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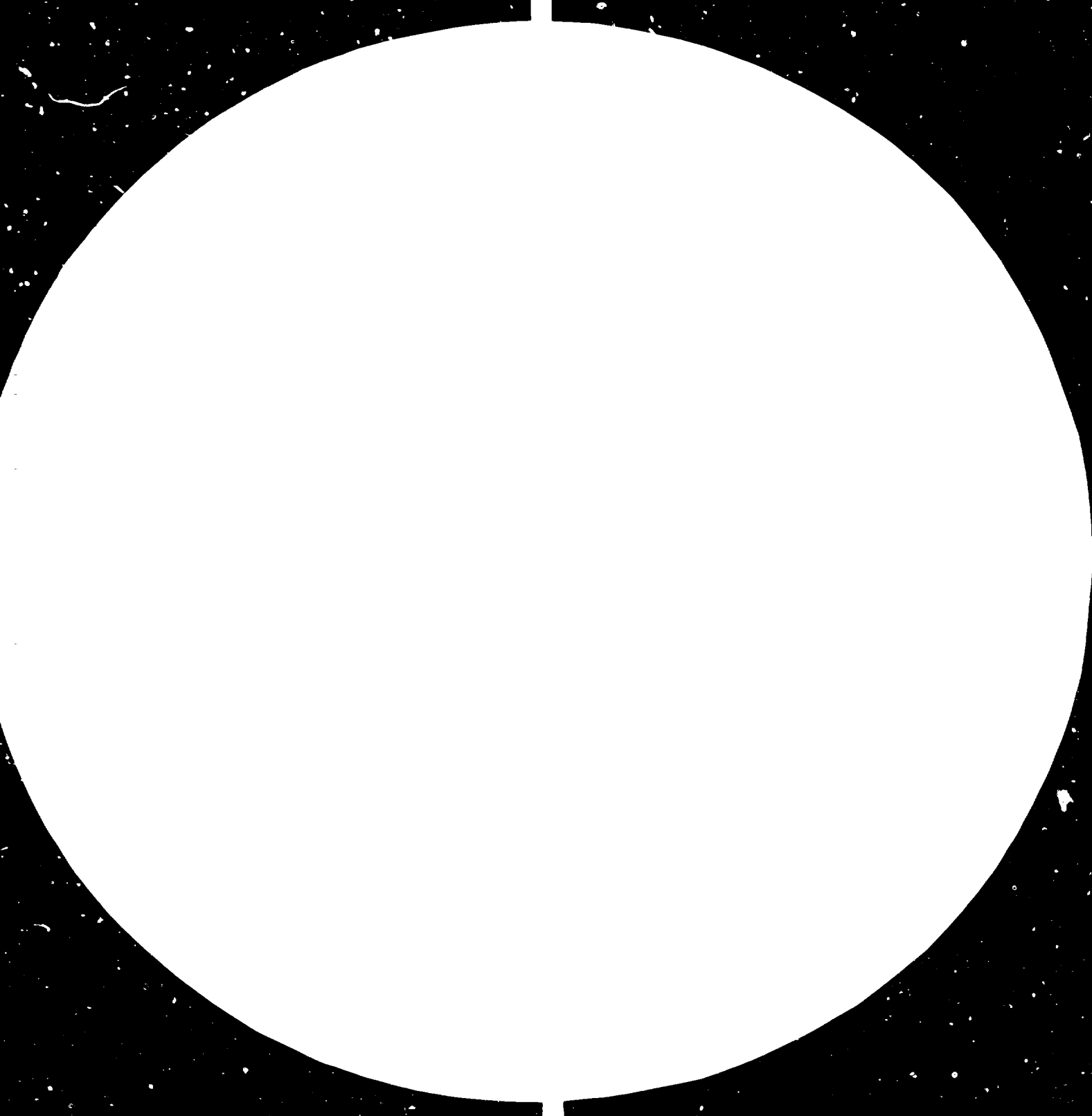
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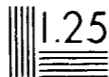
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Resolution test pattern 2.0, consisting of five vertical lines on the left and five horizontal lines on the right, with the number 2.0 in the center.

