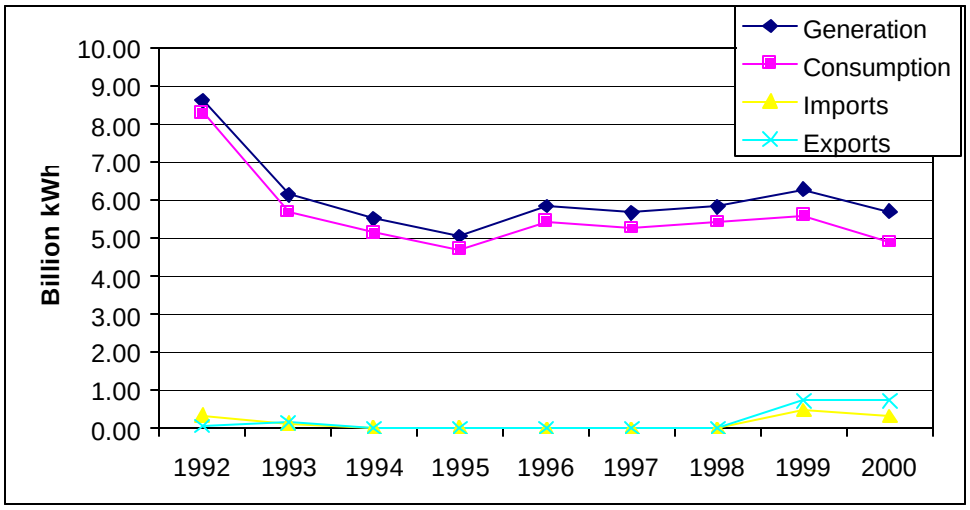
2.0 Armenia

2.1 Overview of Electricity Supply

Armenia has continued to recover from the collapse of the Former Soviet Union and its 6 year war with Azerbaijan. This country of roughly 3,336,100 people has seen somewhat steady economic growth throughout the 90's.

Electricity is currently generated through thermal, hydroelectric, and nuclear resources, with no appreciable renewable energy sources such as wind, geothermal, or solar. In 2000 Armenia produced 5.7 billion kWh while consuming 4.9 billion kWh. The electric supply, however, is currently not available to all regions on a regular basis, thus potential demand far outpaces supply. As evidence by Figure ___ generation and consumption have fallen since the early 90's. The Armenian and Iranian power grids are currently connected, thus allowing electric trade across the border. The interconnection of the power grids in Georgia and Turkmenistan to that in Iran is currently being investigated to increase regional trade and power supply stability.



Armenia's electricity generation is primarily produced via the recommissioned Metsamar Nuclear Plant. This plant has two units with a combined capacity of 815 MW, however, was shut down in March of 1989 because of safety concerns. As shown in the following table, Table ___, there are significant thermal generation resources, however, many of these are in need of rehabilitation and modernization. There are also significant hydroelectric resources.

Table 7-5
Installed Generation Capacity

Fuel	Number of Units	Capacity (MWe)	Percent of Capacity
Nuclear	1	815	28.4%
Thermal	3	1,756	61.2%
Hydro	N/A	296	10.4%
Other Renewables			
Total	N/A	2,867	100%

In addition to the nuclear unit Armenia has 3 thermal plants with a total capacity of 1,756 MW. However, these plants are operating beyond their planned lifetime, significantly limiting plant efficiency, and are in desperate need of renovation. As all fossil fuels must be imported into Armenia, these plants are continually low on fuel and are unable to operate near capacity.

Hydroelectricity provides a significant portion of Armenia's electricity, with a 25% share in 2000. The current hydroelectric capacity is concentrated on the Hrazdan River with many plants currently operating. However, there is a plan to develop 296 MW of additional hydroelectric generation with 38 small plants and three large plants with funding assistance from the EBRD.

