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EFFICIENT FUEL CONSUMPTION IN THE POWER SYSTEMS OF THE USSR

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A. Results of Electrification Utilizing Local Fuels

Thirty years ago the Great Socialist Revolution tore down the old state edifice of Tsarist Russia. On the liberated ground our people themselves undertook to construct a new state edifice according to the plan of our great architects, Lenin and Stalin. Our people realized that, "Only when the country is electrified, and when the technical foundation of a vast modern industry is placed under industry, agriculture and transportation; then, and only then, shall we definitely lead." (Lenin, Vol XXVI, p 47)

Lenin announced, "...Communism is Soviet authority plus electrification of the whole country." The plan of electrification of the country was called "the Second Party Program." After this appeal of the leader, the whole country built powerful electric power plants, installed high-voltage transmission lines, and the curve of power generation rose sharply.

By December 1917, Lenin had already issued instructions on organizing the operation of the Shatura peat deposits. In June 1920, the temporary Shatura electric power plant was started; and by the end of 1925 the opening ceremony of the Shatura GRES (State Regional Power Plant) imeni V.I. Lenin had already taken place. The complex problem of mechanized extraction and efficient consumption of peat had been solved.

Even before the Revolution, the Russian engineer Klasson had conceived the idea of a hydraulic method of extracting peat; but it came to nothing. Upon Lenin's instructions, M. I. Kalinin entrusted T. F. Makar'ov with the task of mastering the use of lump peat. The task was most brilliantly executed. Powerful electric power stations were organized including: the Shatura, "Krasnyy Oktyabr'," Gor'kiy, Yaroslavl', Ivanovo, Dubrovka and others. The extraction of cut peat was mastered at the Bryansk, the 3d Moscow, and

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other plants. Peat deposits became a source of life for towns and villages of the principal areas of the country.

In the middle of 1922, power was supplied to Moscow over 110,000-watt transmission lines from the Kashira GRES. Then brown coal was discovered in the Moscow area. Since 1934, the greatest heating and electric power plant--the Stalinogorsk TRES--has been operating on coal from the Moscow region.

In 1924, in the Urals, the Kizel GRES began to operate on local coal. Since 1932 the high-pressure Berezniki TETs (Heating and Power Central) and, since 1936, the Zakamsk TETs and other plants have been operating on the same coal. The Central Ural GRES, the Krasnogorsk TETs, and the Chelyabinsk Plant have been operating sucessfully on Ural brown coal.

In the electric power plants of the Donetz coal mines and in other regions of the country effective use is made of coal extraction tailings, anthracite culm, which, until the Revolution, formed mountainous dumps. Since 1926 the Shter GRES and, since 1929, the Shakhty GRES have operated on anthracite culm. Since 1931 the Zuyevka GRES and others have operated on anthracite culm.

The Soviet combustion engineers have mastered effective extraction of more than 60 types of different fuels with extremely distinctive properties: moisture content up to 55 percent, ash content in the dry mass up to 40 percent, volatile matter from 3 percent, ash fusion temperature from 1,000 to 1,500 degrees centigrade.

The Soviet hydraulic engineers and water power experts have mastered the water resources at powerful hydrostations, generating electric energy without fuel consumption. The Volkhov GES (hydroelectric station) imeni Lenin was the first result of electrification. The ZA GES, the Kondopoga GES, the Dnepr GES, the Svir GES, the Kadyr' GES, the Dzoraget GES, the Niva GES, the Gizel'don GES, the Burdzharsk GES, the Baksan GES, the Varzob GES, the Moscow-Volga Canal GES, the Tuloma ATs GES, the Komsomol'sk GES, the Uglich GES, the Rybinsk GES, and others began operation following the Volkhov GES.

At the present time, fuel brought from a distance forms only one seventh of the total power balance of USSR regional electric power plants and six sevenths of the power is generated by local power resources.

In pre-Revolutionary days the vast water power resources of the country were not used at all to generate electric energy in general utility plants. Now one seventh of all the power is generated by regional hydroelectric stations without fuel consumption.

In pre-Revolutionary days, the huge deposits of brown low-calorie coal were not used at all to generate power in general utility stations. Now, however, very powerful regional electric and heating stations, generating one third of the total power, operate on this coal.

