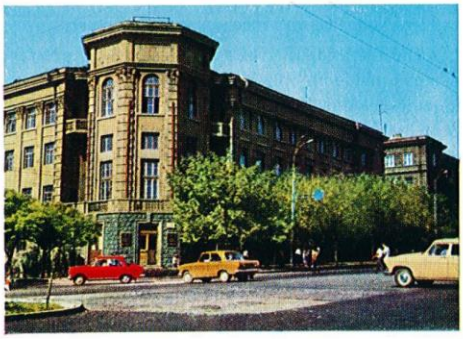
ELECTRIC POWER SYSTEM OF ARMENIAN SSR

ELECTRIC POWER SYSTEM OF ARMENIAN SSR



Main Building of Razdan Supercentral Power Station
Gjumush Hydroelectric Power Station. Turbine House
Monument to David Sasunsky, Hero of the Armenian National Epos
Government House in Yerevan
Armglavenergo Building

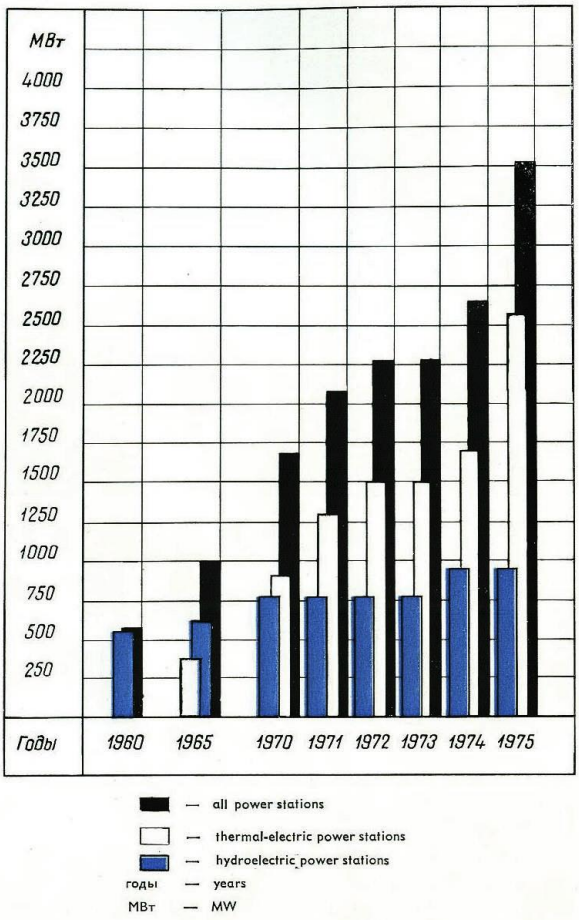
The electric power system of Armenian SSR covers the entire territory of the Republic. It is part of the Transcaucasian united power system which also includes the power systems of Georgia and Azerbaijan. The territory serviced by the power system amounts to 29.8 thousand sq. km with a 2.6million population.

The Armenian power system incorporates power plants and stations of all kinds, such as condensing plants, heat-electric generating stations and hydroelectric power stations. An atomic power station is now being constructed. The installed capacity of all the power stations of the system made up 2.48 million kilowatts on the 1st, January, 1975 with the power output in 1974 of 8.5 milliard kWh.

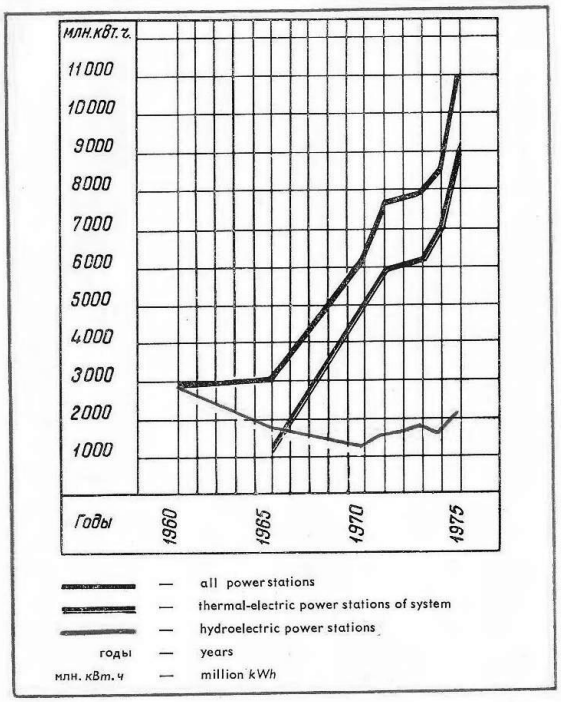
The power system management of Armenian SSR has developed from small individual power plants incorporating low-power equipment to a large power system which meets the power requirements of highly developed socialist industry and highly productive and mechanized agriculture.

The total capacity of power stations of pre-revolutionary Armenia made up only 3165 kW at an annual power output of 5.1 million kWh. The largest power plants built near copper ore deposits belonged to foreign concessions. In 1909 an Alaverdy hydroelectric power station was constructed on the Debed river. It incorporated three 360-kW water-wheel generators and was second in power output in tzarist Russia.

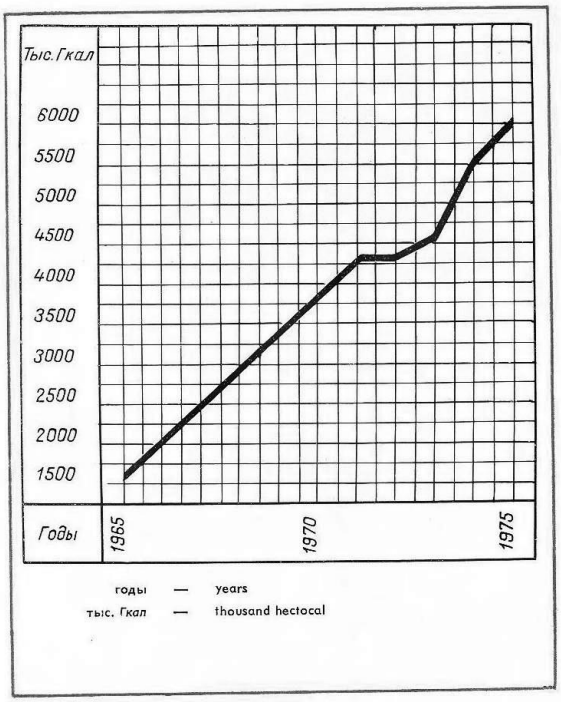
In 1920 the Soviet power was established in Armenia as a result of the victory of a national uprising supported by the Red Army. The people took the wealth of the country in their own hands.