The process of privatization of the electric sector has been met with difficulty. In 1998 Parliament passed a law allowing for the sale of the transmission and distribution networks, while retaining control of the generation facilities. The transmission networks were scheduled to be divided into 4 separate entities. Following this development the EBRD signed an agreement to purchase a 20% share in each of the networks pending participation from an international investor. Subsequent tenders were released for 75% stakes in 2 networks, respectively, however, following a lack of interest in investment the privatization process was halted in March of 2001. The Armenian government is currently in the process of evaluating different privatization strategies before proceeding into privatization.

1.1.1 Wind Resources

Current Status of Wind Energy [1)]

One150 kW Sumitomo turbine was installed in 1992 Armenia. There are also about one dozen US made Wind Barons for water-pumping. The current operating conditions of these units are not known.

A country wide wind-atlas is available, where 2 main areas with annual average wind speeds of 4 - 6 m/s at 30 m height and one area with more than 6 m/s were identified.

Armenian law provides that purchasing of all the electrical energy from renewable energy sources is mandatory until the year 2016. The announced feed in tariff is 0.05 USD/kWh.

No industry association or manufacturer was identified.

Three projects with 2.5 - 30 (?), 10 (NREL) and 20MW (SolarEn)[2)] installed capacity were identified, where as initial project ideas date as early as 1994 (NREL). The average wind speed at the SolarEn site was 8.1 m/s in 1999. This project would produce 60 Mio. kWh/year (34 percent capacity factor). SolarEn was looking for a 0.045 USD/kWh feed in tariff.

At least for the SolarEn project the wind conditions are excellent and the requested feed-in tariff is in line with announced prices. However, none of these projects are under construction or in an advanced state. The main set back seems to be the low financial solvency of the electric power users.

Armenia has a fairly good potential for wind energy development.

Wind Energy Resource Potential [3)]

"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. However, this wind map and its interpretation illustrates the limited validity of large scale resource potential assessments. According to this map the only area worthwhile development would be the Sisian-Pass area in the southeast (power density > 250 W/m^2 at 30 m, estimated > 300 W/m^2 at 50m), where as the SolarEn site close to Zod (power density > 620 W/m^2) does not even figure in the map.

Therefore the wind energy resource potential of $13x10^9$ kWh/y technical potential 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 400 MW.

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

Identification of Areas/Projects with High Potential for Wind Energy

The most promising sites are from north to south, Pushkin-Pass (not far from Vanadzor), Aragaz, Sevan Lake, Sisian-Pass, and Karakhach Pass.

Wind atlas of Armenia

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

Project Name and Location	Size (MW)	Description
Pushkin Pass in Armenia	10MW	NREL and the Russian Ministry of Fuel and Energy Stduy
In Sotk (Zod) site, Northern part	20 MW	SolarEn has secured a long term land lease from the Armenian Government for the project site. (8.1 m/s)
Wind power plant in the Sisian pass region	30MW	

Barriers/Incentives for Wind Energy

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

- Possible coordination of operation duties of Susian wind power plant and nearest hydropower plants of the Vorotan Cascade.
- Restructuring and privatization of the energy sector aiming involvement of private investors has started
- Armenian Energy Regulatory Commission has issued a tariff of 5 cents/kWh (excluding VAT) for the SolarEN project. Armenian law provides that purchasing of all the electrical energy from renewable energy sources is mandatory until the year 2016., however, this tariff level will only be feasible if the wind resources are very good (over 8 m/s at hub height) and projects are 20MW or larger[2)]

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

- Lack of investments in the power industries because of low financial solvency of the electric power users.

Table 1-3. Armenia Wind Energy Profile.

