Electricity is a vital factor in the development of industries. The present varied possibilities of its utilization have made it one of the great economic factors of the industrial world. There are countries like Norway, the industrialisation of which has been based almost entirely upon hydro-electric power. Power, progress and prosperity go hand in hand — this holds true in the case of the present Bigs. The United States of America producing 45 per cent of the world's electricity leads the world in this respect, and is the most powerful country on earth. Lenin, too, attached great importance to power development and went so far as to say "Communism is Soviet Power plus the electrification of the whole country." Water-power has been the dominant factor in Canada's industrial expansion. Her 80 per cent industrial power is hydro-electricity. Even Japan which stands nowhere as compared to India in her water potentials, has more than twice as much installed capacity as the other countries of Asia and the Far East combined, and thus heads the list of installed capacity in the world.

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c Survey of Asia and the Far East,
Since India has become electricity-minded, she has also realised the vital importance of power, but only recently. It would not be unjust to cite the wordings of the Bombay Plan. "We have deliberately placed the production of power first in the list of basic industries, because we believe that the development of our industries, both large and small-scale, as also of transport and agriculture will be determined to a large extent by the development of electricity."

The present installed capacity of the State is only 1,70,000 Kilowatts including the private utility companies. But there are great power potentialities in the Himalayan, Bundelkhand and Rohilkhand areas and the most recent times are anxiously awaiting their development. Since the close of the last war the State planners appear to be power hungry. They are contemplating long range schemes for an increase of 10,00,000 Kilowatts, nearly two-third of what the entire country has at present, and thus to cover the whole State with a network of supply lines, and providing plentiful cheap power to the majority of the community. The capital cost of the schemes is estimated at Rs.500 crores and will take some 10 years to complete and function. Some of the schemes have, however, started and completed their primary stages.

After the implementation of the proposed plans, if Uttar Pradesh, with its poor and deficient mineral resources, cannot be made the Ukraine or the Ruhr of India, it can with its latent power be turned into the Lancashire or the Tennessee Valley of India and thus poverty and squalor can be made things of the past.
Need and Objective of the Power Development

Shouting a lot about industries without power is a cry in the wilderness. Though hydro-electricity occupies a very high place in modern planning, it happens to be absurdly limited for the factories and the cottage industries of the State. The lack of water power in the absence of mineral fuel in the State has inversely affected the employment of the people. Most of the poverty-stricken peasants or artisans of the most antiquity could engage themselves in the wealth producing activities, if supplied with cheap and abundant electric power, which alone can find employment for the youths of the State. The direct application of power to mechanical agriculture not only augments the agricultural production but also diverts population to more profitable industries. Hence cheap and inexhaustible water-power is the greatest need at the moment. It is needed for domestic purposes, for the manufacture of fertilizers, for agriculture and for industries. Its development would further help in the conservation of high grade coal.

In spite of the fact that from the point of view of electric development, Uttar Pradesh is third on the map of India; electrical development as such in this State can only be said to be in its infancy. Mears has estimated that in Uttar Pradesh the total energy now generated is only 5 per cent of the minimum continuous power and only 12 per cent of the probable maximum power. The per capita consumption of electricity in a country is the index of prosperity and power in its economic, social and political spheres. This per capita consumption is only 4 watts in U.P.

Consumption per head for different population groups in the Ganga Grid Area.

<table>
<thead>
<tr>
<th>Population Groups</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>0 - 2,000</td>
<td>0.00</td>
</tr>
<tr>
<td>2,000 - 5,000</td>
<td>0.14</td>
</tr>
<tr>
<td>5,000 - 10,000</td>
<td>0.63</td>
</tr>
<tr>
<td>10,000 - 15,000</td>
<td>0.99</td>
</tr>
<tr>
<td>15,000 - 20,000</td>
<td>1.28</td>
</tr>
<tr>
<td>20,000 - 50,000</td>
<td>2.54</td>
</tr>
<tr>
<td>50,000 - 1,00,000</td>
<td>2.73</td>
</tr>
<tr>
<td>and above one lakh</td>
<td>3.67</td>
</tr>
</tbody>
</table>

"Although we have very extensive works in the United Provinces, when benefits are expressed per head of population, it is only a very small percentage of the population which derives benefit from the capital invested by Government". Thus the rate of industrial progress of the State is far behind that of Bombay, the electrical consumption of which measures 10 times that of U.P.

The capacity of generating plants at Kanpur, Allahabad, Lucknow, Banaras and Agra (including the stand-by plants) is 79,500, 11,750, 10,225, 7,750 and 7,300 kilowatts respectively; while the corresponding further and immediate demand of these towns is 30,000; 3,725; 4,800; 3,525 and 2,800 kilowatts. How does it contrast with London which alone had in 1938, in its six generating stations, an installed capacity of 9,00,000 KWS., that of more than the whole of India put together? Though the Government has schemes for the extension of electrification plans to various towns in U.P., many large towns still lack adequate lighting and other cohorts that electricity can bring. (vide Appendix IX)

1. Figures compiled from the files of the of Chief Engineer, Sarda Canal Power Project, Lucknow

The State is planning to expand large and small scale as well as cottage industries. How can all that be implemented without the adequate supply of motive power, especially, when the integrated total plan is to exploit all resources such as minerals, land and others? It points to the necessity for planning simultaneously to generate colossal quantities of cheap hydro-electric power. It means that the building of high dams and generation of power should proceed side by side with the setting up of industries. Assuming that the annual rate of increase of power consumption during the next 10 years is of the same order as was the rate of increase during the War years, our total consumption of electricity in 1958-59 may be estimated at an increase of about 200 per cent.

