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ELECTRIFICATION OF RUSSIA

By Charles P. Steinmetz .

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THE ELECTRIFICATION OF RUSSIA.

In the early part of 1920, the Council of People's Economy was instructed by the legislative branch of the Russian government, the All-Russian Executive Committee, to work out a plan of electrification. Herefor a special committee was created, the "State Committee of Electrification of Russia", with Prof. G. Krizizhanovsky as chairman.

The following instructions given by the central executive committee are of interest in showing an understanding of the economic importance of electrification, which usually is not found amongst statesmen.

"It is recognized that electrification is of prime importance in the development of the natural resources. The concentration of the generation of power in large plants located at the sources of energy makes it possible to transmit and distribute in the most efficient way over the whole country by means of a network of electric lines, for industrial, transportation and other uses. It will be especially useful in supplying light and cheap power to the farmers for the various needs of everyday life, and so bring to the rural population the superior advantages of urban districts. It will also improve the facilities existing in the country for other home industries besides agriculture."

Over 180 engineers participated in working out the electrification plan, and the report of the Committee was issued recently in the form of a book of 655 pages, of the contents:

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The report says:

"The purpose of every economic activity is the obtaining of maximum results with the least effort, in other words, the obtaining of maximum efficiency. There are three ways in which the efficiency may be increased. 1) By doing, through increase of effort, more work in a unit of time. 2) By mechanization, that is, by substituting mechanical power for the muscular strength of men and animals. 3) By rationalization of the work, that is, by proper

organization and management and following a well laid out plan of production.

It can be easily shown that the electrification works in all three ways."

Then follows a discussion hereof.

The report then gives a review of the status of the Russian industries, and the electrical industry in particular, up to the war, and a statement of the effect of the war, as far as pertinent hereto.

It states that a total of three million horse power of prime movers was installed in Russia, in 1916. Of these, 1.8 to 2.0 million horse power were used for driving electric machinery. The aggregate capacity of public electric plants amounted to .45 to .5 million horsepower, that of private electric plants to 1.35 to 1.5 horse power.

It is interesting to note that Russia had a considerable electrical industry before the war, so that in 1913 more than half the electrical machinery used in Russia was built in Russia. These electrical industries were however largely owned and operated by foreigners, and in 1920 the output of the electric factories in Russia was very low. It is stated however, that their equipment including tools, etc. was perfectly intact and ready to resume large scale operation.

Of the importations, 86.6% came from Germany, 6% from England and 1.8% from the United States.

This figure does not fairly represent America's participation in the electric industry of Russia. While little was imported into Russia from America, a considerable amount of American electrical apparatus was built by the large branch factories operated in Russia by America's large electrical corporations. This appears amongst the 311540 KW in generators and motors, and 96313 KW in transformers, of a total value of seven million dollars, manufactured in Russia in 1913.

The basic problem considered in planning the electrification of Russia, was to utilize in a most complete and perfect way the available resources of production and of labor.

In order to work up a rational plan of the country's economic life, the country was sub-divided in economic self-contained units - regions - and the plans for electrification of each region was prepared with the assistance of local organizations, familiar with the local conditions. Eight such districts are considered, as shown on attached map and Table I.

The present transportation crisis in Russia is well known and should be only briefly mentioned here, before we consider how much the electrification can improve it and thus pave the way to wide co-operation of various economic centers of the country.

Russia possesses several widely used river systems which do not require much capital to make them real factors of cheap transportation of goods from the place of their production to the centers of consumption. However some of the most important in-

TABLE

I

DISTRICTS.

	Northern	Central Industrial	Southern	6	Volga	Ural	Caucasus	Siberia and Turkistan	TOTAL
No. of Steam Plants.	1	6	4	—	4	3	1	1	20
No. of Hydro-plants.	3	—	1	—	—	1	3	2	10
Rated Capacity of Steam Plants KW.	30,000	280,000	280,000	—	100,000	140,000	20,000	40,000	890,000
" " " Hydro " "	130,000	—	200,000	—	—	25,000	100,000	80,000	535,000
Installed " " steam " "	40,000	360,000	330,000	—	120,000	180,000	30,000	50,000	1,110,000
" " " hydro " "	155,000	—	230,000	—	—	30,000	125,000	100,000	640,000

~~Of this, 86.6% came from Germany, 6% from England~~

dustrial centers (as for instance Moscow) are located on water divides, just as some of the most important coal and metal mines are located in mountainous regions remote from large rivers.