Current status of wind energy	
Installed capacity	0.15 MW
Projects under construction	N/A
Supporting regulations?	Yes, Armenian Energy Regulatory Commission has issued a tariff of 5 cents/kWh (excluding VAT) for the SolarEN project. Armenian law provides that purchasing of all the electrical energy from renewable energy sources is mandatory until the year 2016.
Industry association?	None.
Wind energy resource potential	
Level of information available	Good
Highest wind class	Class 6 (> 600 W/m^2)
Country-level wind atlas available?	Yes
Estimated potential (MPWD)	$2.6*10^{12}$ kWh/y, gross (theoretical) potential $13*10^{9}$ kWh/y, technical potential $60*10^{6}$ kWh/y, economic potential
Estimated potential (Interwind)	400 MW, technical potential
Target established?	No
High wind speed locations	• Southern-eastern regions of the country, Northern slope of the Zangezur ridge (Sisian pass with especially high wind velocities) • Central regions of the country, Western coast of the Sevan lake, Gegam ridge • Western coast of the Sevan lake, Gegam ridge, Zone near the Aragatz mountain (wind velocities at the lower limit)
Identification of areas/projects with high potential for wind energy	
Recommended strategic assessments	Study 1 : site specific investigation of identified projects above 10 MW installed capacity Study 2 : an appraisal of legal and economical frame work
Identified areas/projects	• 10MW, NREL Study, Pushkin Pass in Armenia • 20 MW, SolarEn, In Sotk (Zod) site, Northern part • 2.5 MW (-30MW), Project Name 3, Sisian pass region
Incentives/barriers for wind energy	
Significant incentives	• Armenian Energy Regulatory Commission has issued a tariff of 5 cents/kWh (excluding VAT) for the SolarEN project. Armenian law provides that purchasing of all the electrical energy from renewable energy sources is mandatory until the year 2016.
Significant barriers	• Lack of investments in the power industries because of low financial solvency of the electric power users.
Overall Prospects	**Fair** Armenia has a good wind energy resource potential, but it is difficult to realize projects, with the knowledge that consumers are not in a situation to pay the electricity bill.

[1] Wind Power Monthly, various issues
[2] http://www.solaren.am
[3] "Master Plan of Wind Power Development of the USSR till 2010", 1989

5.2 Armenia Renewable Energy Profile

5.2.3 Solar Resources

Current Status of Solar Energy

In spite of very favorable climatic conditions and absence of own traditional energy resources, the using of solar energy in Armenia has no noticeable development. It should be noted the project "Autonomous solar power supply for National service of seismic protection and National meteorological service" [1], which is realized by means of outside investments. In accordance with this project 150 complex seismic stations carrying out the monitoring of seismic activity should be equipped with PV sources of power supply. However the total electric capacity of pointed photovoltaic plants will not exceed some tens kW.

Solar Energy Resource Potential

The solar energy resource potential is characterized by the data presented in Tables 1 and 2 for three points at Armenian territory: Yerevan (a capital), Sevan, Kochbek. The last one is located at Southwest of Republic at the height 2387 m over sea level. The data of Tables 1 and 2 were taken from [2] and are the averaged ones for the observing period of many years.

Table 1

Monthly and annual total solar radiation incident on horizontal surface, MJ/m^2

Name of place	I	II	II	IY	Y	YI	YII	YII	IX	X	XI	XII	Yearly
Yerevan	200	267	417	540	720	821	858	754	594	428	251	171	6021
Sevan	281	357	518	545	666	768	825	743	580	435	285	234	6237
Kochbek	311	392	537	573	654	764	817	743	589	445	299	272	6396

Table 2

Monthly and annual direct solar radiation incident on surface normal to sunlight beams, MJ/m^2

Name of place	I	II	II	IY	Y	YI	YII	YII	IX	X	XI	XII	Yearly
Yerevan	178	243	364	450	667	826	861	810	740	534	312	175	6160
Sevan	387	386	441	442	565	734	774	775	704	587	440	373	6599
Kochbek	391	384	408	409	534	749	848	804	743	616	461	373	6720

As follows from the data presented in Tables 1 and 2, the solar energy resource potential in Armenia is quite high that creates the good conditions for its usage.

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

The territory of Republic is very small (only 30 ths km^2). The climate is practically uniform at this territory. Therefore the solar energy resource potential depends not on the fact, as in what part of the country the given pointed is located, but as on which height it is above sea level. It is evident that the solar energy resource potential is increased with this level that is also seen from data of Tables 1 and 2.