Only 6-7 per cent of the available water resources of the State is being utilized at present and the balance of 93-94 per cent is running waste to the sea. "Not to promote the integrated development and utilisation of latent water resources as promptly and fully as all relevant, technical, economic, and social conditions warrant, is to invite waste of potential wealth and so is incompatible with the public interest". In the State, even the existing installed power is not well distributed. There are areas like Bundelkhand, which though potentially fertile, do not have electricity for tube well irrigation. Besides, by 1961, the State is estimated to have a population of about 7,00,00,000. Basing the per capita consumption of electricity at 50 units, the total demand

of energy may be 35,00,00,000 Units which at load factor of 60 per cent may be taken at about 58,40,00,000 Units. To achieve this goal the electricity plan should essentially aim at perfecting ways and means to use all available power resources. The proposed power projects should be given the first priority and implemented expeditiously. Pt. Nehru, the Prime Minister of India, while laying the foundation stone of the Yamuna Hydro-Electric Project urged early completion of the scheme and said "the sooner such projects are contemplated, the better will it be for the country which is in urgent need of schemes to liquidate poverty and solve economic difficulties". Such a power development would be panacea for many of the economic ills particularly when the pre-eminent agricultural character and village industries to a large extent in the planned national economy are to be maintained.

Thus, to develop the potentially fertile areas and to fight the mal-distribution of power projects in the State, we shall have to go "Back to the land and water" to see that the waters now wasted are controlled and made to work and that the miracle which is being aimed at is made to happen.

Sources of Power

Varied are the sources of power, some of which are exhaustible, while all of them are not available at all places. Nature has deprived Uttar Pradesh of sources like mineral oils, peat, natural gas or tides. Hence, the question of their utilisation in the State does not arise.

1. Alcohol

Incidentally, Uttar Pradesh happens to be a great producer of sugar cane and molasses, quantities of which, at present, are wasted, but it can be fully utilised for the production of power-alcohol. The bright prospects of the vast potentialities for the production of power-alcohol will be dealt with separately.

2. Wind

The Scientific Committee of the Indian Council of Agricultural Research is making efforts to harness wind power at a ridiculously low cost. In this connection, the Committee has approved the schemes for trial of wind mills in different places in the country. For the present, three wind-mills have been installed under a Government scheme, one at the Bichpuri Agricultural Farm of the Balwant Rajput College, Agra, another at the Dharam Samaj College, Aligarh, and the third at the Government Higher Secondary School, Meerut. The wind-mill at Agra is in the country side, and it is expected that a scientific analysis of wind velocities correlated with water discharges would be possible there.

3. Sun

Under a high sun and cloudless sky, an acre of earth surface receives about 7,000 horse power. "If even a small fraction of this could be utilised directly for the production of power, the problem of the power supply for India would be satisfactorily solved for ever". When Russia, situated in the cool temperate zone, could make use of the sun's power, it is not impossible

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2. The McGraw Hill Overseas Digest, Jan. 1946, and also Central Board of Irrigation Journal, July 1946, p.151
for U.P. to make commercially successful schemes, when the temperature in the major part of the State runs as high as in deserts during the summer months. The manufacture of solar cooker is a practical step in this direction.

4. Fire-wood

In running some of the cottage industries in U.P. fuels like wood and straw play an important role. The glass-bangles, bottles and beads industries of Sikandra Rao and Kasganj are entirely dependent on such fuel. But the conservation of wood-fuel, too, is essential. Gas-engine-driven generators - an aspect of power generation - has received only scanty attention in the State.

In the chapter on Forest Resources, it has been mentioned that in U.P. firewood, in particular, is found in profusion. Hence in places where firewood is cheaply available or may be transported easily, gas-engine-driven generators should be preferred to diesel engines. Czechoslovakia and the U.S.A. have developed a combine diesel and gas engine power unit. Such possibilities should be explored in this State as well.

Motor transport vehicles were consuming large quantities of charcoal during the War period owing to scarcity of petrol. It is suggested that producer gas plants may be installed in large towns and supplies of gas be made to every household, and to motor vehicles in place of petrol or fuel at depots in and outside the city. They will help to reduce our dependence on petrol to a great measure. It will do away with the drudgery of the kitchen, improve the general cleanliness of the house and perhaps lower the cost of domestic fuel.
5. Coal

Coal is so unevenly distributed in India that it has to be imported into U.P. at a high cost from the Damodar Valley. Still, the installed capacity of the thermal stations is far in excess of the hydro-stations.

The coal resources recently discovered in parts of U.P. are not only meagre but are of poor quality as well. (See Chapter II). Hence, whatever coal there exists must be reserved for manufacturing processes instead of power production. Besides, the imported coal should be utilised by conservative methods only, i.e. by its conversion into electricity, thus not only avoiding wastage but also making possible the recovery of a large number of by-products which are the basis of a wide range of industry.

