: Artem-Island, Minguechaur and Nakhichevan. The first of them is located near Apsheron at Caspian Coast, the second one – in the Northwest part of the country, while the third one – in Azerbaijan enclave between Armenia and Iran.

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
Artem-Island	176	228	378	552	737	804	801	707	512	403	222	159	5679
Minguechaur	178	234	361	503	667	712	722	632	458	345	196	150	5158
Nakhichevan	221	297	456	565	714	812	850	769	609	439	279	193	6204

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
Artem-Island	177	181	251	433	630	774	745	662	506	337	206	162	5064
Minguechaur	210	246	292	395	534	622	632	573	444	391	236	193	4760
Nakhichevan	209	265	430	469	643	842	895	838	756	579	383	232	6541

The data presented in Tables 1 and 2 were borrowed from [1] and are the values averaged for the measuring period of many years. As it follows from these data, Azerbaijan possesses the high solar energy resources potential, which can be efficiently used under such conditions.

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

The solar energy resource potential is high practically at the entire territory of Republic. However it is especially high in the areas of Apsheron and Nakhichevan.

Barriers/Incentives for Solar Energy

The main barrier for development of solar energy is an economic one. For the existing state of economy in the country there are not considerable sources for investments for using solar

energy. On the other hand there is no acute need for using this energy source, because the Republic is not only provided with the sufficient oil resources for inside consumption, but it is the exporter of oil. That is why Azerbaijan doesn't advance the noticeable incentives and projects on using solar energy.

Table 3-3. Azerbaijan Solar Energy Profile.

Current status of solar energy	
Installed capacity	Is absent.
Projects under construction	No data..
Supporting regulations?	Are absent
Industry association?	No data.
Solar energy resource potential	
Level of information available	Fair
High range of solar insolation	3.0 – 3.5 kWh/m ² /day [2] (worst month); up to 4.7 kWh/m ² /day (year average [1])
Country-level solar atlas available?	No.
Target established?	No data.
High solar insolation locations	Area of Apsheron peninsula. Area of Nakichevan.
Identification of areas/projects with high potential for solar energy	
Recommended strategic assessments	Technical-and economic analysis of possibilities for using solar energy in the modern economic and ecological conditions.
Identified areas/projects	Development of experimental project of using solar energy in the area of Nakhichevan, which represents in isolated enclave in the country territory
Incentives/barriers for solar energy	
Significant incentives	Favorable solar climate.
Significant barriers	Existence of own excess energy resources (oil) Low tariffs for electricity and heat. Absence of inner sources of investments in solar energy. Absence of legislation in the area of nontraditional energy.
Overall Prospects	Poor because of action of negative factors.

References

1. Applied scientific reference book on climate of the USSR. Hydrometheoizdat, L.,. Issue 15, 1990.
2. Internet site: [www.bpsolar.com/ContentDocuments/17/PV System Sizing Tools.zip](http://www.bpsolar.com/ContentDocuments/17/PV%20System%20Sizing%20Tools.zip)

5.3.4 Geothermal Resources

Current Status of Geothermal Energy

Geothermal resources of Azerbaijan are presented by thermal water of low and middle temperature (35-65⁰C). The thermal water is extracted from natural sources. It is used for heating greenhouses and in balneology (settlement Istisu at west of the country and in the area of Lenkoran lowland). It is planned to use thermal water in city Gandzha for heating the rooms. The data on overall used thermal power are absent.

Geothermal Energy Resource Potential

The reserves of thermal water were discovered and partially studied with exploration drilling for oil and gas. The generalization of these data in Atlas of thermal water resources in the USSR [2] allowed to allocate the prospective water-containing complexes in Kura and Kusarodivichinsk troughs and to carry out the assessment of geothermal resources. The total (theoretical) thermal power of thermal water with temperature 30-110⁰C makes up 130 MWt with free flow operation and up to 700 MWt with pumping operation.

In addition at Apsheron Peninsula the inflows of thermal water were obtained with temperature 60⁰C from exploration oil wells.

Identification of Areas/Projects with High Potential for Geothermal Energy

High potential geothermal resources for electricity production have not been identified.

Barriers/Incentives for Geothermal Energy

The considerable incentives for using geothermal energy in Azerbaijan are absent. Specific barriers to the implementation of geothermal projects in Azerbaijan include: Large volumes of oil production make uncompetitive the utilization of thermal water. Low tariffs for electricity and heat.