Barriers/Incentives for Solar Energy

The main barrier for using solar energy is an economic one. The unsatisfactory state of economy in the country has as a sequence the absence of investments. Hence any large projects on using solar energy are absent, though the climatic conditions for it are very favorable. The usage of small domestic solar plants with different purpose is restrained by a very small solvent demand.

Table 2-3. Armenia Solar Energy Profile.

Current status of solar energy	
Installed capacity	Solar water-heating plants with total power 2-3 MW (thermal) Photovoltaic plants of autonomous application with total capacity up to 10 kW.
Projects under construction	The project "Autonomous solar power supply of national service of seismic protection and national meteorological service" with overall capacity up to 100 kW is now in the process of realization.
Supporting regulations?	Are absent
Industry association?	Open joint stock company "Kontact-A" (city Yerevavn) for manufacturing of photovoltaic modules.
Solar energy resource potential	
Level of information available	Fair
High range of solar insolation	3.0 – 3.5 kWh/m2/day [3] (worst month); up to 4.9 kWh/m2/day (year average [2])
Country-level solar atlas available?	No.
Target established?	No data.
High solar insolation locations	There are no points or regions with sharply expressed maximum of solar radiation.
Identification of areas/projects with high potential for solar energy	
Recommended strategic assessments	Technical-and economic analysis with allocation of the most efficient directions of using solar energy in the modern economic conditions.
Identified areas/projects	The full completion of project pointed out in item 1.2.
Incentives/barriers for solar energy	
Significant incentives	Quite favorable solar climate. There is a shortage of own traditional energy resources.
Significant barriers	Absence of inner sources of investments in solar energy. Low tariffs for electricity and heat. Absence of legal and normative base.
Overall Prospects	Fair taking into account the action of negative factors.

References

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2. Applied scientific reference book on climate of the USSR. Hydrometheoizdat, L., Issue 16, 1990.
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5.2.4 Geothermal Resources

Current Status of Geothermal Energy

Though Armenia is located in a zone of high tectonic activity and recent volcanism, its geothermal resources are not so rich and presented by low-to-medium temperature thermal water. Currently thermal water is used only for swimming pools and in balneology. So far obsolete technologies are in use: spouting (free flow) well operation, direct use of geothermal water. Total installed heat capacity is less than 1 MWt. There is no national program promoting use of geothermal energy. To advance development in Armenia it is necessary to carry out careful analysis of available geological and geothermal data including the results of hydrodynamic investigations and testing of geothermal reservoirs in existing wells to reveal prospective areas. Reviewing published data; it appears technically possible to use the low-temperature thermal water with heat pumps in Martuni and Sisian. However the economic expediency should be confirmed by technical and economic evaluation. Additional investigation will be required to assess the possibility of binary GeoPP development for higher temperature reservoirs [1].

Geothermal Energy Resource Potential

The underground reservoirs containing the thermal water were formed both in the porous alluvial sedimentary rocks of intermountain basins and in fissured crystalline rocks. A narrow zone in the central part of Armenia (*Sisian – Martuni – Sevan*) is considered to have the best potential. The geothermal gradient here reaches 50^0C/km. The maximum measured temperature in the deeply occurring reservoirs is 140^0C.

Geothermal reservoirs in porous rocks containing high-temperature thermal water were investigated in some places [1-3]:

– inflows of thermal water with temperature of 110^0C were obtained in the upper cretaceous sediments in wells with a depth of 2.5 km (*Bajandur, Dilidjan, Vanadzor*);

- a temperature of thermal water of 100^0C was recorded at a depth of 2.6 km in the upper cretaceous sediments of Ararat basin (*Razdan*). It is projected that at a depth of 3.6 km the temperature might be up to 160^0C.