Geographical Conditions of Water-Power Development

Incidentally, the natural forces have produced a topography of folded and fractured rock structures, both in the north and south of the State, which although hamper settlement and communication, provide favourable geographic features for the generation of power from falling streams. The Himalayas, with their rocks ranging from low hills to thousands of feet in height, perpetual snow, glaciated topography, lakes, falls and heavy precipitation, offer the most favourable physical conditions and hence are the most favoured parts of the world in respect of rich water-power resources. Therefore, it is no wonder if people look to the Himalayan heights with awe and reverence and gratefulness as they hurl their waters down into the plain beneath; literally, millions of kilowatts of potential cheap hydro-electric power.

The harnessing of the Yamuna river and a net drop of 1,000 feet available in the Karmali river by means of tunnels along
the intervening hills has also revealed that foot-hills of U.P. quite analogous to any other country, contain almost comparable potential sources of industrial development.

The inundation characteristic of streams flow is the chief impediment to the development of water-power resources of U.P. "Feast or famine" describes any of the steep rivulets of hills which vary from wild torrents, dangerous or quite impassable in the rainy season, to little brooks which one can step-across without wetting one's feet in the dry season³. Yet there are certain rivers which flow during wet and dry seasons alike, and drop rapidly as they skirt the southern flanks of the mountains; at the same time, volume is greatly increased from contribution of tributaries that drain the glaciers. Thus, the sources so vast and, in fact, inexhaustible in a way, if properly harnessed and exploited may cause U.P.'s industrial development to be based on hydro-electric power.

Complementary Power Development

Not only are the countries which possess abundant resources of coal interested in thermal electricity, but also those which are far away from collieries, in developing thermal plants for emergency purposes. This is evident from South India where there are large thermal stations accounting for 20 per cent of the total energy generated at present². But it is an established fact that thermal power can never compete with the cheap production of hydro-electric power, except when it is produced on

1. Flow in the Sarda Canal varies from 9,500 to 4,000 cusecs. This results in the variation of power output from 38,000 K.W. to 20,000 K.W. which in a very dry year may drop to 16,000 K.W.

the spot, i.e. when it does not have to bear the cost of transport, according to which the thermal stations are at an advantageous position.

Careful investigations have shown that the construction of a peak load steam power station at Chandausi for energizing the tube-wells in the Moradabad and Badaun areas is a cheaper policy than the alternative of constructing two or possibly three additional power stations on the canal some 150 miles distant and transmitting the cheaper hydro-electric power there-from to the Chandausi area, by means of an extensive system of duplicate high capacity lines. In the latter case, power to the extent of 15 per cent is lost on the intervening transmission system. A further advantage in setting a steam station is that it acts as a stand-by plant in cases of emergency, when the canal may have to be closed for inspection or repairs or due to possible closure at the headworks. Contrarily owing to wide variations in the annual flow of rivers, storage is usually necessary for maximum benefits but storage is a costly affair. It can thus be realised that the hydro-thermal stations are not competitive but complementary. For these advantages, thermal-power generation in the State is about 1,20,000 KWS, far in excess of hydel power, nearly six times the normal output of the water power plants.

Electricity and Industries

Electricity will constitute the most important item of amenity in the life of our backward and neglected rural population. With cheap electric-heating the people can save cow-dung for

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1. "The falling water does not and cannot supply the country's need for power .... Hydro must be firmed up with steam." The National Geographical Magazine, Vol. XCV, 1948, p. 656.
fertilisers. They can save fuel-wood and thus help in con-
erving our forest wealth for more profitable and long range
exploitation. Even during recent years in villages, industr-
ies connected with agricultural raw materials have sprung up
all round in great numbers. Cane-crushing, ginning, rice-
hulling, chaff-cutting, wool-carding, flour-mills and hosiery
manufacturing are some of the small scale industries which
are a common sight in villages. (Appendix X) Electricity
thus enables decentralisation of industries and location of
industrial units in every home and village.

The Rihand Dam, if an when constructed, would provide
a larger block of power which may be utilised in electro-
mechanical, metallurgical and other basic industries at the
site of the dam. Raw-materials for these industries exist
in abundance within a close range (pp. 52-58). Other indus-
tries like the manufacture of machinery, manures, aluminium,
cement, steel, paper, etc., will also have good chances of
development.

Rural Electrification

The rural population comprising 86 per cent of the total
population of the whole State is deprived of the benefits of
the service of electricity. How to carry electricity to this
vast population is an important problem. It is not so simple
as in England where 80 per cent of the population is urban and
rural electrification means extending the benefits only to 20
per cent of the population. It is particularly noteworthy that
only 0.23 per cent of the villages with population of less than
5,000 persons have the advantage of electricity.
### Table

<table>
<thead>
<tr>
<th>Population Range</th>
<th>Total No. of towns and villages</th>
<th>No. of towns &amp; villages with public electricity supply</th>
<th>Percentage of towns or villages with public electricity supply to total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Over 1,00,000</td>
<td>49</td>
<td>49</td>
<td>100.00</td>
</tr>
<tr>
<td>50,000 - 1,00,000</td>
<td>87</td>
<td>86</td>
<td>98.80</td>
</tr>
<tr>
<td>20,000 - 50,000</td>
<td>277</td>
<td>231</td>
<td>83.40</td>
</tr>
<tr>
<td>10,000 - 20,000</td>
<td>607</td>
<td>225</td>
<td>37.10</td>
</tr>
<tr>
<td>5,000 - 10,000</td>
<td>2,367</td>
<td>211</td>
<td>8.90</td>
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<tr>
<td>Below 5,000</td>
<td>5,59,746</td>
<td>1,293</td>
<td>0.23</td>
</tr>
<tr>
<td>Total</td>
<td>5,63,133</td>
<td>2,095</td>
<td>0.37</td>
</tr>
</tbody>
</table>

From: Rural Electrification in India, 1949.