These centers quite naturally become surrounded by railroads, but the latter were always laid as independent trunk lines with the purpose to move goods along the shortest (in mileage) route, without any regard to the advantage of moving the freight in some other way, possible and at times more beneficial to the country at large.

I. Southern District:

This includes the largest high-grade coal mines of Russia in the Donetz District. Electrification of the trunk lines connecting the Donetz coal mines with the Moscow industrial district will decidedly increase their capacity. This is the reason why the electrification of these lines is considered as one of the most urgent works to increase the output of coal in ^{the} Donetz District. Another urgent preliminary work in the same district is the unification of the existing power plants in order to improve their load factor and to provide the mines and steel plants with electric power so needed for their functioning.

There are about 70 power plants in the Southern District each of 1000 HP or over. Their aggregate capacity is over 200000 KW.

The majority of coal mine plants and some of the steel mill stations are located in three industrial centers: HUGHSOVO-MAKEEVSKY, ALMAZNO-MARIEVSKY and Central. Their total capacity is estimated as 87,000 KW as shown in the following table:

	: Number of		: Total Capacity:		Load Factor	
Industrial Centers:	Power Plants		: in 1000 KW		:	
	: Coal	: Steel	: Coal	: Steel	: Coal	: Steel
	: Mining:	Mills	: Mining:	Mills	: Mining:	Mills.
31. Hughsovo-Makeevsky	10	12	36	15.5	34.7%	35.5%
32. Almazno-Marievsky	6	2	14.5	6.5	30.5	20.5
33. Central.	4	1	7.2	7.5	26.4	45.8

When these plants are interconnected the load factor will be improved, which will permit a higher degree of the mine's electrification and will increase their output as compared with pre-war time.

It is probable that in several instances the underground equipment of the mines had suffered more than their power plants, with the result that power will be available to electrify the railroad branches of these mines where the equipment was left intact and where the need of better means of transportation is most urgent.

The above stations are situated in the coking coal districts whereas from the broader point of view the coking coal should be preserved and the use of anthracite stimulated. It is advisable therefore to install an additional temporary anthracite plant in the district of Shtervoka. This power plant will serve as a nucleus to a larger regional plant erected for supplying power to the anthracite mines and for other uses of that district.

The anthracite resources of Donetz District are so vast that part of the output can be exported abroad. The port of Mariupol will be used as an export base and the trunk line connecting this port with the mines will be the first to be electrified.

The countries bordering on the Mediterranean are in dire need of mineral fuel and thus there is a good market for the export. Care should be taken however to increase the efficiency of labor in coal mining.

As compared with the pre-war times the labor efficiency is reduced due to underfeeding, loss of qualified labor, and to obsolescence or lack of implements. The electrification of mines will remove the last two causes.

A comprehensive feeding program will be introduced to offset the decline of labor efficiency.

It has been pointed out above that a small temporary power plant will be erected at Shtervoka, in order to start at once the increase of anthracite coal output.

In the near future the capacity of this plant will be increased to 100,000 KW.

This will be in line with the general tendency to develop the steam plants into very large producers of power, with a range of action up to a radius of 200 km.

Simultaneously with the Shtervoka plant, another one will be erected at Lisichansk, with an initial capacity of 80,000 KW. The immediate purpose of this station will be the power supply to the district where the long flame coals are mined and also to the Bachmut District, rich in salt mines and various mineral resources. The same plant will supply power for the electrified railroads (part of the net of Donetz railroads and the section of the trunk line, adjoining Lisichansk.)

The Shtervoka plant will use as fuel, the anthracite scrap, whereas the Lisichansk station will work on coals rich in ashes and not suited for transportation.

Anticipating the tremendous increase of electric power demand in a district where coking coal mines are close to high grade iron ores (Krivoy Rog and Nikopol Veins), plans are made for a hydro-electric plant on ^{the} River Dniepr, at the city of Alexandrovsk.

By concentrating the river fall in one spot, a very large amount of power will become available and at the same time that part of the river Dniepr, which is known for its cascades, will be made navigable.

The initial capacity of the contemplated hydroelectric plant will be 200,000 KW. (See map Station No. 3). The hydraulic part of this installation will have to be built to the full extent at the start, which will require considerable time, both for preparing detail design and for actual erection.