In pre-Revolutionary days only one low-power station operated on lump peat. Now, however, powerful regional stations operate on lump and cut peat and generate one ninth of the total power.

Earlier varieties of costly fuel do not appear on the fuel balance sheet of regional electrification. Mazut was entered as a small part of the balance (7.5 percent), but instead of the high-grade petroleum consumed earlier, it was a high-viscosity waste product of oil refineries. Oil residues are used on the spot (Baku, Groznyy, Ufa) as local fuel. Mazut also went out of use for kindling boilers in many stations.

Donetz coal is an important part in the balance of regional stations; it is not, however, the former high-value gas coal, but mainly anthracite culm, formerly left lying in coal mine dumps without being used.

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3. Efficient Utilization of Fuel Resources

Efficient utilization of the power resources of the country has been proven possible due not only to the successful mastery of methods of fuel combustion and mastery of hydroelectric stations but also to the building of various power systems with extensive high-voltage transmission lines.

Even before World War II, the unified high-voltage electric network of the Gor'kiy, Ivanovo, and Yaroslavl power systems was established. In wartime, these systems were connected with the hydrostations of the Upper Volga. Due to this, efficient use was made of the local power resources of the central industrial region of the country: coal from the Moscow areas, peat, and water power.

From Solikamsk to Magnitogorsk, a vast high-voltage network extends along the whole Ural mountain chain, uniting the three Ural systems joined by powerful regional electric power stations operating on local Ural coal. During World War II superpower regional heating and power plants, the Krasnogorsk and Chelyabinsk heating and power plants, were added to these systems. In these plants high-ash content coal of the open-pits is used.

Modern power systems guarantee not only an efficient regional supply of electricity but also the supply of heat in the country, supplanting the old technique of production and consumption of power.

In the USSR, all forms of power resources are integrated and the product systematically distributed in accordance with the requirements of the unified economy of the people.

(See Figure 1 following page.)

6. Reduction in Specific Norms of Fuel Consumption

The technical re-equipment and the new organizational forms of Soviet power production find expression both in the structure of the fuel balance according to the kind of fuel and in the qualitative indexes of the fuel utilization of the same power systems.

This may be seen in Figure 1, which shows the drop in average specific consumption of fuel per generated kilowatt hour for all regional electric power stations as compared with consumptions of general utility stations in 1913. At the beginning, the successful realization of Program A of the GOELRO plan was reflected in the drop in the specific consumption of fuel. In accordance with this program, the mistakes of pre-revolutionary Russia were corrected by interconnecting the stations in united networks. As these measures were carried out in the great industrial centers, success was achieved in the expedient utilization of more economic equipment, and due to this, the pre-revolutionary power plant indexes were far exceeded. In addition, great fuel economy, exceeding that resulting from power unification, was achieved by halting uneconomic industries and other small plants.

With the fulfillment of the second, basic part of the GOELRO plan, Program B, which provided for even greater power production, the qualitative indexes of electric power stations showed an even greater improvement. The wide realization of this program was preceded by a period of learning how to master new forms of fuel for comparatively low-power equipment and, therefore, there was no sharp break in the consumption curve. The break began with the year 1933 when powerful modern condenser-station installations and heating equipment were put into operation.