In the interests of the people living in urban areas themselves, the electrification of rural areas is a vital necessity. Apart from all social benefits, it will ensure certain conveniences in the matter of production of food crops and cash crops as raw materials for our growing industries, accelerate development of small-scale industries and thereby bring the present backward condition of the people of the State to the generally accepted level of 60 per cent on agriculture and 40 per cent/rural industries.

**History of Hydro-Electric Development in U.P.**

The history of the hydro-electric development in Uttar Pradesh reveals the piecemeal development of individual schemes. Those were either the tempting commercial undertakings in times of peace or as emergency war measure at the eleventh hour, and thus have resulted merely in a medley. Even as a part of State schemes, the practice of treating electrical development merely as a remunerative undertaking has tended to make it
short-termed and often short-sighted.  

Some forty years ago, the first hydro-power house in the State was founded at Mussoorie. In this very region, more than 20 years ago, a small fall at Bahadurabad in the adjoining district of Saharanpur was first utilised for generating energy and it became the nucleus of the Ganga Canal Grid, stretching from Hardwar to Aligarh. Again, in the same Dun valley, for the first time in the history of the State, a river valley project, the Yamuna Hydel Power, has been launched. Hence Dehra Dun and the adjacent districts of western Uttar Pradesh have been pioneers in the field of electric development.

Since its inception, the Ganga Canal Hydro-Electric Scheme has undergone many stages of development and remunerative extensions as and when the demand rose in adjacent towns and rural areas not included in the original scheme. The Pathri Power Station, which has just been completed, is to replace the existing Bahadurabad Power Station and to give an additional 15,000 kilowatts.

The "grid" enables 88 towns having population of 5,000 and over to be supplied with cheap power for light, fans, and minor industries and also to energise several hundred village and zamindari tube-wells and sugar plants, the latter by means of a system of 'rural branch lines' installed in the tracts between the towns.

At the time when India was threatened by Japanese invasion, the Bhatpara Power Station, (West Bengal), with a capacity of 20,000 KWS situated on the Hoogli River was accommodated on the grid system at Harduaganj (Kasimpur, Aligarh District) and was

arranged to supply power to the ordnance works and shadow factories. Certain boilers were retained in Calcutta with the result that the station had only an output of some 7,800 KWS. It is connected to Sunera, the nearest Power Station.

Thus, the whole history of the Hydro-Electric Development in the State is a story of continuous and gratifying progress. Now, all experience gained over long terms is being utilised in the execution of new schemes.

The Existing Distribution of Power Supply

In the entire Republic, not to speak of Uttar Pradesh alone, there is a mal-distribution of electrical power which is confined only to six States. Prior to 1946-47, the Government enterprise in electrical development in the State was confined mainly to the western districts in what is popularly known as the Ganga Canal Hydro-Electric Grid. The eastern part of the State had only Sohawal Power Station in Faizabad District.

In the beginning of the Five-Year-Plan the State had a total installed capacity of 1,70,000 kilowatts consisting of 55,500 kilowatts from the State electric sources (including State thermal stations and stand-by plants) and 1,14,500 KWS. from private electric undertakings. By the end of the Plan (1955-56) it will rise to 2,56,900 Kilowatts. These are not negligible figures and although they fall far short of the power demand, they compare favourably with those of the other States of Northern India. What is required in the future is a proper distribution of the power so that the entire State might have the opportunity to be served equally.
The Future Possibilities of Power Development

The year 1946-47 really marks a cleavage from the past. To fight a growing power shortage directly attributed to industrial expansion, ambitious power development schemes were launched not only in the western districts, but also in the more neglected areas of the State. The State and the Central Government Engineers have contemplated the utilisation of untapped resources with an estimate of 600 per cent of the present installed capacity. When all the schemes under contemplation are taken up, the production of power would be sufficient even for the running of electric trains.

The schemes and the projects undertaken by the Government may conveniently be split up into the following categories:

(a) Projects under construction - they relate to the schemes sanctioned by the Government for which work is already in progress.

(b) Projects sanctioned but the work is yet to begin.

(c) Projects awaiting Government orders for commencement of works.

(d) Projects under investigation in the Department.

(e) Projects, the working results of which have proved their failure.

As a step in the implementation of the policy of judicious nationalisation of government control over electric power generation and development, the State took over Azamgarh Electric Supply Company in May, 1947, and have acquired the Cawnpore Electric Supply Company (now Kanpur Electricity Supply Administration) on expiry of its licence in September, 1947. The importance of this step can be fully appreciated from the fact that the Kanpur undertaking, one of the largest thermal power stations in Asia, has an installed capacity of about 90,000 KWS.
whereas the total existing Hydel Grid has an installed capacity of 45,000 KWS. only. The installed capacity of the other steam stations owned by public utility undertakings is almost equal to that in Kanpur. On its strength about 15 mills which have got an All India status are running. The number of small factories, of course, is innumerable.