Considerable inflows of low-temperature thermal water were obtained in two regions:

- *Martouni:* prospecting wells with a depth of 1200 m investigated the reservoirs with the thermal water. Its temperature is 32-40 ^{0}C, mineralization 2-3 g/l, inflows- 2-50 l/s. The total thermal capacity is estimated as 8 MWt;

Sisian: prospecting wells investigated the adjoining hydrothermal system, where the temperature of thermal water is 36-43 ^{0}C, its mineralization 4-6 g/l, the inflows 20-100 l/s. The total thermal capacity is estimated as 8 MWt.

Identification of Areas/Projects with High Potential for Geothermal Energy

The only definite opportunity for geothermal development in Armenia lies in creation of state-of-art heat supply systems with heat pumps. Any electricity production projects need high cost investigations with additional exploration drilling.

Barriers/Incentives for Geothermal Energy

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

The shortage of fuel-power resources in Armenia results in the necessity to import large volumes of expensive natural gas. Development of geothermal resources would preserve capital in the country.

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

Need for high cost investigations to discover high temperature reservoirs.

Low tariffs for electricity and heat

Absence of legislative measures encouraging development of geothermal resources

Shortage of budget funds and absence of investors

Low tariffs for electricity and heat.

Table 2-4. Armenia Geothermal Energy Profile

Current status of geothermal energy	
Installed capacity (electric)	0
Installed capacity (thermal)	>1 MWth Total
Projects under construction (electric)	0
Supporting regulations?	No
Industry association?	No
Geothermal energy resource potential	
Level of information available	Poor
Country geothermal atlas available?	No. Atlas of Thermal Water Resources of the USSR describes only thermal springs.
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	Analysis of available geological and geothermal data to reveal prospective areas
Identified areas/projects (electric)	No data
Incentives/barriers for geothermal energy	
Significant incentives	Shortage of own fuel-energy resources in Armenia
Significant barriers	Need for high cost investigations to discover high temperature reservoirs. Low tariffs for electricity and heat Absence of legislative measures encouraging development of geothermal resources Shortage of budget funds and absence of investors
Overall Prospects	Poor for electricity production projects in near future. Though there are areas with very high geothermal gradient in Armenia, but high temperature reservoirs are not discovered yet, so long term and expensive exploration is necessary.

References

1. A Strategic Plan for the Development of European Geothermal Sector. *Blue Book on Geothermal Resources*, European Communities, 1999.

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3. R. Henneberger, D. Cooksley and J. Hallberg. Geothermal Resources of Armenia, *Proceedings World Geothermal Congress 2000*, Tokyo, 2000.

5.2.5 Biomass Resources

Current Status of Biomass Energy

In 1994 Armenian Ministry of energy articulated a strategy to "Develop and demonstrate a set of improved farm scale biogas concepts" Under this program a few digesters were developed. The Armenian State Engineering University, the Armenian Agricultural Academy, and the Biological Institute assisted in the technical design and construction of a few digesters. As a result, a few experimental small biogas systems were built at state farms in three regions of Armenia: 0.5 m^3 digester at Vanadzor. However, given the reorganization at the farms and lack of technical and organization support, these systems became non-operational over a short time. No meaningful data was therefore generated. Anyway the interest to anaerobic digesters is strengthening by the privatization of agriculture and farm in Armenia. Family farms are increasingly incorporating strong commercial elements. One result is livestock concentration, a situation offering potentially larger quantities of available animal manure, in addition to other benefit.

One organization, VISTAA Expert Center, is superheading the effort. Under US grant, it has successfully installed few demonstration units. These include a farm-based 5 m^3-biogas digester in Aparan, and another biogas digester of 5 m^3 at Edvard's farms. A larger system, 30 m^3 capacity has been installed in village Barzrashen (Masis region). The system provides biogas for heat in a privately owned greenhouse.

In 1997 VISTAA also organized biogas-training sessions in all regions of Armenia. Training sessions covered various aspects of biogas concentrating on feasibility study, design, installation, and performance including economics. Over 250 farmers participated in these training sessions. VISTAA also developed and distributed information materials and booklets. These projects have a potential to provide valuable data and information.