Installed Capacity of Armenian Power System Stations



Power Output in Armenian SSR



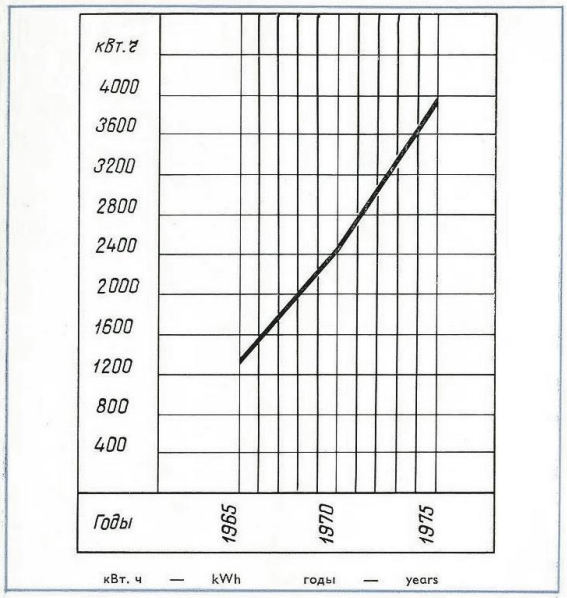
Thermal Power Delivered by Power Stations of Armenian Power System

The development of the Republic's national economy was determined by the Lenin's GOELRO plan (Plan of electrification of Russia) which envisaged in particular, the construction of a hydroelectric power plant of about 85-thousand kW capacity on the Goktcha (Sevan) lake. During the early step of development of power generation, emphasis was laid on local power resourses, i. e. on hydraulic power.

In early twenties, it was decided to build a hydroelectric power station on an irrigation canal near Yerevan. In May, 1926, the first stage of the Yerevan hydroelectric power station comprising two 880-kW water-wheel generators was put in operation and in 1929 its capacity was as high as 4560 kW. At the same time, power transmission lines of 22 kV connected the hydroelectric power station with the Aygerlitch pump plant (the first mechanical irrigation installation) and then, with the Arzni health resort.

The best equipped hydroelectric power stations built during the first Five-Year Plans were the Dzoraget station of 22.2-thousand kW capacity on the Dzoraget river (1932) and the Yerevan-2 hydroelectric power station of 2.4-thousand kW capacity (1932), the latter being the first automated station in the USSR. The Dzoraget station was connected with the Kirovakan city via the first in Armenia power transmission line of 110 kV.

In spite of apparent success achieved in the construction of



Power Output per Capita in Armenian SSR

hydroelectric power stations it was obvious, however, that dependable power supply for the needs of national economy cannot be ensured through the utilization of the run-off of mountain rivers which have no water reservoirs for hold-over storage. A necessity arose to build power stations having a stable power output all year round, such as thermal-electric stations or hydroelectric stations with seasonal storage reservoirs. Since Armenia has no fuel deposits and the cost of imported fuel was rather high at that time, the development of hydroelectric power engineering was quite natural.

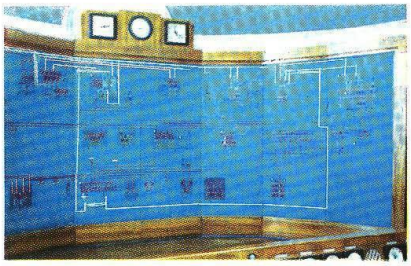
The problem of reliable power supply for the needs of the Republic's industry and agriculture and of the development of the irrigation system was solved due to the utilization of the Sevan lake and Razdan river waters.

In 1931 a plan was drawn up envisaging the utilization of the waters of the Sevan lake and the Razdan river for irrigation and power generation. It was planned to construct a cascade of six hydroelectric power stations and 17 irrigation canals to supply water to a cultivated area of 120 thousand hectares in the Ararat plain.

The Kanaker station was the first of the cascade. The first water-wheel generator of this station (10.6 thousand kW) started in 1936 made it possible to afford highly dependable power supply to the consumers of the Yerevan power centre and to join the hydroelectric stations of the Republic for parallel operation. By that time the Armenian regional power system management (Armenergo) was organized.

Since early 1938, as the construction of the Kirovakan-Spitak-Yerevan, and then Spitak-Leninakan 110-kV power transmission line was brought to the end, Armenergo began joining the hydroelectric stations for parallel operation. Hence the Kanaker station was combined with the Dzoraget station and its capacity reached 42 thousand kW. Somewhat later, the Kanaker station was placed in joint operation with No. 1 and No. 2 Yerevan stations, and by the end of that year, with the Leninakan station.

Thus, by the end of 1938 all the power stations of the Republic were united into the Armenian power system, the leading one being the Kanaker power station which has considerably increased the reliability of power supply for the needs of national economy due to its storage ability.