The biggest of the schemes call for the construction of Nayar Dam, Rihand Dam, The Betwa, the Yamuna and the Sarda Canal Projects. Some of them will be dual and multi-purpose schemes. On the completion of the power development plans, the installed capacity will be raised to 7,78,000 KWS. High tension transmission lines will cover the length and breadth of the State and besides electrifying the entire rural and urban areas will provide sufficient power for large scale industrial development of the State.

Nayar Dam Project

The Nayar Dam project is one of those undertakings of the State, the execution of which has been given up owing to the defects recently explored in the geological strata of the Dam site.

The Nayar Dam Project was designed to generate 2,00,000 KWS. and 32,000 KWS., at the Marora and the Byasghat Dams respectively. It was both a power and an irrigation scheme. It comprised the construction of two dams on the River Nayar, a tributary of the River Ganga which it joins at Byasghat, located near village Marora about 7 miles up-stream from Byasghat and 50 miles north of Hardwar. The construction of the Dam, 190 feet of concrete structure, at that altitude would have been an
engineering feat, as it would have been very near in height and size to the Boulder Dam in U.S.A. which is one of the highest dams in the world. The water released from the reservoir mainly during the dry season would have been utilized to irrigate an area of several lakhs, most of which is served at present by the Upper Ganga Canal system. It would have increased not only the production of food grains but also produced raw materials for industries as well, such as 1,50,000 additional maunds of sugar-cane and 60,000 additional maunds of cotton.

Some alternative site should be explored for a dam as the whole scheme is of such vital significance to the industrial development and prosperity of the region.

Rihand Dam Project

The Rihand Dam Project, like the Nayyar Dam Project, was postponed in October, 1949, after construction had been in progress, to be re-started again.

The project is designed to supply 2,40,000 kilowatts of power. It was to be constructed at Pipri about 109 miles from Mirzapur which would be the rail-head for the Dam. It is a multi-purpose scheme comprising power, irrigation, recreation, fisheries, flood control, land reclamation, afforestation and navigation on the Rihand, a tributary of the Son.

The effect of the scheme would be tremendous and far-reaching. The power will be utilised in 19 districts mostly in U.P. within a radius of 200 miles, the Dam would bring not only electrical energy to urban and rural areas but would develop the vast areas which have more or less been completely neglected (Map no.23). It would bring 20,00,000 acres under
cultivation and thus increasing an yield of 3,00,000 tons of grains by providing a huge lake spreading over an area of 180 square miles, which could be used for sports, recreational purposes and pisci-culture. The scheme would also enable boats to ply from Calcutta right into the interior of Rewa District (V.P.) through a system of lock arrangement. A large block of power would be utilised in electro-chemical and other basic industries at the site of the dam, raw materials for which exist in abundance within a close range in the districts around Mirzapur. The scheme has been taken in hand only in the year 1954. The preliminary survey is in progress. It is expected that the entire scheme would be completed by 1970, but probably electricity would be made available by 1960.

The following schemes are being investigated into by the State, and projects are expected to be submitted to the Central Government as soon as full investigations have been carried out:-

<table>
<thead>
<tr>
<th>Name of the Scheme</th>
<th>Installed Capacity</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Kho power project</td>
<td>9,000 KWS.</td>
</tr>
<tr>
<td>2. Minor Hill power projects</td>
<td>3,000 KWS.</td>
</tr>
<tr>
<td>3. Haldwani Hydel Scheme</td>
<td>1,000 KWS.</td>
</tr>
</tbody>
</table>

Yamuna Hydel-Power Project and Tons-Giri Project

The Yamuna Hydro-Electric Scheme is the first river valley project in the State and it aims at utilising 750 feet drop available in the river Tons and the Yamuna. The scheme was taken up in the year 1939 but was shelved. It has now been taken up again after the results of investigations revealed greater possibilities than the previous ones.
Although the combined system is called the Yamuna Valley Project, the Tons, a tributary of the Yamuna, having the larger drainage basin, is responsible for the major portion of the supplies. It is consequently essential that any power generation scheme in the area must utilise the Tons supplies. Accordingly, the project has been split into two stages. In the first stage, it is proposed to utilise a 150 feet drop on the Yamuna River, by the installation of two power stations in the Dehra Dun District between Dakpathar and the junction of the Ahsan and Yamuna Rivers, the drop being 100 feet and 50 feet respectively. It will have an installed capacity of 51,000 KWS. In the second stage, yet to be sanctioned by the Government, a single drop of 600 feet will be utilised for installation of a power house near Kalsi where the Tons meets the Yamuna, by constructing a 6.75 miles long and 20 feet diameter tunnel. The capacity of the station will be 30,000 KWS. firm and 60,000 KWS. seasonal. It is a joint project of U.P. and the Panjab Governments. The share of each is to be equal.

The project, apart from ejecting power into the Ganga-grid, will also distribute energy to Himachal Pradesh, Dehra Dun, Rishikesh and Narendra Nagar. Though the foundation stone of the project was laid on May 23, 1949, it is not likely that it will be completed for some years to come.