Table 3-4. Azerbaijan Geothermal Energy Profile

Current status of geothermal energy	
Installed capacity (electric)	0
Installed capacity (thermal)	No data
Projects under construction (electric)	0
Supporting regulations?	No
Industry association?	No data
Geothermal energy resource potential	
Level of information available	Fair
Country geothermal atlas available?	No. Atlas of Thermal Water Resources of the USSR describes only theoretical resources.
Estimated potential (electric)	0
Target established?	No
High enthalpy geothermal locations	Not discovered
Identification of areas/projects with high potential for geothermal energy	
Recommended strategic assessments	No

Identified areas/projects (electric)	No
Incentives/barriers for geothermal energy	
Significant incentives	Absent
Significant barriers	1. Large resources of organic fuel. 2. Low electricity and heat tariffs.
Overall Prospects	Poor. Insufficient geothermal resources and large oil resources make thermal water utilization unprofitable.

References

1. A Strategic Plan for the Development of European Geothermal Sector. *Blue Book on Geothermal Resources*, European Communities, 1999.
2. G.Kulikov, B.Mavrisky *et al.* Atlas of Thermal Water Resources of the USSR. Moscow, 1984.

5.3.5 Biomass Resources

Current Status of Biomass Energy

The references of information don't contain the data on realized projects of using biomass for energy production in Republic Azerbaijan.

Biomass Energy Resource Potential

Table shows the overall biomass resource data for Azerbaijan

Azerbaijan 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)	7,806,794 (18)	901 (19)
Top 10 primary crops		
Mixed Grasses, Legumes	2,600,000	300
Maize for Forage & Silage	1,200,000	139
Wheat	1,189,327	137
Potatoes	479,325	55
Tomatoes	370,678	43
Apples	281,767	33
Watermelons	252,579	29
Vegetables and Roots, Fodder	231,667	27
Barley	208,967	24
Vegetables Fresh (misc)	133,000	15
Animal units, number	(number)	(number / 1000 Ha)
Cattle	1,933,270	223
Poultry	12,972,000	1,498
Pigs	22,900	3
Equivalent animal units	2,072,150	239
Forest products, cubic meters	(avg 1999-2000, cu m eters)	(cubic meters /1000 Ha)
Wood fuel and charcoal	6,300	1
Wood residues	NA	NA

The area of forests in Republic is 14,400 km² or 3.2% from the overall territory.

Republic occupies the first place among Republics of the former USSR and the fourth place in the world in production of raw cotton. The population of Azerbaijan is using the waste of cultivating cotton and cereal crops as a fuel in private household equipment.

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

Reconstruction of treatment systems for municipal sewage in Baku and other large cities for the further utilization of biogas has been envisaged.

Barriers/Incentives for Biomass Energy

- Insufficient investments in pilot and demonstration projects with renewable energy sources.
- Insufficient incentives of leading energy organs and services in the area of renewable energy sources.

Table 3 -5. Azerbaijan Biomass Energy Profile.

Current status of biomass energy	
Installed capacity	No data
Projects under construction	No data
Supporting regulations?	No
Industry association?	No
Biomass energy resource potential	
Level of information available	Poor
Relative biomass potential (total / density)	Total: 1%; Density: 14%
Country-level biomass investigations available?	No
Estimated potential	about 1000 toe., technical potential
Target established?	Yes. Reconstruction and construction of systems for municipal sewage treatment in Baku and other large cities for the further utilization of biogas.
High density biomass areas	Baku and other large cities
Identification of areas/projects with high potential for biomass energy	
Recommended strategic assessments	Study 1 Detailed evaluation of biomass potential for using in energy purposes. Study 2 Formation of a list of investment projects
Identified areas/projects	Reconstruction and construction of systems for municipal sewage treatment in Baku and other large cities for the further utilization of biogas.
Incentives/barriers for biomass energy	
Significant incentives	Considerable volumes of domestic sewage.
Significant barriers	1. Insufficient investments in pilot and demonstration projects with renewable energy sources. 2. Insufficient incentives of leading energy organs and services in the area of renewable energy sources
Overall Prospects	Fair

References

1. Initial National Communication of Climate Change, 2000.
2. Economy of the USSR in 1990. Statistical yearbook/Gocomstat of the USSR. – Finances and Statistics, 1991.
3. Journal of abstracts/ Nontraditional and renewable energy sources. VINITI, Moscow, 1990-2002.
4. Renewable energy. Quarterly Information Bulletin published by Russian Center on Solar Energy “Intersolarcenter”, Moscow, 1997-2002.