Armglavenergo Control Center Switchboard

Layout of Power System of Armenian SSR

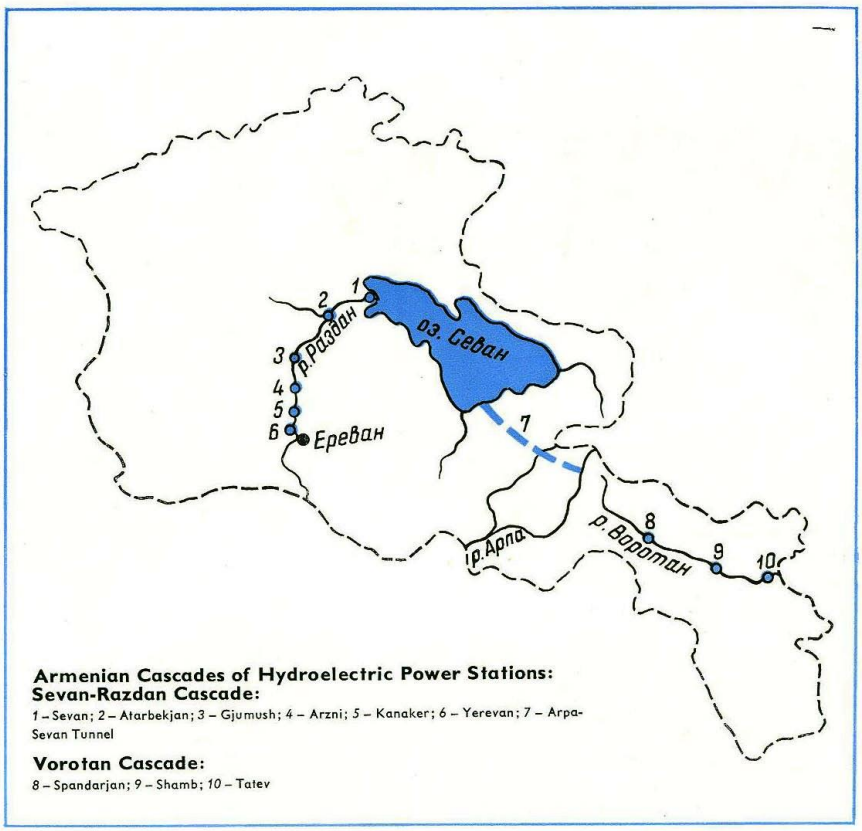
All the power stations built and placed in service after 1938, with the exception of a few ones, were included into the power system. Only farming power plants of Selenergo and collective farms, as well as small hydroelectric power stations and the power generating train belonging to the enterprises of the Ministry of Non-ferrous metallurgy in the south of Armenia were not joined to the Republic's power system. These power stations were included in the system in 1958 after the Atarbekyan-Shinuajr-Kadzharan 220-kV power transmission line was completed.

The construction of the first stage of the Sevan-Razdan cascade, the Sevan hydroelectric power station, was started in 1940. This station was meant, in addition, to function as a water intake; preparatory work was carried out for the construction of the Gjumush hydroelectric power station. When the Great Patriotic War broke out, the construction of power generating and supply installations was ceased for the time being. The war was not yet over, however, when the construction of the Sevan-Razdan cascade was recommenced. In 1953 the largest Gjumush hydroelectric power station of 224-thousand kW capacity was placed in operation. The power output of the Armenian system grew twice as high. The characteristic feature of the power system of that time was that it included, for the most part, high-manoeuvrability hydroelectric power stations.

In the second half of the fifties the initial plan of utilization of the Sevan lake waters was revised. Backed up by a great experience in the hydropower construction in the USSR, the Armenian specialists were able to build high-dam hydroelectric power stations on the Vorotan river. Meanwhile, an immense progress in Soviet thermal power engineering gave rise to the construction of thermal power stations in Armenia. The plan was revised and a decision was adopted by the USSR government to maintain the water level of the Sevan lake as close as possible to its natural level, to reduce the water pass from 1200 to 500 million cu. m (380 million cu. m for irrigation and 120 million cu. m for power generation). To restore water storage in the Sevan, it was envisaged to build a tunnel of more than 48 km to transfer part of the Arpa river flow to the Sevan lake.

In 1960 the output of the Armenian power system reached 577 thousand kW. However, it was insufficient to compensate for the reduction in power output of the Sevan-Razdan cascade while the power demand of industry and agriculture was growing. In 1960 the power systems of the three Transcaucasian Republics Azerbaijan, Georgia, and Armenia — were joined to operate in parallel. Power transmission lines were brought to the Akstafa switchgear centre from the Mingetchaur hydroelectric power station of Azglavenergo, from the Tbilisi supercentral power station of Gruzglavenergo, and from the Atarbekjan hydroelectric power station of Armglavenergo. The power deficiency in the Armenian power system was compensated for by power transmitted from Azerbaijan. The 220-kV power transmission lines connecting the Akstafa and Tbilisi stations as well as the Akstafa and Mingetchaur stations were changed in 1964 to 330 kV, which made it possible to transmit more power to the Armenian power system.

The first large thermal-electric station of the open type was put in operation in Yerevan in 1963. The Kirovakan heat-electric



Armenian Cascades of Hydroelectric Power Stations:
Sevan-Razdan Cascade:
1 – Sevan; *2* – Atarbekjan; *3* – Gjumush; *4* – Arzni; *5* – Kanaker; *6* – Yerevan; *7* – Arpa-Sevan Tunnel

Vorotan Cascade:
8 – Spandarjan; *9* – Shamb; *10* – Tatev

generating plant was started in 1964. The thermal-electric engineering was further developing cumulatively. During the eight Five-Year Plan (1966–1970) the investment in power engineering grew twice as large as during the preceding five years. 682-thousand kW capacity was newly assimilated, including that of the Razdan heat-electric generating plant (300 thousand kW), the Yerevan heat-electric generating plant (200 thousand kW), Kirovakan heat-electric generating plant (25 thousand kW). The construction of the Razdan supercentral power station was developed. The design capacity of this station is 1200 thousand kW.

In 1970 the Tatev hydroelectric station of 157.2-thousand kW capacity was built on the Vorotan river. The construction of the first Armenian atomic power station was started.

In 1970 the capacity of the power system reached 1677 thousand kW and its power output considerably increased.

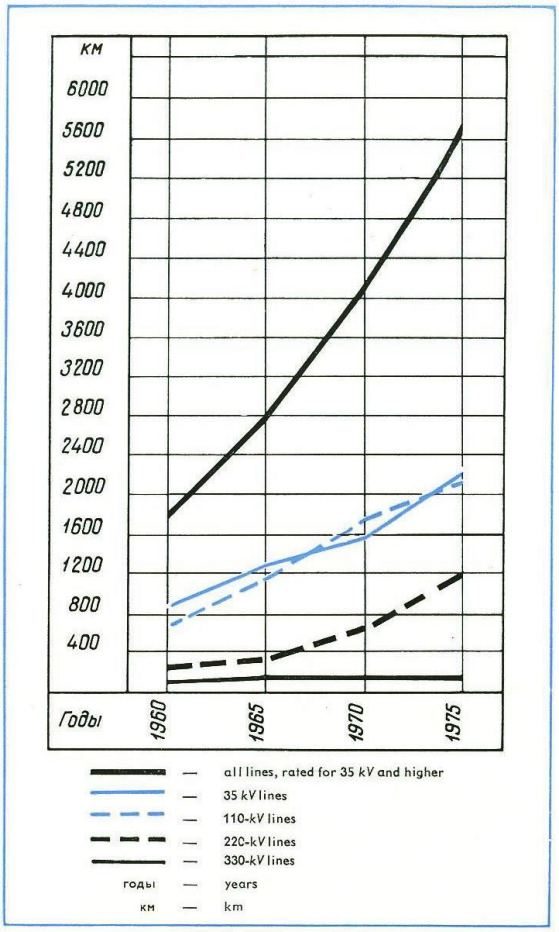
Along with the construction of power stations, power transmission lines and substations were erected, particularly after 1960. In 1970 the length of power transmission lines, rated for 35 kV, increased almost twice, that of lines, rated for 110 kV, 2.5 times, and that of 220-kV lines, almost 3 times. Within

ten years the transformer power capacity grew six as high and reached 4300 thousand kVA. While in 1960 the power system did not comprise 220-kV substations, in 1970 the installed capacity of 220-kV substation transformers made up 1030 thousand kVA.