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Resolution test pattern 1.8, consisting of five vertical lines on the left and five horizontal lines on the right, with the number 1.8 in the center.

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SMALL-SCALE HYDRO-POWER PLANTS
IN YUGOSLAVIA*

by

Dzemat Humo**

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ELECTRO-ENERGY SYSTEM

Yugoslavia comprises area of 255.800 km² and it has 22 million inhabitants. It is organized on the federal principle and it consists of six federal republics and two autonomous provinces.

All affairs relating to planning and construction of electro-energy facilities as well as production and distribution of electrical energy have been effecting in republics but coordination and unification of all these affairs have been performing in the Government institutions and associations of electro-industrial organizations of republics.

We consider that the most important event in the development of electro-energy system in Yugoslavia was ending of the Second World War (1945) when the country got its liberty, changed the social structure and started the regeneration of the country which was destroyed during the war and construction of industry which almost did not exist before.

Electrification of Yugoslavia started at the end of XIX century by construction of the small-scale plants for needs of local industry and household.

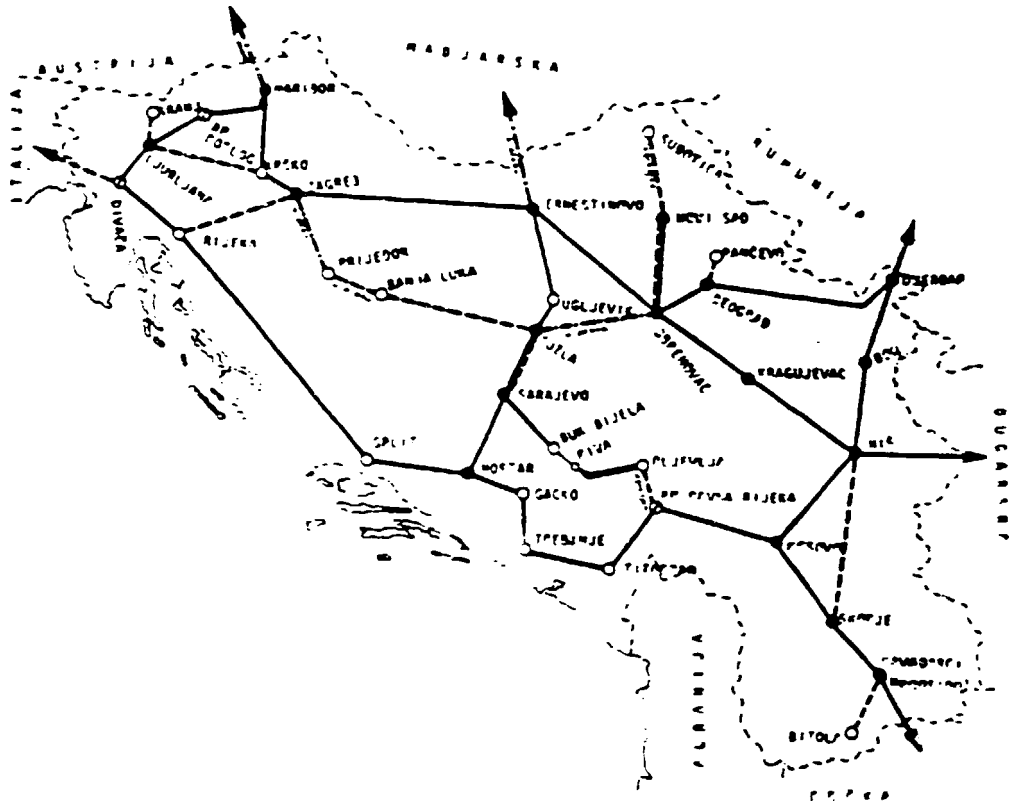
Up to 1945, Yugoslavia possessed a lot of autonomous electro-energetics systems which were consisted of one, two or more plants with the highest transmission voltage of 30 (35) kV.