Renewable Energy Profile (draft)

REPUBLIC OF AZERBAIJAN

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 Azerbaijan amounts to 1.5 billion kWh, meeting 15% of power and 10% of energy demands of the power system.

Hydro installed capacity totals 0.9 million kWh.

Existing Hydro Power Plants in Azerbaijan

Hydro power plants	Installed capacity, MW	Share of HPPs in hydro power, %
Large HPPs	852	95
Including: Shamkir	380	
Minguechaur	360	
Enikend	112	
Small HPPs	44	5
Aras	22	
Varvarinsk	16	
Mugan	6	

2. Hydro Power Resources of Azerbaijan

Potential hydro resources of Azerbaijan are rather scarce, but by concentration of hydro resources on the territory the potential is significant as compared to other CIS countries.

Water resources of Azerbaijan are presented by:

- the lower reaches of the Kura River with its multiple tributaries;
- the Aras River (the Kura tributary), which is on the border;
- a group of creeks inflowing into the Caspian Sea

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	43.5 500	28.6	66
Technically feasible hydropower capability, Billion kWh/year	16	4.9	30
Economically feasible hydropower capability, Billion kWh/year	7.6	Not determined	
Power generated by existing HPPs, - Billion kWh/year - per cent of economic potential, %	1.5 21.4	0.1	7

The developed hydro potential accounts for one tenth of gross theoretical value. Hydro potential of the Kura River is mostly developed.

At estimation of total hydropower potential of Azerbaijan small hydro was singled out. The largest small hydro potential is concentrated in multiple tributaries of the Kura and the Aras rivers and a group of creeks inflowing into the Caspian Sea.

3. Plans for Development of Hydropower Potential

Further hydro development of the Republic is connected with significant available economically feasible hydropower capability, which permitted working out a large-scale program for construction of the most feasible projects. There is a Master Plan of hydropower development of the Republic.

First Priority Potential Medium-Size Hydro Power Projects

Projects	Installed capacity, MW	Location
New construction: Poilinsk HPP	90	Fifth in the cascade on the Kura River
Kudialchai HPP at the irrigation project	90	Kudialchai River

Small hydropower development is the most promising nowadays in power sector. Under existing conditions it is technically and economically feasible to develop vast potential of small creeks, use drops on the irrigation canals, water releases

from reservoirs, which will permit construction of small HPPs on the territory of the Republic with combined capacity of about 240 thou.kWh.

Proposed Program of Small Hydro Development

Type of construction	Quantity	Installed capacity, MW	Average overyear power output, Million kWh	Note	Region
Reconstruction of existing HPPs		27	130	Mostly multi-purpose projects of capacity within 0.80-8MW	Located near settlements
Adding to water management projects		180	840		
New construction		31	170	Small HPPs on non –regulated creeks	Piedmont districts of Large and Small Caucasus. Districts with isolated power supply
Total		240	1140		

Nakhchivan Autonomous Republic being a part of Azerbaijan is always in deficit of electric energy starting from 1990. At present the Nakhchivan local power system is isolated from that of the Republic. It is feasible to start with small hydro development on the territory of Nakhchivan Autonomous Republic.

First Priority Potential Small Hydro Power Projects of Azerbaijan

Projects	Installed capacity, MW	Location
Reconstruction of small HPPs: Varvarinsk HPP	16.5	Kura River
Rehabilitation of small HPPs		
Kusar	1.2	Samur-Apsheron canal
Kubinsk	1.15	Kudialchai River
Shekin	1.66	Kishchai River
Zurnabad	2.76	Gianjachai River
Adding to water management projects		
Mill	28.2	Main Mill canal
Nakhchivan Autonomous Republic		
Arpachai	12.0	Arpachai River
Vaikhir	4.7	Nakhchvanchai River
HPS #1 and #2	12.9	GianjachaiRiver

4. Favorable Factors for Development of Hydro Potential

- Deficit of fuel and escalation of organic fuel prices;
- Yearly growth of electricity consumption in the country;
- Azerbaijan Ministry of Economic Development is working at privatization of small hydro

Bibliography

1. Power Resources of the USSR. Hydropower Resources. A.N.Voznesensky et al.,1997
2. Small Hydropower, L.P.Michailov et al, 1989
3. Master Plan of Wind Power Development in the USSR, 1989
4. Periodicals: Hydraulic Construction, Power Stations, etc

Zones of location of planned small HPSs