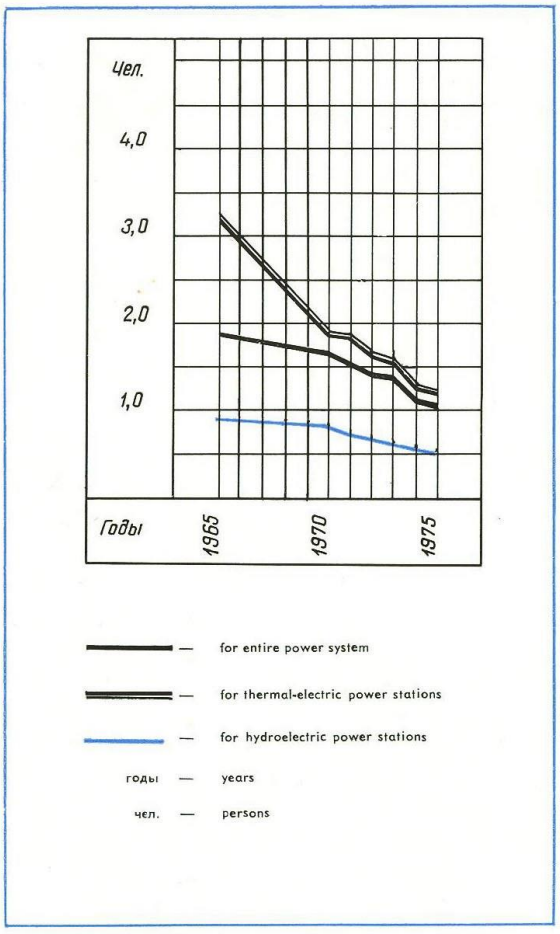
A new technology has been widely introduced in the Armenian power system since 1950. Technological processes on the hydroelectric power stations have been automated.

By 1965 the water-wheel generators of all the main hydroelectric power stations of the system were fully automated. The Sevan, Dzoraget, No. 1 and No. 2 Yerevan hydroelectric power stations were shifted to automatic control without constant attending personnel. Measures were taken on the main hydroelectric power stations to make their water-wheel generators suitable for running as synchronous condensers, sixteen of them being changed over to synchronous condenser operation automatically. Automatic water-coarse regulators were installed in the Dzoraget, Atarbekjan and some other hydroelectric stations. To ensure trouble-free operation of the automated hydroelectric power stations, the latter were reconstructed, the equipment was renewed, closed-circuit electrical control, telemechanics and high-frequency coupling over the high-voltage lines were introduced.

In 1965 the centralized power and frequency control system was fully introduced and made it possible to automatically control power transmission over the intersystem 330-kV line



Grow of Length of High-Voltage Power Transmission Lines in Armenian Power System



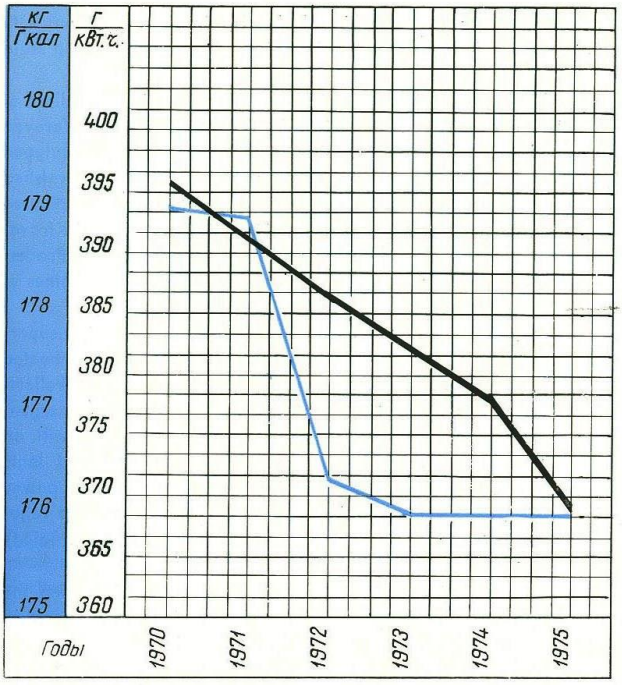
Number of Industrial Production Personnel per 1000 kW of Installed Capacity

connecting the Atarbekjan hydroelectric power station with Akstafa. The power system is controlled from the Yerevan main control centre.

Great attention was given to the automatic controllers of thermal processes. Hence, in 1965 six boiler units of the Yerevan and Kirovakan heat-electric generating plants were equipped with automatic feed controllers, two boiler units were furnished with combustion controllers and three units received superheated steam controllers. Deaerating plants of the Yerevan and Kirovakan heat-electric generating plants are fully automated. Process protective gears were introduced in the boilers and turbines of these stations.

The 200-MW power generating units of the Razdan supercentral power station incorporate feed controllers, superheated steam temperature controllers, condenser vacuum controllers, thermal load controllers, furnace pressure controllers, emergency spray controllers, etc. The power units are equipped with an automatic control system built around computers and logic circuits. The cooling towers of the Razdan supercentral power station are furnished with automatic differential pressure regulators which control the pressure of inlet and outlet (cooled) water.

The Republic's industrial production will rise during the ninth Five-Year Plan (1971–1975) by more than 60 per cent. As a result, the growing demand of electric and thermal power will cause an increase in the generation of electric power to 9.1 milliard kWh and in the thermal power supply to consumers of up to 6 million hectocalories.