On the whole the experience in Armenia is very limited. The few digesters convey a mixed picture. Among the key bottlenecks, it is possible to mention the lack of financial support. Governmental funding is unavailable. Private funding demands high collateral and a very high interest rate of up 36% annually. So, in spite of strong technical potential and interest, the institutional barriers do not support wider biogas development.

Biomass Energy Resource Potential

Table shows the overall biomass resource data for Armenia.

Armenia 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)	4,101,449 (23)	1,454 (14)
Top 10 primary crops		
Forage Products (misc)	2,513,333	891
Potatoes	356,072	126
Maize for Forage & Silage	233,833	83
Wheat	229,984	82

Tomatoes	156,301	55
Grapes	115,698	41
Vegetables Fresh (misc)	82,333	29
Cabbages	69,253	25
Watermelons	65,380	23
Barley	52,291	19
Animal units, number	(number)	(number / 1000 Ha)
Cattle	473,904	168
Poultry	3,722,000	1,320
Pigs	78,370	28
Equivalent animal units	542,472	192
Forest products, cubic meters	(avg 1999-2000, cu meters)	(cubic meters /1000 Ha)
Wood fuel and charcoal	NA	NA
Wood residues	NA	NA

As a result of increased privatization of the family farms since 1991, there are now 340,000 new farms from 850 state collective farms. Each farmer became an owner of 1-2 hectare of land. About 70% of those farmers also became owners of 1-2 cows. In the past cattle breeding farms were located in mountainous area, now cattle-breeding farms are also located in valleys.

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

Armenia has a hard continental climate. It is obvious that at valleys and pre-mountain areas average temperature during winter (therefore during all year) is higher than at mountains. If biogas production system is constructed in warm areas, it will gave opportunity to decrease quantity of biogas for digester heating, therefore efficiency of use of biogas would be increased. As a recommended site for pilot project small farms of following areas could be suggested:

1. At farms, which are located in valleys from Ararat and Armavir regions.
2. At farms, which are located in valleys and pre-mountain areas from Tavush, Aragatsotn, Kotayk, Sunik, and Vayotsdzor regions.
3. At small-scale farms, which are located at regions pointed out in items 1 and 2 that owns 3-7 cows each.
4. At medium-scale farms, which are located at regions pointed out in items 1 and 2 that owns 12-14 cows each.

At large-scale farms, which are located at regions pointed out in items 1 and 2 that owns 22 and more cows each.

Barriers/Incentives for Biomass Energy

1. Absence of norms for designing and construction of biogas production systems.
2. Absence of safety and fire standards for construction and maintenance of biogas production systems.
3. Absence of draughts for several plants of biogas production system.
4. Several plants of biogas production system are not produced in Armenia.
5. Farmers don't have practically any information about biogas production systems.

Table 2-5. Armenia Biomass Energy Profile.

Current status of biomass energy	
Installed capacity	There are no operating plants
Projects under construction	There are no projects in a stage of construction
Supporting regulations?	Yes.
Industry association?	Yes. "SolarEN"
Biomass energy resource potential	
Level of information available	Good
Relative biomass potential (total / density)	Total: 1%; Density: 22%
Country-level biomass investigations available?	Yes
Estimated potential	Data about biomass potential that can be used for energy purposes are absent
Target established?	Yes
High density biomass areas	1. At farms, which are located in valleys from Ararat and Armavir regions. 2. At farms, which are located in valleys and pre-mountain areas from Tavush, Aragatsotn, Kotayk, Sunik, and Vayots dzor regions.
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	At large-scale farms, which are located at regions pointed out in above items 1 and 2, each owner has 22 and more cows.
Incentives/barriers for biomass energy	
Significant incentives	Absence of organic fuel deposits and field at the territory of Armenia
Significant barriers	1. Absence of norms for designing and construction of biogas production systems. 2. Absence of safety and fire standards for construction and maintenance of biogas production systems. 3. Absence of draughts for several plants of biogas production system. 4. Several plants of biogas production system are not produces in Armenia. 5. Farmers don't have practically any information about biogas production systems.
Overall Prospects	Good

References

1. Evaluation of renewable energy resources in Armenia. Draft Report on "Energy efficiency, demand side management and renewable energy resources program", USAID Task Order # Out-LAG-1-816-98-00004-00, BIO ENERGY, January 2002.