The ultimate capacity of the Alexandrovsk hydro-electric plant will reach 820,000 HP.

Due consideration should be given to the plant (No. 34) (see map) in the Ekaterinslav District, and to the 40,000 KW plant (No. 4) to be built in Grishino.

The Grishino coal district was rapidly growing during the last years and its power plant should shortly increase its initial capacity.

The eastern anthracite region will be taken care of by a 60,000 KW plant, planned at Belaia Kalitva. (No. 5)

The plant No. 35, now existing at Grushevka mines will be extended.

The power stations in Rostov will be consolidated and enlarged.

II. Caucasian District:

The Kuban province will be the first to regain its normal life and to make further strides. Its favorable situation and density of population give every reason to believe in that.

River Belaya may be utilized and may give, as estimated 70,000 KW.

A small (20,000 KW) steam plant will be installed in the lower Kuban Valley (See No. 6.) It will be used in the first years of electrification and will serve as nucleus of the huge steam hydro-electric system of this district.

The water power plant (No. 7) in the upper Kuban Valley (40,000 KW) will take care of that country, rich in copper, zinc, lead, iron, nickel, chrom^{ium} and also in coal. Among other riches of this land the various mineral water springs should be mentioned, which made this land famous for its summer resorts.

The water power plant (No. 8) on river Terek 40,000 KW is close to the Republic of Georgia. Power will be supplied to Tiflis (capital of Georgia) with its district. On this side of the boundary line zinc, lead, copper and iron ores are found in abundance.

The Vladikavkaz R.R. which already has considerable traffic will soon reach the stage, when its electrification will become profitable. The power will be derived from the above two water plants.

An oil burning plant (20,000 KW) will be built in the Grozny oil fields (No. 9). The need of this plant is a most urgent one, as with the electric power on hand the work of rehabilitating of the oil wells, equipments will be speeded up and facilitated.

The oil burning plant at Grozny and the water power plant on River Terek may be operated as one unit, thus making better use of the equipment.

The plants at Baku (No. 37) will be enlarged to 30,000 KW. It should be noted that due to the condition of the oil fields, an oil shortage should be expected for several years. The available oil should be used rather for making lubricants, etc., instead of being used for fuel. The district where fuel oil has been most extensively used was the Volga Valley. Another sort of fuel should be substituted for it.

III. Volga District:

The anthracite of the eastern Donetz region will be brought to Tsaritsine on the Volga, over an electrified line. This railroad will carry as freight in the return direction, timber for the mines. The timber and lumber is sent on rafts down the Volga river from Northeastern parts of Russia.

= Thus the freight rates will be low, and the cost of anthracite in Tsaritsine will be close to its cost at the mines.

The timber comes to Tsaritsine in rafts from the upper Volga and there it is delivered to numerous sawmills. The great quantity of timber scrap can be used as fuel for the regional power plant together with the coal brought hence over the electrified railroad. This fact will greatly reduce the cost of power generation and, in turn, this cheap power will further stimulate the growth of industries. Even before the war, Tsaritsine was a growing industrial center. This city is also the most important shipping point on the lower Volga. The rivers Volga, Kama and their numerous tributaries bring south timber and miscellaneous other goods, but beyond Tsaritsine the water transportation must be changed to rail. It is therefore of prime importance to

- (a) provide unloading facilities at this point.
- (b) equip adequately the sawmills in order to bring the received timber into shape most suitable for railroad transportation.
- (c) build docks and warehouses to take care of proper coordination of the seasonal character of river transportation with all year operation of railroads.

The further development of the Volga system as means of transportation will have a decided effect on the exploitation of natural resources of the Northeast, particularly of the Ural region.

High grade pig iron ores are worked in the Ural by charcoal, - timber scrap is used extensively for this purpose. In the southern Ural it will be necessary besides this to work by mineral coal the rich veins of iron ore of Magnit Mountain.

It is planned to build a large steel plant at Ufa, on the river Balaya, using water transportation for bringing coke and anthracite from the Donetz District and, in turn, ship the Ural iron ores down the river to Tsaritsine, where large steel plants are already in existence.

The Tsaritsine Power Plant will be of some 40,000 KW capacity and will operate on timber scrap. It is also feasible to utilize the blast furnace gases of the steel plants.