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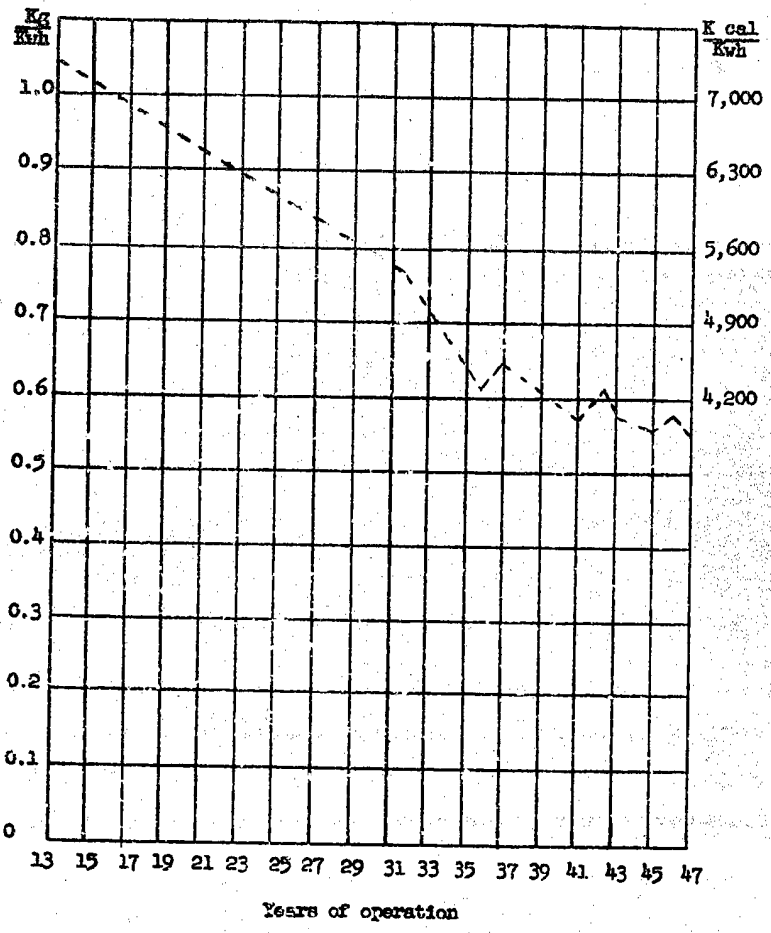
Figure 1. Drop in average annual specific fuel consumption per generated kilowatt hour in the system of the Ministry of Electric Power Plants of the USSR.



In peat and brown coal of a fixed quality a coefficient of efficiency of over 85 percent was obtained and at "ASh" it was brought up to 83-84 percent. Power plants generated electric energy in powerful condenser turbogenerators with a specific consumption of about 0.51 kg/kwh and, correspondingly, with a coefficient of efficiency of about 25 percent. The Kashira GRES lowered consumption to 0.48 kg/kwh.

An especially important result was obtained by the organization of complex generation of electric and thermal energy in heat and power plants, which was extensively developed in the unified USSR economic plan.

In the generation of electricity at central heating plants, power plants have saved the State over one million tons of ideal fuel.

In heating plants with full utilization of exhaust heat, the specific consumption of fuel was reduced to 0.2-0.25 kg/kwh, i.e., twice the best indexes of condenser power plants. The pioneer of thermification, the 3d LGES imeni Ginter, operated on such a specific fuel consumption. The plant was modernized from a technically outmoded plant into a progressive one. Other plants followed the same course. Recently the Tomsk GRS celebrated its fiftieth anniversary. It might seem that, after this celebration, the plant might be placed on the reserve list. But the personnel gained the right to the continued life of the plant, thanks to its conversion to thermification, just as in the case of the 3d LGES, the Novosibirsk TETs No 1 and of other plants of the Soviet Union

In 1940, as seen in Figure 1, all power plants, united under the Ministry of Electric Power Plants, USSR, consumed an average of 0.596 kg of ideal fuel per kilowatt hour.

The German invaders did great damage to the national economy. This is shown in the increased specific fuel consumption during 1942.

Soviet power-engineering experts pitted their strength against wartime difficulties, and it was not long before results were achieved. Beginning in September 1942 the crisis was at hand, and the indexes began to rise. At the end of 1942 the plants had already changed over to the prewar economic level and held specific fuel consumption down to 0.570-0.575 kg/kwh. The reduction in specific fuel consumption during the war and in the postwar period was facilitated by advancing the dates for putting into operation new and reconditioned economic equipment and by increasing the utilization of economic equipment.

For example, we erected the Chelyabinsk GRES. In prewar days the consumption of this plant was high, 82.7 percent in 1940. In 1942 utilizing the specified power the plant operated for 8,368 hours, i.e., about 96 percent of the scheduled time. With the change to record-breaking utilization of equipment, the specific consumption of the plant rose 3 percent. However, thanks to its larger share in the united network and its substitution for less economic plants, the average specific consumption in the system did not deteriorate.

During the same period the Central Ural GRES increased its use of power from 6,634 hours to 7,724 hours, not only without increasing its specific fuel consumption but decreasing it to 2.67 percent. Excellent operating indexes were obtained in the work of the Central Ural GRES by keeping the equipment in good condition. All trouble was discovered in good time by the personnel and eliminated as soon as it arose.