Another scheme to utilise the waters of the Yamuna near Paonta Sahib in the Nahan Sirmoor District (H.P.) for developing 30,000 KWS. power is worthy of consideration.
Extension of the Sohawal Thermal Power Station

This power station was constructed to raise water from the river Gogra for irrigation purpose. It is equipped with two 1,250 KWS. of generating sets, but owing to the restricted boiler capacity, it can take up a load of 1,000 KWS. only. The station is very important as it gives bulk supply to the towns of Faizabad, Ayodhya, etc. Under a new scheme the capacity of this station will be increased to 7,500 KWS.

Ghagra Power Project

The Ghagra is a river with immense potentialities for power development. It is estimated that hydro-electric power to the extent of 3,000,000 KWS. will be generated on the Karnali river to benefit both U.P. and Nepal.

The Pathri Project

The Pathri Power Station started in 1950, is the largest on the Ganga Hydel Grid with an installed capacity of 20,400 KWS. This power station would replace the old Bahadurabad power house which has become out of date.

Mohammadpur Power Station

The station is close to Roorkee on Meerut Road, opposite mile 31 of the Ganga Canal. The station will give relief to the heavily burdened Ganga Canal Hydro-Electric Grid Area. The station will have an installed capacity of 9,300 KWS. and firm capacity of about 6,000 KWS.

Harduaganj Thermal Power Station

The power station can generate up to 9,800 KWS. But the turbines are capable of generating a maximum of 23,000
kilowatts, provided extra-boiler capacity is added. In addition to the new boiler installed recently, three more boilers are under erection (Page 131).

**The Ganga Grid Extension**

Reinforcement and extension of the transmission lines of the Ganga Canal Hydro-Electric Grid have also been taken up to transmit power of the Mohammadpur Power Station to strategic distribution points.

**Ram Ganga River Project**

The first stage of this project is the Kothri Dam or the Bijnor Habar Colonisation, while the second stage is the main Ram Ganga Project.

In the first stage it is proposed to impound 7,840 million cubic feet of water in the valley of Kothri, a tributary of the Kho, by building a rock-fill dam about 250' high from the existing bed of the river. The proposed site of the dam is 10 miles from Kotdwara. About 2/3rd of the water will be available annually for irrigation and the scheme will generate secondary power to the extent of 5,000 KWS. The scheme will operate in the district Garhwal & adjacent Habar areas.

The main Ram Ganga Project is a multi-purpose project which would comprise a 340 feet high earth and rock-fill dam on the river Ram Ganga, two miles from Kalagarh, across a gorge. It will impound 78,000 million cubic feet of water for providing irrigation to 4,68,000 acres of new area and greater irrigation facilities to 7,78,000 acres at present inadequately served by the Lower Ganga Canal system.
REFERENCES

- 132 kV DOUBLE CIRCUIT LINE
- 66 kV DOUBLE CIRCUIT LINE
- 66 kV SINGLE CIRCUIT LINE
- 33 kV DOUBLE CIRCUIT LINE
- 33 kV SINGLE CIRCUIT LINE
- SUB-STATIONS 132, 66, 33
- POWER STATION
- THERMAL STATION
Approximately, 65,000 KWS. of seasonal power would be available from the scheme between the first week of November to middle of May. It will supply electric power to the districts of Garhwal, Maini Tal, Almora, Bijnor, Moradabad, Badaun, Bareilly, Etah, Mainpuri and Farrukhabad. When Bhageshwar, Phoh and Haldwani Stations are linked with the Ram Ganga Project, it will bring the total to 2,55,000 KWS. firm power and 2,95,000 KWS. seasonal power. Floods on the Ram Ganga will also be rendered harmless by the construction of the dam. The scheme shall be taken up in the second Five Year Plan.

Sarda Canal Hydro-Electric Scheme

The Sarda Hydel Scheme, which is likely to ameliorate the lot of millions in north Uttar Pradesh, continues to maintain its steady constructional pace. In this scheme, the Sarda River has been diverted into the Sarda Canal at Baribassa, the Headwork of the Sarda Main Canal in the Pilighit District.

Incidentally, between mile 7 and 20 of Sarda Canal, the water level falls through about 70 feet. This drop is distributed over 18 small falls ranging from 2 feet to 5½ feet. Leaving about 10 feet for absorption in the natural gradient of the canal bed, the rest of this fall is being utilised in the creation of one fall of 59' by reconstructing the Sarda Main Canal for a length of 12½ miles. The power house capable of yielding as much as 41,400 KWS. of electrical energy with a firm power of about 23,000 KWS. is situated at Khatima, in the Maini Tal District or opposite mile 8 of the Sarda Canal.
The foundation raft of the main block was laid at a depth of about 65 feet below the normal water table of the area. The tract is marshy. The sub-soil water supply is naturally copious. In order to lower the spring level for doing all excavation in dry, a system of tube-well pumping has been adopted. This has been a unique way of tackling the problem for the first time in this part of the world.

The power house has been completed in 1955, electric power is available to about 231 towns and villages of the districts of Naini Tal, Almora, Bareilly, Pilibhit, Shahjaharpur, Lakhimpur-Kheri, Sitapur, Hardoi, Lucknow and Barabanki for domestic, agricultural and industrial purposes.