— per 1 Hectocal of heat

— per 1 kWh of electric power

годы — years

кг/Гкал — kg/Hectocal

г/кВт.ч — G/kWh

Specific Consumption of Arbitrary Fuel for Power Stations of Armenian Power System

Four 200-thousand kW power units are being placed in operation on the Razdan supercentral power station. The Kirovakan heat-electric generating plant is expanding. The construction of the Armenian atomic power station of 815-thousand kW capacity is now underway. The middle and upper stages of the cascade of hydroelectric stations on the Vorotan river – the Shamb station and the Spandaryan hydroelectric power station – are still under construction. The Arpa-Sevan tunnel will be soon completed. The water level in the Sevan will be maintained constant while water passage from the lake for power generation will be increased mainly in winter time. As a result, the Sevan-Razdan cascade of hydroelectric power stations will contribute more to the control of the power system loads.

1600 km of power transmission lines, rated for 35 kV and higher, will be put in operation within the ninth Five-Year Plan. New power transmission lines (2000 km) and substations of 0.4 to 10 kV are being further erected to satisfy the needs of farming and domestic power consumers.

The organization and development of the electric power system in Armenian SSR accomplished with the brotherly assistance of all the peoples of the Soviet Union was closely connected with the creation and advance of national specialist in the job. Many of those, who started from Armglavenergo, are now working in many electrical enterprises of the all-Union importance.

MAIN POWER STATIONS OF POWER SYSTEM OF THE ARMENIAN SSR

Razdan Thermal-Electric Power Station

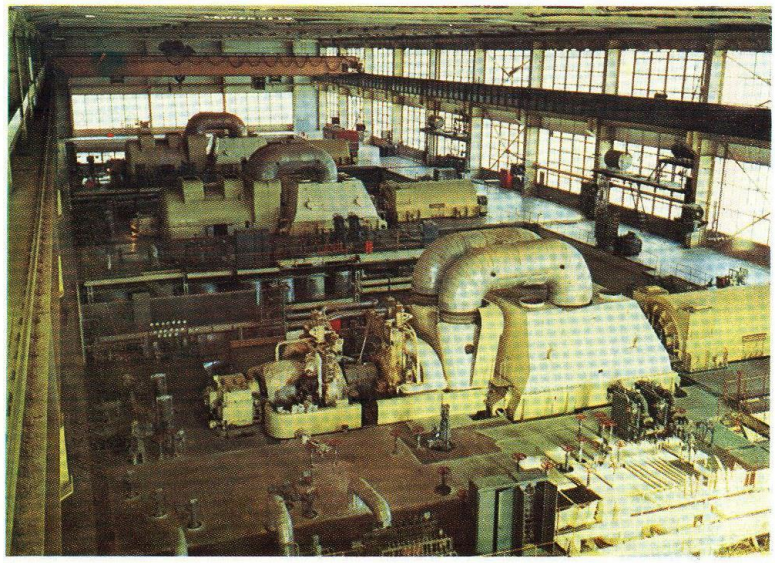
The Razdan Supercentral Power Station is a power-generating enterprise comprising a condensing power plant and a heat-electric generating plant both having a common management.

Design power of the condensing power plant is 1200 thousand kW. The plant comprises power units each consisting of a 200-thousand kW turbine unit and a 640-t/h boiler unit. The irst power unit was placed in operation in 1971.

The heat-electric generating plant capacity is 300 thousand kW. It comprises two 50-thousand kW turbine units, two 100-thousand kW turbine units, and five 320-t/h boilers. The first turbine unit was put in operation in 1966 and the last one, in 1969.

Fuel is furnace oil and gas.

Razdan Supercentral Power Station. General View



Razdan Supercentral Power Station. Turbine House

Razdan Supercentral Power Station.
Main Control Board

Yerevan Heat-Electric Generating Plant

The plant capacity is 550 thousand kW. It comprises five 50-thousand kW heat-generating turbine units with five 420-t/h boiler units, and two power generating units, each comprising a 150-thousand kW turbine unit and a 500-t/h boiler unit. The first turbine unit was started in 1963, the last (seventh) one, in 1966.

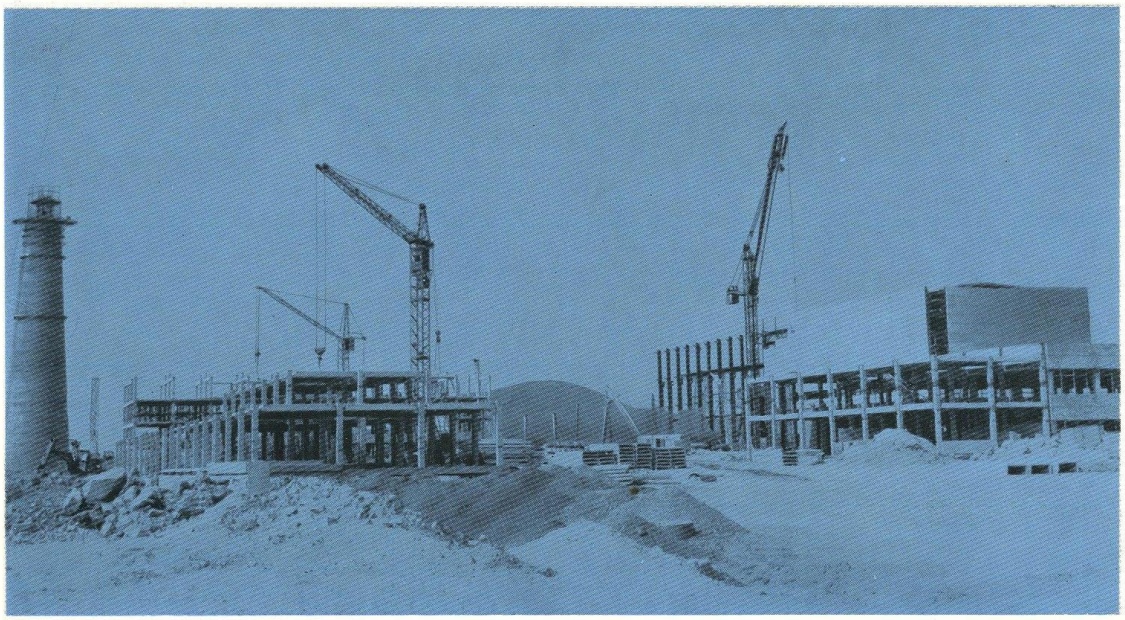
Fuel is furnace oil and gas.