After 1945, sudden development of industry as well as of electro-energetics sources have begun so that need for transmission of electrical powers of 50 MW has appeared. This has had great influence on construction of transmission lines 110 kV in particular republics. Soon, it has appeared necessary to connect these autonomous systems and Yugoslavia has got unique - interconnected electroenergetics system with voltage of 110 kV.

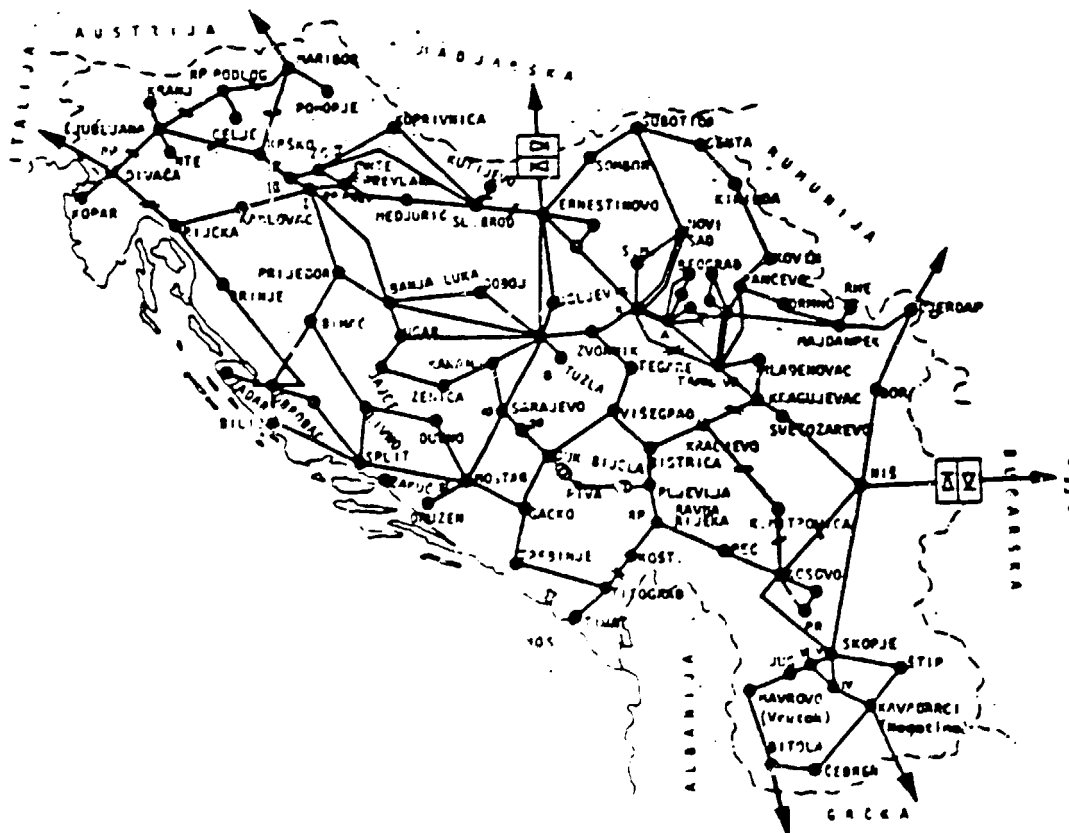
Further economic development has formed the need for electrical powers of 200 MW so that the construction of 220 kV lines and 380 kV lines began in Yugoslavia in 1950 respectively in 1965.

Yugoslav 380 kV network in 1980 and planned 380 kV network in 2000 are given on the following two diagrams.

YUGOSLAV 380 KV NETWORK IN 1980



YUGOSLAV PLANNED 380 KV NETWORK IN 2000



The boundaries shown on maps do not imply official endorsement or acceptance by the United Nations.