Ken and Betwa River Projects

Each of these rivers is capable of producing at least 4,00,000 KWS. in stages. Though some of the sites were visited by an American expert long ago, yet it is the first power project to be started in the Bundelkhand Region. The Betwa Power Project is all the more important because of its significant location in the State. The river is nearer the centre of gravity of the state than any other and power can be transmitted from this river to any portion of the State where load is developing rapidly.¹

The Betwa Power Project consists of a storage dam at Pipri on the Narain River, a tributary of the Betwa and a power station at Dhukwan Weir. The additional water in the storage dam at Pipri will give a suitable discharge and enable

2,500 KWS. of firm hydro-electric power to be produced in the first stage of the scheme.

The second stage of power development on the Betwa provides for an installed capacity of 15,000 KWS. The firm capacity is 14,599 KWS. The site of the dam would be Singhpura.

The Ken River Project envisages the construction of 6 dams and 10 power stations to yield an aggregate of 2,96,000 KWS., at 75 per cent load factor. The fulfilment of this project will prove a boon to the Ganga-Yamuna Doab. Electrical energy would be supplied to the towns of Lalitpur, Jhansi, Hamirpur, Crai, Kalpi, Mahroni, Chirgaon, Orchha, Mota and Datia.

Both the Betwa and Ken River Projects are recommended to be linked with other projects of the State in the final stage.

**Electrification in the Gorakhpur District**

It is proposed to set up a diesel oil engine to generate 3,090 KWS. power at Gorakhpur to provide electricity to 100 tube wells and to supply electrical energy for domestic, agricultural and industrial purposes in the districts of Deoria, Gorakhpur and Basti. Besides, to energise 340 tube wells in the districts of Mainpuri, Farrukhabad and Etah, a thermal plant of 10,000 KWS. capacity will be installed. Under another similar scheme Mau and Gorakhpur will have two thermal plants of 10,000 KWS. capacity, while the capacity of the Rampur Power house is increased by 1,000 KWS.

**Electricity and Gas for Kanpur**

This scheme is expected to make available to residents of Chakeri and Jajmau, two suburbs of Kanpur city, electricity and

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1. 'Times of India', New Delhi, November 17, 1951.
gas for domestic and cooking purposes.

**Pindar Hydro-Electric Development**

The Pindar river is a tributary of the Ganga and the proposed site is close to Karamprayag. It is proposed to build two dams - 200' and 500' high which will give 40,000 KWS. of firm power and 50,000 KWS. of seasonal power. This would provide cheap power for the development of the Upper Garhwal, and to the Almora and Naini Tal Districts.

When all these schemes will be completed, the State will get an additional 5 lakhs and a half Kilowatts firm power and about seven and a half lakh Kilowatts seasonal power as compared with the present capacity of 1,70,000 KWS. only.

**Planned Use of Water Resources - General Lines of Development**

1. **Multi-purpose schemes**

   The regulation and integrated development of rivers for all useful purposes is not an unattainable goal, and for the same reason, there has been a highly favourable trend towards an unprecedented emphasis on multi-purpose projects. In spite of some criticisms to the effect that more than one function cannot be performed, multi-purpose undertakings are being constructed in increasing numbers, because they have already demonstrated that they are sound, logical and effective checks against capricious Nature. Hence every single purpose project to be built up in the future should be carefully scrutinized to determine whether it can serve more than one purpose. In fact, water-power development, if suitably located, can render three-fold services. It can, at almost the same capital cost, provide hydro-electric power,
irrigation supply and inland waterways transport facilities, so woefully neglected due to the erstwhile faulty policy of the railway department (page 109).

Mr. Leonard K. Elmhirst, the Development Commissioner in the United Kingdom, holds that the speed of execution of the projects is a major factor in limiting costs. Quick results from the multipurpose projects cannot be achieved by fractional developments. It should be stressed that planning should be based on a long term policy but construction taken up on short term basis.

What Dr. Morgan of T.V.A. fame says "Building great dams is a more serious matter than many people realise" is also true.

The avoidance of constructing several mammoth schemes simultaneously is strongly recommended. "If we had the money and spread it over a thousand smaller schemes, should we not get a much better, richer and quicker return? In a poor agricultural state like the Uttar Pradesh, mere execution of big projects and utilisation of power for heavy industry will be a lopsided development and it has proved an utter failure in many instances like the Nayar Hydel Project. The small-scale projects for rural electrification would be conducive to the Nation's economy, and its healthy growth. This is what has been tried in Bundelkhand recently and had been realised by the western countries year back. Hence the amendments in the schemes under consideration or execution by the Government with speed would be in the interest of the people. In this connection installation of minor

1. The author had a personal discourse with Dr. Morgan on this subject.
PROSPECTIVE POWER

INDEX
- FIRM POWER
- SEASONAL POWER
- POTENTIAL

YAMUNA HYDEL
1st STAGE 22,560 kw. F. 28,360 kw. S.
2nd STAGE 2,500 kw. F.
3rd STAGE 14,000 kw. F.
4th STAGE 4,000 kw. S.

RAMGANGA 60,000 kw. F.
32,000 kw. P.

PINDAR 40,000 kw. F.
50,000 kw. S.