Yerevan Heat-Electric Generating Plant. General View

Armenian Atomic Station

Design capacity of the station is 815 thousand kW. It comprises two power-generating units. Each unit consists of water-moderated water-cooled power reactor ВВЭР-440 and two 220-thousand kW turbine units.

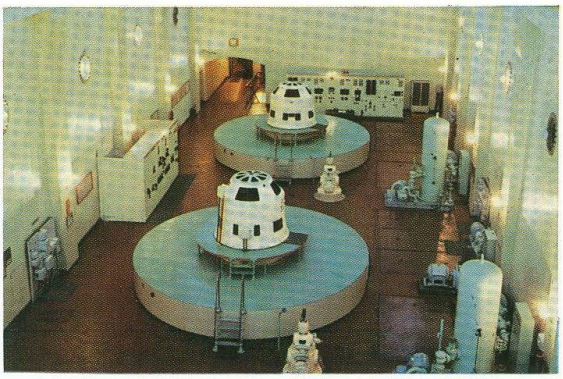
Armenian Atomic Station. Construction Site



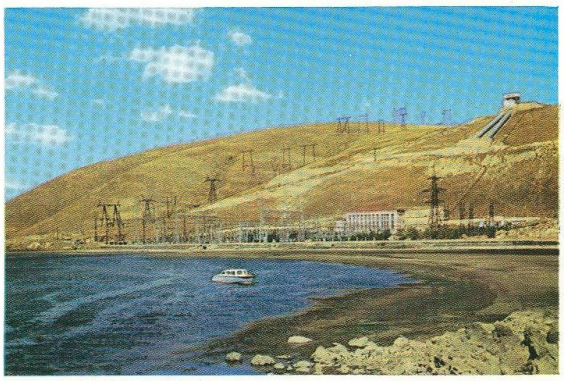
Sevan-Razdan Cascade of Hydroelectric Power Stations

The cascade includes six stages. The total installed capacity is 556 thousand kW; average annual power output within the period of 1963 to 1972 has made up 1.21 milliard kWh.

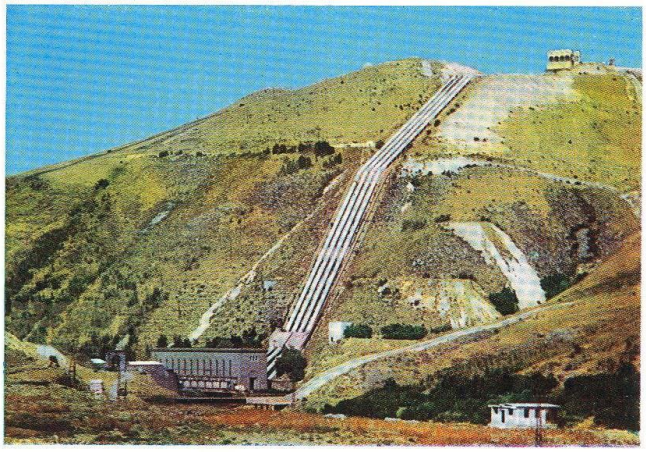
Hydroelectric power stations	Capacity, thousand kW	Mean annual output, million kWh	Number and power of units, MW per unit	Rated flow rate, *cu. m/s*	Maximum head, *m*	Volume of water basin, million *cu. m*		Year, placed in operation
						full	useful	
Sevan	34.24	57.4	2×16.96 1×0.32	65.0	50.0	—	—	1948
Atarbekjan	81.6	161.3	2×40.8	70.0	138.0	—	—	1959
Gjumush	224.0	453.5	4×56.0	70.0	297.0	5.6	4.1	1953
Arzni	70.56	199.0	3×23.52	70.0	118.0	1.0	0.3	1956
Kanaker	102.0	225.5	4×12.5 2×26	60.0	173.0	—	—	1936
Yerevan	44.0	114.0	2×22.0	62.0	90.8	0.3	0.1	1961

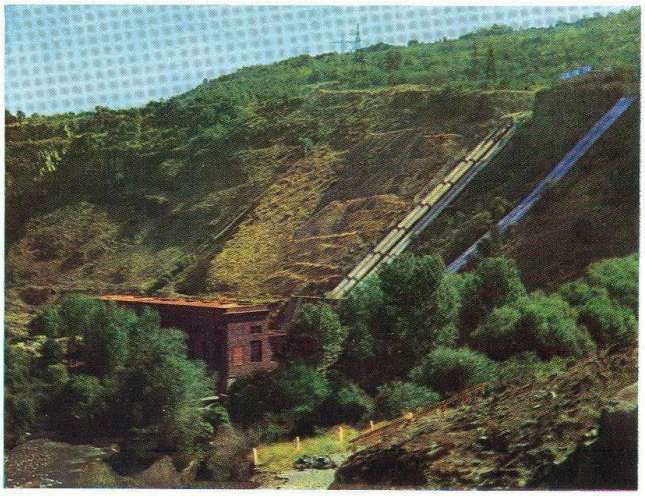


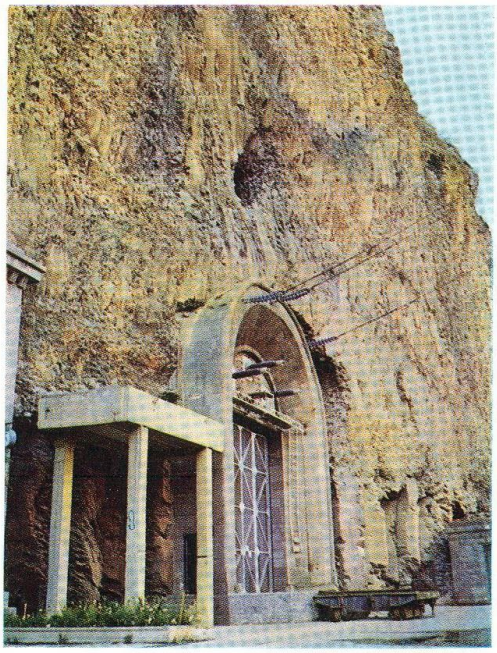
Sevan Hydroelectric Power Station. Underground Turbine House