As it can be seen from the above diagrams, the base of Yugoslav electroenergetics system forms 380 kV network in ring form with transversal connections and it connects big plants with consumption centres and at the same time it exchanges electrical energy as with border countries so with big interconnections OES SEV and UCPTÉ.

Some statistical data on the development of Yugoslav electro-energy system in last four decades are given in the following tables.

Total consumption of electro energy, in GWh

| Year | 1950 | 1960 | 1970 | 1980 * |
|--------|-------|-------|--------|--------|
| Energy | 1,949 | 7,329 | 21,857 | 55,400 |

Consumption per inhabitant, in kWh

| Year | 1950 | 1960 | 1970 | 1980 * |
|--------|------|------|-------|--------|
| Energy | 119 | 398 | 1,073 | 2,310 |

Total installed power, in MW

| Year | 1950 | 1960 | 1970 | 1980 * |
|--------|------|-------|-------|--------|
| Hydro | 290 | 1,391 | 3,636 | 6,881 |
| Thermo | 383 | 1,077 | 3,243 | 8,904 |
| TOTAL | 673 | 2,468 | 6,879 | 15,789 |

The highest individual power of generating set, in MW

| Year | 1950 | 1960 | 1970 | 1980* |
|--------|------|------|------|-------|
| Hydro | 21 | 24 | 175 | 240 |
| Thermo | 32 | 110 | 200 | 600 |

Length of lines in km

| Year | 1950 | 1960 | 1970 | 1980* |
|--------|------|-------|-------|--------|
| 110 kV | - | 5,428 | 8,770 | 15,612 |
| 220 kV | - | 409 | 3,691 | 6,027 |
| 380 kV | - | - | 203 | 3,297 |

* planned

Chart of hydroelectric sources of Yugoslavia is given on the following page for the purpose of illustration.