Experience shows that small defects in equipment and operational organization, which are not noted and eliminated in time, sooner or later become focal points of trouble and cause increased fuel consumption, difficult to correct when a maximum use of the specified power is demanded. For this reason, in the USSR regional power plants, great attention is devoted to systematic preventive inspections, cleaning and repairs of the main and auxiliary equipment.

Even in wartime, in spite of the needs of reserve power, the order of compulsory removal of equipment under repair was strictly followed at the date planned and within the fixed time.

Soviet power-engineering experts consider their tasks not only the maintenance of equipment committed to their charge but also its continuous improvement with a view to attaining the best operating indexes. The Ministry of Electric Power Plants of the USSR carries out systematic work in proportion to the increased power, safety and economy of the power equipment. Every year compulsory measures are planned for all power plants for the economy of fuel and electric power for their own needs and, at the same time, material resources are duly distributed.

For each power plant there may be a long list of effective measures which have been drawn up. In many boiler installations heating surfaces are developed at the back and steam blast cleaning of their flues introduced; heating installations are converted to steam and the blow-out heat used; installations for preparing pulverized coal are improved, etc. In many turbine installations the original steam factors are improved, the turbine between the inlet and outlet valves improved, exhaust steam divided between their own needs and thermofication, and the condenser installations improved. Great attention is paid to the preparation of feed and circulating water. Work is being carried out on the properties of auxiliary installations and on improvements in their regulating in accordance with established priorities. It is impossible to give here the whole list of the diverse measures which, in a systematic manner, have been introduced into power plants as the results of many years of work.

But it was not on technical measures alone that the foundation was laid for success in mastering new power sources and new varieties of fuel. Success was guaranteed by improving the organization of Soviet power production and by training staffs of experts in power engineering.

In 1940 uniform regulations were introduced for the technical operation of electric power plants and net rks. These regulations summarized the experience of the best Soviet power plants over many years of operation, and a wide development of this experience was obtained.

The introduction of uniform regulations contributed to the consolidation of technical training, organization of efficient operation and improvement of the electric equipment of the power systems.

The personnel of the plants are assigned a concrete production task formulated according to systematized and technical norms, and established according to a single method. Personnel are assisted in the attainment of assigned indexes by instruction and by the establishment of goals. Constant technical control has been instituted over equipment and its operation in conjunction with a closer analysis of indexes. Productive initiative is developed in personnel and progress in work is stimulated by the bonus system and the organization of socialist competition.

Time has educated Soviet power engineers in the spirit of economy toward the equipment in their charge, and toward fuel and generated energy. The conservation of fuel is matter of honor to a Soviet power engineer. Specific fuel consumption for a unit of generated power is one of main indexes in the All-Union Socialist competition of plants and systems.

For success in efficient fuel utilization, individual plants and experts in energetics have been given high government rewards. Plants having received the Order of Lenin and the Order of the Red Banner of Labor are the Kashira and the Shatura; those having the Order of the Red Banner of Labor include: Chelyabinsk, Central Ural, Krasnogorsk, Beryuzyan, Zuyevka, "Krasnyy Oktyabr'" imeni Klassen, 9th Moscow, Kizel, Gor'kiy, Ivanovo and the 2dLoningrad plants. The excellent work of these plants during peace and war serves as an example for other plants and will give rise to new successes of labor.

A task has been given to the Soviet energetics experts: "To secure further technical progress in all branches of the economy of the USSR, as a condition for the increase of productive labor, for which it is necessary not only to overtake but, in the shortest possible time, to surpass science beyond the borders of the USSR" (from Section 1 of the Law relating to the Five-Year Plan).

Our power plants are making progress in the mastery of local low-grade fuels. According to technical and economic indexes our regional power plants have already surpassed, from the view-point of efficiency, the English unified system, and we are surely overtaking the American power plants. In 1932 our specific fuel consumption exceeded 21 percent; in 1935, 16 percent; in 1945, 4 percent; and thus the gap is being closed year by year.

In electric power plants, in laboratories pertaining to production and scientific research, and in industry, strenuous work goes on for new types of power equipment with high operational factors. Side by side with the new techniques new personnel organizations and new methods of operation are being studied. The strength of power systems will be increased, and Soviet power engineering will be foremost in the world.

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