Renewable Energy Profile (draft)

REPUBLIC OF ARMENIA
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

Hydro installed capacity totals 1.02 million kW. Share of hydropower is 30%. Average annual hydropower generation in Armenia amounts to 0.93 billion kWh. There are 30 existing large and small HPPs.

Existing Hydro Power Plants in Armenia

Hydro power plants	Installed capacity, MW	Share of HPPs in hydro power, %
Sevan-Razdan cascade HPPs	556	54
Sevan	34	
Razdan	82	
Argel	224	
Arzni	70	
Kanaker	102	
Erevan	44	
Vorotan cascade HPPs	405	40
Spandarian	76	
Shamba	171	
Tatev	158	
Small HPPs	61	6

2. Hydro Power Resources of Armenia

Potential hydro resources of Armenia are rather scarce, but by concentration of hydro resources on the territory the potential is significant.

Water resources of Armenia

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	21.8 730	6.1	17
Technically feasible hydropower capability, Billion kWh/year	9.2	1.9	
Economically feasible hydropower capability, Billion kWh/year	6.0	Not determined	Not determined
Power generated by existing HPPs, - Billion kWh/year - per cent of economic potential, %	0.93 15.5	0.14	

The Razdan River, Lake Sevan, the Vorotan, Debed, Aras Rivers have the largest potential, which is nearly fully developed.

At estimation of total hydropower potential of Azerbaijan small hydro was singled out. The largest small hydro potential is concentrated in the Northern part of Armenia (the Kura River basin), Central part (Lake Sevan basin) and in the south of the Republic (the Aras River basin).

3. Plans for Development of Hydropower Potential

The Government of Armenia is taking efforts in rehabilitation of power sector; there was developed the investment program of power development up to the year of 2010.
Further hydro development is connected with using potential of medium-size and small rivers.

First Priority Potential Medium-Size Hydro Power Projects

Projects	Installed capacity, MW	Average overyear power output, Million kWh	Location
New construction:			
Megra HPP	78.9	469	Aras River, border section between Armenia and Iran
Shnokh HPP	75	300	Debed River, Northern Armenia
Loriberda 1and 2 HPPs	59	200	Dzoraget, the Debed River tributary, Northern Armenia

Programs of small hydropower development in Armenia include 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.

Proposed Program of Small Hydro Development

Type of construction	Quantity	Installed capacity, MW	Average overyear power output, Million kWh	Note	Region
Adding to water management projects	8	27	90	Small HPPs of capacity within 1.5MW-6MW	Northern and Western regions
New construction	317	230	680	Small HPPs power supply of remote settlements	Spread on the whole territory of Armenia
Total	325	257	770		

First Priority Potential Small Hydro Power Projects

Projects	Installed capacity, MW	Location
Reconstruction:		
Dzoraget HPP	26	Dzoraget River, North Armenia
New construction:		Talin canal,Western Armenia
Talin	2.3	
Vardenis	2.6	Vardenis River

4. Unfavorable Factors for Development of Hydro Potential

- Decrease of power consumption during the period of reforms, the most sharp among the CIS countries (50%)

5. Favorable Factors for Development of Hydro Potential

- Activities in restructuring and privatization of power sector;
- Absence of the country's own fuel resources

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2. Small Hydropower, L.P.Michailov et al, 1989
3. Periodicals: Hydraulic Construction, Power Stations, etc, Proceedings of SHC "Institute Hydroproject")

Zones of location of planned small HPSs

Map No. 3762 Rev. 2 UNITED NATIONS
November 1997

Department of Public Information
Cartographic Section