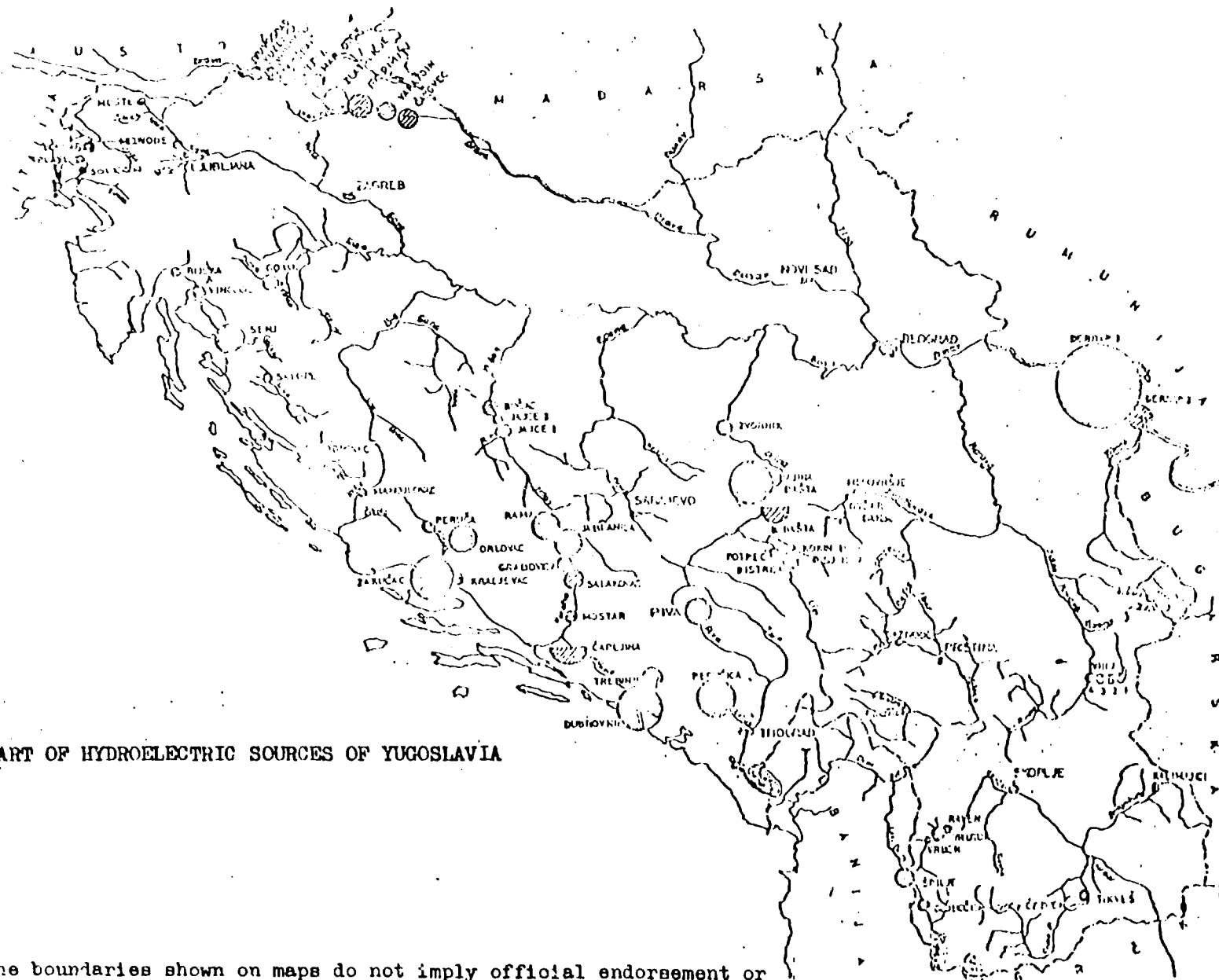


CHART OF HYDROELECTRIC SOURCES OF YUGOSLAVIA

The boundaries shown on maps do not imply official endorsement or acceptance by the United Nations.

SHORT HISTORY OF THE SMALL-SCALE HYDRO-POWER PLANTS

We have already mentioned that electrification of Yugoslavia started at the end of XIX century. So, in the period before the Second World War Yugoslavia had a several hundred of the small-scale hydro-power plants in operation. They were mostly run of the river plants of small power, which were used for autonomous power supply of the small trade shops or nearby settlements. We have already stated that after 1945, large number of separate electrical networks of voltage up to 30 (35) kV were gradually changed for interconnected systems of 110, 220 and 380 kV. By construction of big sources of electrical energy and of strong and jagged transmission network, small plants have lost a lot of their former importance so that almost all of them have stopped the operation or they still exist but as museums. In these conditions electrification of small and distant consumers has been done by construction of long lines of medium voltage (10 and 35 kV) which sometimes transmits insignificant powers what, in any case, represents uneconomical solution.

We have already stated that in the last period the intention was to build big hydro-power plants and thermo-plants so it was necessary to investigate the basic hydro-potentials and determine locations for construction of so - called valley reservoirs on all large water currents while possible locations for construction of small reservoirs and plants, especially of those in hilly and mountainous region in Yugoslavia are under investigation only now, although this region comprises 80% of the national territory.

PRESENT VIEW ON CONSTRUCTION OF THE SMALL-SCALE HYDRO-POWER PLANTS

Energy crisis which appeared in 1973 and which is stronger every day made the whole world and so Yugoslavia to pay

a lot of attention to production of energy, and to rely on its own resources as much as possible. We, in Yugoslavia, also examine the possible substitutions of the classical energy sources: solar energy, wind energy, tide energy etc. That's why, we have started reconstruction of the existing small-scale hydro-power plants and construction of the new ones with great care.