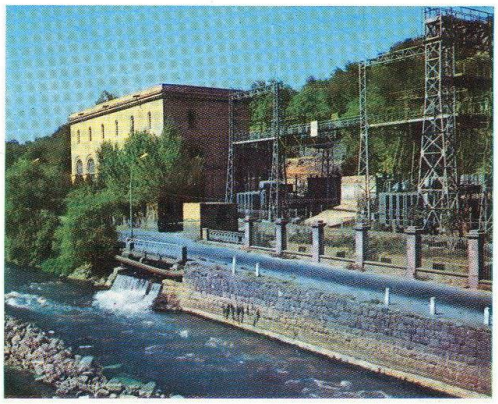


Atarbekjan Hydroelectric Power Station. General View of Head Centre









Gjumush Hydroelectric Power Station. General View of Head Centre

Arzni Hydroelectric Power Station. Entrance to Underground Building of Station

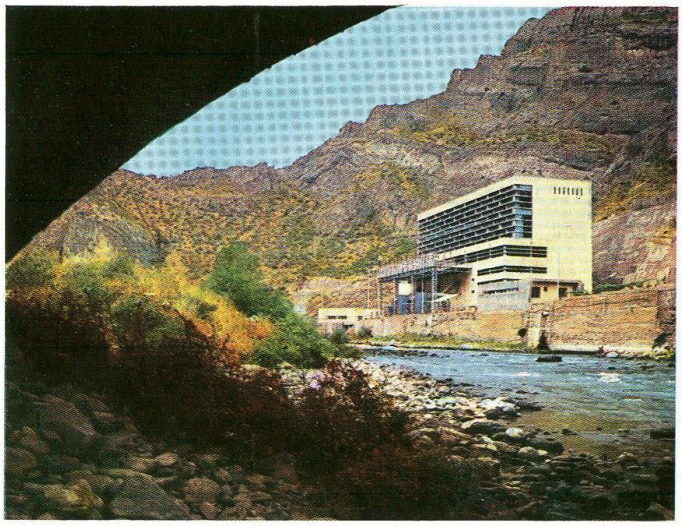
Kanaker Hydroelectric Power Station. General View of Head Centre

Yerevan Hydroelectric Power Station. View on Station Building and Substation

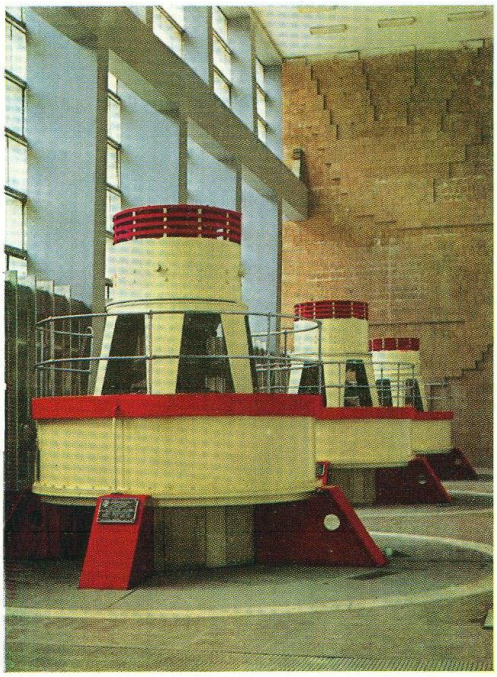
Vorotan Cascade of Hydroelectric Power Stations

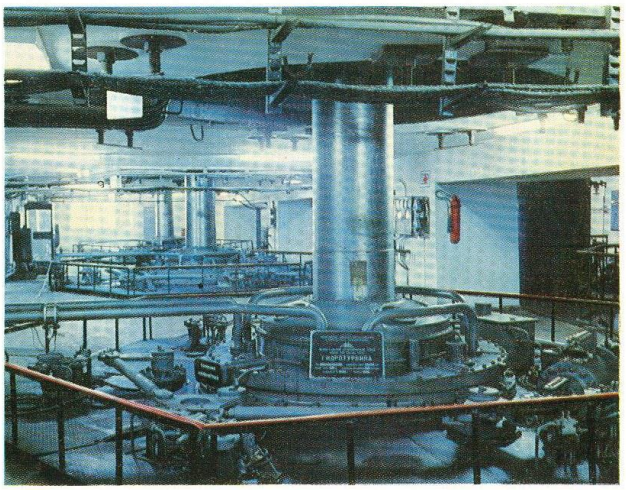
This cascade of three hydroelectric power stations is being built on the Vorotan river. The total installed capacity of the cascade stations is 404.2 thousand kW. Mean annual output is 1.1 milliard kWh.

Hydroelectric power stations	Capacity, thousand *kW*	Mean annual output, million *kWh*	Number and power of units, *MW* per unit	Rated flow rate, *cu. m/s*	Maximum head, *m*	Volume of water basin, million *cu. m*		Year, placed in operation
						full	useful	
Spandarjan	76	157	2×38.0	30	394	277	237	1977
Shamb	171	330	2×85.5	75	314	96	80	1976
Tatev	157.2	670	3×52.4	33	576	13.6	1.8	1970



Tatev Hydroelectric Power Station. View on Station Building





Tatev Hydroelectric Power Station. Water-Wheel House

Tatev Hydroelectric Power Station. Turbine House

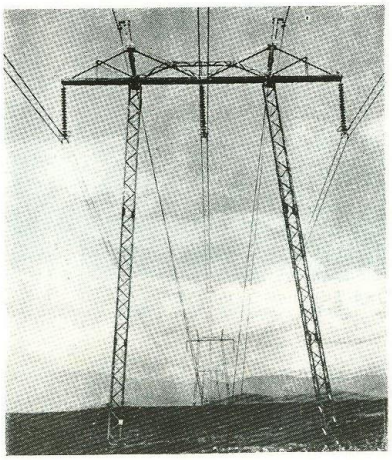
ELECTRIFICATION OF NATIONAL ECONOMY IN ARMENIAN SSR

The dependable electric power system of the Republic has made it possible to develop industry, farming, agriculture, to improve the living conditions of the population, to raise their standard of culture.