The next point to the north of Tsaritsine where a regional power plant will be erected is Saratov (See map No. 11) and Kashpur. (No. 12). Timber scrap will be used as fuel and also low grade coal obtained near Kashpur. Both plants (11) and 12), some 250 km. apart will be interconnected and will work as one operating unit.

The main task of these plants will be to supply power for agricultural purposes.

Attention should be paid to the salient features of this region which call for its electrification:

- 1) Periodical draughts on otherwise fertile lands.
- 2) Spring of short duration. This requires a concentration within a short period of time of enormous work, necessary for the cultivation of fields.
- 3) At present the peasants split their land in three parts, of which only two are cultivated each year, while the third is recuperating every third year in rotation. In most cases only one kind of crops is planted. Thus if the year is a bad one - all land is affected by the draught, and besides with one third of acreage remaining idle, it will be necessary to introduce more variety in plantations, and also stimulate a deeper plowing. On the other hand the animal stock is greatly depleted, and mechanical power should be made use of.

This is last year's famine region.

IV. Central Industrial District:

An urgent need for electric power exists in Nijny-Novgorod, which always was a very important industrial center and grew even more so during the war, when many factories were moved hence from western Russia.

Vast resources of peat fuel are found in the deltas, formed by rivers Oka and Volga. The peat marshes near the city of Balahia alone contain over 30,000 acres of good peat. These marshes are near the Volga, where a regional power plant could be built.

The work of developing peat will be combined with the drainage of marshes and with making them available for cultivation. It is of interest to note that on the southern end of the marshy delta, on the Oka river, there was recently built and started up a chemical plant for producing fertilizers which plant uses peat as fuel.

The most urgent problem of ^{the} Moskow District is that of bringing in raw materials, especially fuel. To relieve the critical situation it is planned, in the first place: a) to electrify the coal region around Moskow with power transmission from Kashira¹⁾ and Epiphan power plants to Moscow, b) to electrify the trunk line Moscow-Donetz District to provide cheap transportation of coal.

A radical improvement in the fuel question will come when the use of peat - already started - will be more and more introduced.

There exists at Bogorodsk, near Moscow, a regional peat-power plant feeding Moscow in conjunction with the Moskow plants. (See Map No. 57 and 58). The industrial power plants of Bogorodsk District are connected to the same system (No. 59).

Bolshovskia Plant (See No. 56) acts as a nucleus of another regional station in the district of Mitishti.

All above plants are using peat as fuel, using wood in emergencies. Only the plants of Moscow are built for oil burning.

To stimulate the peat production a 5000 KW plant is built on the Shatursky peat marshes. Eventually it will be developed into a regional plant interconnected with the Bogorodsk system.

The existing plants in Ivanovo - Voznesnsk and in Kineshno - Vichugsk districts will be consolidated. The aggregate capacity is about 20,000 KW. (See map No. 46, 50). On some of these plants steam is also used for manufacturing processes, so that the power generation is ⁱⁿ expensive.

1) The Kashira plant was opened a few weeks ago, supplying power to Moscow over a 110,000 volt transmission line.

A few similar plants around Podolsk and Serpuhov (Nos. 66 and 69) will also be included in the system of the 60,000 KW Kashira plant, now under construction.

The Epiphan plant, also of 60,000 KW capacity will be located in the center of coal mining district, where iron ore is also found.

The coal mines around Moscow do not produce coking coals and these will be brought from Donetz. The return cars will carry the ore to the south, supplementing the output of Krivoy Rog iron mines.

The existing steam plants around Briansk (No. 64) will be consolidated.

A 40,000 KW station will be built at Belgorod (No. 19) to supply power for the adjoining section of the electrified trunk line.

V. Northern District:

First the power supply of Petrograd will be taken care of, in order to revive the industrial life of this section and of the Port of Petrograd. The largest items of the port's turnover were:

Export of timber (104 mil. pouds = 1,872,00 short tons in 1913).

Import of coal (191 mil. pouds = 3,430,00 short tons in 1913).

Imported coal was used for the industrial and power plants of Petrograd.

is
The lumber/brought to Petrograd over inland waterways, over the rivers Svir and Volhov, abundant in cataracts. The building of water power plants on these rivers will at the same time improve the navigation.

The hydro-electric plants on the Svir and Volhov will be built in the first place (See Nos. 21, 22, 23). (x)

The Volhov plant (initial capacity 30,000 KW) will incidently connect Petrograd with some 2000 km. of navigable rivers.