So, in the field of the small-scale plants in the period 1975 - 1980 it was done, i.e., it has been working on:

- Taking of an inventory of areas and determination of location of small reservoirs and small-scale hydro-power plants,
- Standardization and classification of hydro-mechanical, mechanical and electroequipment as well as of the appurtenant hydro-energetics facilities.

In Yugoslavia nowadays, an action is undertaken to build about 750 small-scale hydro-power plants in mountainous region in the period 1980-2000. These plants are to be plants with autonomous power supply of the particular consumers and with possibility of parallel operation with local distributive network. If we add to this the possibility of construction of several hundred plants in valley regions, then, we are talking about construction of 1000 small-scale hydro-power plants in Yugoslavia during following several decades.

Construction of the small-scale hydro-power plants and reservoirs, especially in the mountainous region, should have multipurpose character:

- Water supply of inhabitants
- Irrigation of agricultural areas
- Production of electrical energy
- Improvement in water regime
- Development of fishing, tourism etc.

We have already stated in the first chapter "Electro-energetics system of Yugoslavia" that right and responsibility for power supply lie upon each republic and that all plans of production and consumption are coordinated on federal level. So problems relating to construction of small reservoirs and hydro-power plants are not treated in each republic at the same time and in the same way. The situation is such also because of the fact that one republic has more water currents in valleys and the other one in mountainous region so the construction of small reservoirs and small-scale hydro-power plants in particular republic is more or less urgent.

Yugoslav conference on small-scale hydro-power plants held at Opatija from 21 to 23 May, 1979 is one among many events which shows that we, in Yugoslavia, take the problem of small-scale hydro-power plants in completely different way, much more different than it was several decades ago.

The following bigger design organizations and institutes from Yugoslavia deal with problems of designing of the small-scale hydro-power plants:

- Water power Institute "Jaroslav Černi", Beograd
- "Enerprojeekt", Beograd
- "Energoinvest", Sarajevo
- "Zavod za vodoprivredu", Sarajevo
- "Elektroprojeekt", Ljubljana
- "Elektrostopanstvo", Skoplje

The following factories and institutes deal with standardization and classification of the equipment:

- "Metalna", Maribor (hydro-mechanical equipment)
- "Litostroi", Ljubljana (turbine equipment)
- "Turboinstitut", Ljubljana (turbine equipment)
- "Bade Končar", Zagreb (electro-equipment)

All the above listed design organizations, institutes and factories are renowned Yugoslav institutions so that their services are considerably expensive in relation to the invested funds. Because of that, the new practice has been introduced so that these institutions are given to realize only their part of work and some less renowned design organizations and factories or even workshops that do not possess expensive technology of fabrication are to be included in designing and production of the equipment for small-scale hydro-power plants. It is also proposed that local authorities take on the problems relating to construction of small-scale plants and reservoirs. In connection with this, the construction of factory of the equipment for small-scale hydro-power plants "Elektromontaža" is in progress in Ohrid.

It is certain that, nowadays, we cannot talk about classification and standardization of the equipment for small-scale hydro-power plants in Yugoslavia as about something which has been already done.

We are still working on selection of types of turbines and generators, size of generating sets in connection with relation $Q-H$, constructional solutions of the particular structures and elements adaptable for simple production and easy maintenance, simple solutions in relation to regulation of number of revolutions and voltage, synchronization with the local distributive network, kind and scope of electrical protection as well as on possibility of automatic operation without permanent presence of personnel.

C O N C L U S I O N

Although considerably strong interconnected electro-energetics system which comprises the whole territory and reaches, in most cases, the remote mountainous regions and villages, connected to the strong European interconnected systems, has been constructed in Yugoslavia, we have been planning, lately, the construction of small reservoirs and small-scale hydro-power plants which can completely justify its construction in normal conditions as well as in exceptional conditions in which we can find ourselves.

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YUGOSLAVIA

P.S.

This material has been prepared in such way so that it can give as many answers to the questions as possible, the answers which are requested in order to be processed, for this occasion, in "Country Paper".