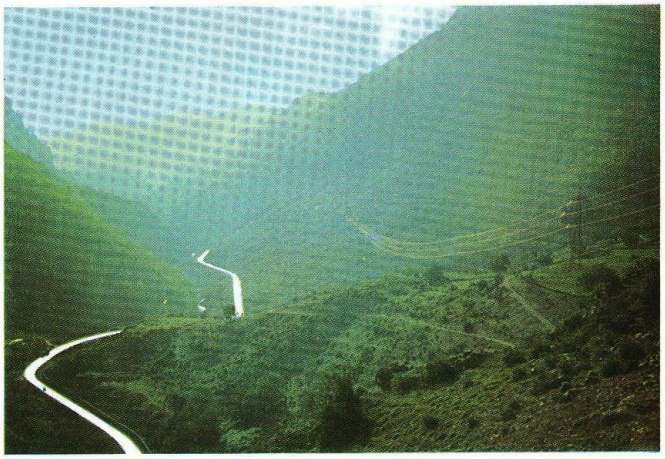
Power Consumed in Armenian SSR, million kWh/per cent

Description	Years			
	1960	1965	1970	1975 (planned)
Power output	2746.8	2855.2	6107.5	9110
Power supply to consumers	2716.4	3858.7*	5755.2	7557
	100	100	100	100
including:				
Industry and construction	2320.4	3109.5	4388.9	5362
	85.4	80.6	76.1	71
Transport	44.1	112.9	187.0	265
	1.6	2.9	3.3	3.5
Agriculture	110.6	287.8	511.3	870
	4.1	7.5	8.9	11.5
Domestic needs of urban population	224	290.4	525.0	850
	8.3	7.5	9.2	11.2

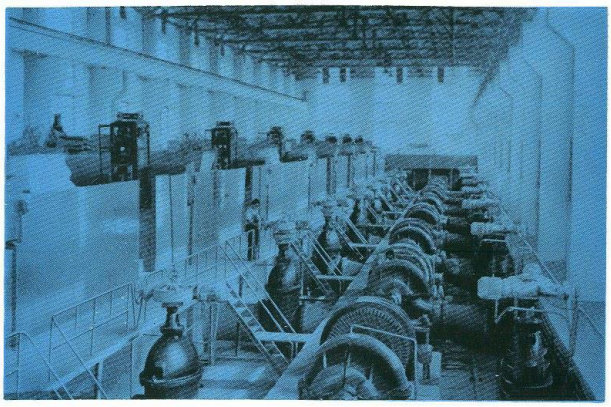
* Power supply to consumers exceeds the power output which is compensated for at the expense of the neighbouring power systems included in the Transcaucasian united power system.



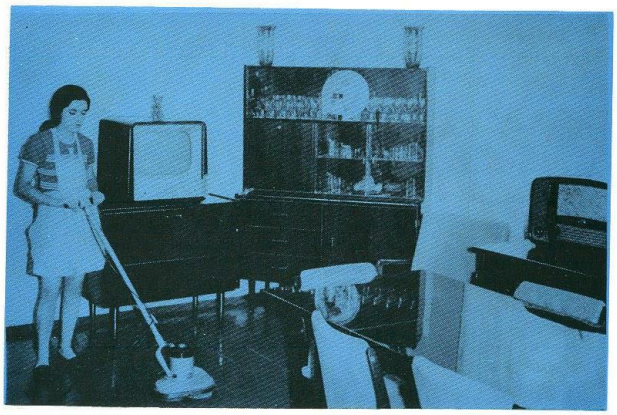
Duralumin Tower on 220-kV Power Transmission Line Connecting the Atarbekjan Hydroelectric Power Station with No. 2 Shaumyan Substation



In Zangezur Mountains to Connect Kafan with Kadzharan



Electromechanical Irrigation. Mkhtchan Pumping Station in the Artashat District



Electricity is working in each house

A 48-fold increase in the production output of Armenia was achieved in 1972 as compared with the prewar year of 1940. Power requirement for industry has increased 17-fold within the same period of time. While in old times Armenia displayed at international fairs and exhibitions only agricultural raw materials and their produce, the range of goods exported by Soviet Armenia has considerably extended. Nowdays, Armenia exports abroad manufactured goods, such as electrical machines, machine-tools, electronic devices, etc. The Republic delivers its goods to all the regions of the Soviet Union and to 70 foreign countries.

Armenia is now growing into one of the USSR centres of manufacture of electronic computers. The "Razdan" and "Nairi" series of transistorized computers, which were designed and manufactured exclusively by Armenian specialists, have gained a fine reputation.

The development of economics of the Republic has brought about a considerable increase in freight turnover. Electrification of the Tbilisi-Leninakan-Yerevan-Sevan mainline railway has made it possible to greatly increase its capacity. The total length of electrified railways in Armenia is about 500 km.

Power consumption in agriculture has increased 62 times in 1972 as compared to 1940. Full electrification of agriculture was completed as early as in 1960 through the use of local power plants. By the close of 1964 the Armenian power engineers were first in the USSR to transfer all the farming power consumers to centralized power supply from the power system lines. Old power transmission lines were modified and new lines of 0.4–6–10 and 35 kV with substations were erected.

Внешторгиздат. Заказ № 431Э

Vsesojuznoje Exportno-Importnoje Objedinenije "Technopromexport" renders, on request of foreign firms and organizations, various kinds of technical services associated with the construction of steam, gas turbine, Diesel-engine and hydraulic power stations, transformer substations and power transmission lines on all the continents of the globe and under various climatic conditions.

V/O "Technopromexport"

— carries out surveying and other jobs which are necessary for devising technical and economical substantiation of the expediency of erection of a power project or a complex of such projects and for expansion of the power system of a region (country);

— works out technical projects for the construction of power projects or their complex with a detailed description of the methods for carrying out the jobs enumerated.

The above-mentioned work is performed by special design organizations on the basis of the latest developments achieved in realizing power projects both in the USSR and abroad.

V/O "Technopromexport" can deliver:

— complete power-generating and electrical equipment and materials;

— construction and erection equipment, machines and mechanisms needed for the construction and erection of process equipment for the power projects.

The equipment being delivered has been developed with due regard to the latest achievements in the USSR at the moment of placing the order and manufacturing the requisite equipment. Detailed specifications for the equipment offered can be sent by the Objedinenije to your address on the first request.

V/O "Technopromexport"

— sends its experts for rendering all the necessary services associated with preparatory, surveying and research work, construction, erection, setting-up and commissioning of power projects;

— carries out professional training of local attending personnel both on the construction site and in the Soviet Union.

All inquiries should be addressed to V/O "Technopromexport"

Postal address: V/O "Technopromexport", 18/1, Ovchinnikovskaja nab., Moscow, Zh-324
Cables: Moscow Technopromexport
Telephone: 220-15-23
Telex: 158

TECHNOPROMEXPORT
SSSR·MOSKVA