The work on the Svir will radically improve the capacity of the existing Mariensky waterway system. The capacity of the Svir plant will be 100,000 KW.

The capacity of the seven plants in Petrograd to be consolidated will be brought up to 112,000 KW. (Altogether there are in that city over 200 plants, of which 44 are of 500 KW or more). A number of units, not included in the plan of consolidation will be thus made available for other parts of Russia.

The construction of a regional power plant in the Petrograd country was started before the war. It will be completed, and the plant capacity brought to 30,000 KW. (See No. 20).

The Petrograd steam plants will be interconnected with the water power plants. The steam plants will use peat and timber scrap as fuel. The total fuel consumption will not be great as the basic load will be carried by the hydro-electric stations.
(X) The Volhov plant is now under construction, the electrical and turbine equipment being ordered in Sweden (Lau.)

The installations on the river Svir will supply power not only to Petrograd but also for the district along the southern part of the Murmansk R.R. The country traversed by this line is noted for its abundant water systems which are thus tapped by the railroad, and also for its riches in timber, minerals, and water power.

The plant (No.23) on the Svir will furnish power to the canal zone of the Mariensky System. The latter will be reconditioned to take care of bulk traffic from Volga and Kama to Petrograd.

VI.Ural District:

The Ural mountain ridges, separating Europe from Asia and the adjoining country quite recently were connected to European Russia only by the River Kama and by two narrow gauge railroad lines; the latter were used, mainly, for the Siberian traffic. The construction of the Volga-Bogolminkaia and of the Kazan-Ekaterinenburg Railroad, with bridges at Simbirsk and at Sviajsk makes the situation better, but there still is an imperative need of improvement of navigation on the river Kama (up to the city of Perm) and the river Belaia (up to the city of Ufa.) At these points the waterways are tapped by the trans-Uralian railways, which capacity will be raised by electrification.

In the first place the line from Perm to Nijnytagil, and the branch to the Lunievskie coal mines should be electrified. The power will be supplied from the Kizel plant, now under construction; this plant, built for coal mine use, will be converted into a regional plant of 40,000 KW. (See map No.24).

A 25,000 KW hydro-electric plant will be built on the river Chusovaya. (No. 25).

The above plants will be interconnected and together will cover a territory with the most important Ural coal mines and steel plants.

The Ural district has no coking coals and their place is taken by charcoal, the available supply of which is limited by reforestation restrictions. Therefore the use of charcoal should be restricted to purely metallurgical processes, whereas for other purposes mineral coal should be used as fuel. Its output should be fostered by means of electrification of the mines. The electrical power should be generated on plants built at the mouth of the mines.

A 40,000 KW plant will be erected at the Egorshinsky anthracite mines. Another 60,000 KW plant will be built at Cheliabinsk, near the rich brown coal mines (See Nos. 26 and 27).

The vast peat resources found around the Egorshinsky plant will be worked up. The experiments have proved that some sort of available peat can be made into peat coal; this will substitute the charcoal for blast furnaces.

VII and VIII. West Siberia and Turkestan:

The Ural is so rich in high grade iron ore that it is very essential to connect to coal mine regions and to develop to a higher degree the blast furnace operations.

The connection of southern Ural with the Donetz district has been dealt with above. Another plan is to connect Ural with the Kuznetsky coal district (in western Siberia). The enormous riches of this latter country in coal of the highest grade and the general natural wealth of this country require its systematic development with the aid of foreign capital.¹⁾

The northern part of Turkestan, adjoining Siberia is in a similar position.

A 40,000 KW hydro-electric station will be built shortly in the Fergan District (Turkestan).

The preceding table gives an approximate idea of the first part of the electrification of Russia, comprising a total of 20 regional steam plants and 10 regional hydraulic plants, of a total capacity of 1.75 million KW, and an estimated cost of \$425,000,000 for electrical plants, and \$145,000,000 for electrification of railways, a total of \$560,000,000, for the first part of the program.

Whether it willbbe possible to carry out this program in the estimated time of ten years, will depend on the assistance which can be enlisted from America. America is the only country today, which has the financial and technical strength to carry out such a program promptly and expeditiously, and without America it may take a long time to carry out the work, but it is being carried out in spite of the economic difficulties besetting Russia, and only a short time ago we received notice of the completion and opening of the Kashira plant, in the central territory, which supplied power to Moscow over a 110,000 volt transmission line, from the brosn coal mines south of it.

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