Mohammadpur 6,000 kw. F.
19,300 kw. S.

Kothri 20,400 kw. F.

Pathri 20,400 kw. F.

Navar 32,000 kw. F.
20,000 kw. P.

Khoi 3,000 kw. F.
9,000 kw. S.

Haldwani 20,400 kw. F.

Sarda 23,000 kw. F.
40,000 kw. S.

Sarda 13,000 kw. F.

Gogra 8,000,000 kw. P.

HARDUAGANJ 13,000 kw. F.

Gorakhpur 2,430 kw. F.
23,000 kw. S.

KANPUR GAS WORK 2,000 kw. F.

BETWA 1st STAGE 2,500 kw. F.
2nd STAGE 14,000 kw. F.
15,000 kw. S.
4,000,000 kw. P.

Rhand 1,87,000 kw. S.

SOHAWAL 2,000 kw. F.

H.7,000 kw. S.
generating plants at places such as Sultanpur, Azamgarh, Jaunpur, Pratapgarh, can be suggested. (See Chapter VI)

Suggestions

For the irregular flow of the rivers throughout the year in Uttar Pradesh, a scientific combination of hydro and thermal schemes would be the most economical as it increases the amount of firm power. The satisfactory results of such combined stations in the Ganga Canal are living examples to prove the possibility of further development of these schemes. For such a scheme the economic proportion of hydro-thermal power should be determined after a careful study of an hydrograph for a selected year and the duration curve of the river flow over a period of at least 20 years.

Inter-State Electric Projects - For a well planned and co-ordinated power development, the problem shall have to be tackled from an all India angle. The development of electrical resources of the State must be co-ordinated with those of Nepal, Madhya Pradesh, Vindhya Pradesh, the Panjab and the other adjoining states. The region of the largest waterfalls lies near Allahabad in Vindhya Pradesh which has considerable sources of power in the Vindhyan Hills. The V.P. Government is considering to develop these resources. It is suggested that the U.P. Government should cooperate in harnessing them to the fullest extent. The Ghagra Power Project, if implemented on the Karnali River, may benefit not only this State but Nepal too. Similarly the Yamuna and the Betwa Projects would benefit the adjoining states. This would not only help the State in financing and better designing the project but also in making
it suitable for extension or inter-linking with an all India grid.

Grid-system - Regarding the extensions of the transmission of the power to utilisation centres, the hydro-electric development easily buds into the growth of grid systems. But the electric grid systems should be decided to be established only in those regions which lend themselves to such developments economically. New power stations, both hydro and thermal, should be constructed and inter-connected wherever possible.

It appears probable that the Yamuna Valley Hydro-electric Project when completed can be linked with the Sakatra-Nangal Project of the East Punjab. It can ensure the generation of an average block of power amounting to 5,00,000 KWS. for consumption in the thickly populated tract between Ludhiana and Aligarh. It is also possible to inter-link the Nangal, the Yamuna, the Mandi (H.P.) and the Upper Ganga Canal system into a single grid at Delhi. Saharanpur lies in the centre of this region and there is no reason why the area within economic transmission distance of Saharanpur should not be highly industrialised, if cheap power be made available for manufacturing processes.

In any possible link-up of the various projects, Rihand, has the undoubted advantage of central location. It will be only 157 miles from the Damodar Valley corporation, 197 miles from Hirakund and 225 miles from Lucknow where it has already been decided, it will be linked up with the Sarda grid.

Owing to the various advantages, the Betwa Power when completed should be linked with the Ganga-grid in the north, with the Kanpur Electric Supply Company and the Rihand Dam
Project in the east and finally it should be linked up with the Chambal Valley Project of the Rajasthan and Madhya Bharat states. The inter-linking of the Betwa River with the Nayar Dam Project will convert the whole of its power into firm power, while the connecting of the Sarda Power House with the Ganga Grid will inject the surplus energy into Kanpur during the stage of high production, thereby causing a saving in the consumption of coal in the steam plant generation.

Then again, there are many steam stations existing in the State and oil engine stand-by plants at various local centres, e.g. Allahabad, Baharanpur, Banaras, Mathura, Agra, etc., which are run by individuals for personal gain. All these power stations can be inter-linked if the Government takes over charge of these power stations.

Thus, the grid system can be established not only all over the State but the practical possibilities of a nation-wide electrical grid to substitute and supplement the present and the scattered tiny units can also be visualised. It is only in this way that the greatest benefit can be conferred upon the greatest number of people.

Power Costs - Industrialists, generally with their own programmes of large-scale development, are closely watching the possibilities of low cost power with a view to establishing basic industries in competition with those in other countries. Furthermore, certain electro-chemical and other heavy industries cannot be developed economically at all unless power is available at rates below certain levels. Hence a plentiful supply of electricity at attractive rates to the majority of the
people by covering the whole State with a net-work of supply lines must be the aim and goal of hydro-electric development in the State.

In this regard the Rihand Dam Project has a promising future. The cost of generation electricity at this station will be the cheapest so far in Asia - 2.27 pies per unit. The cost at the consumers' end in bulk supply, 5.4 pies per unit - compares favourably with the cost under other projects - 8.5 pies in the Ganga grid, 7.5 pies at Jogindernagar in the Panjab; 6.5 pies at Mettur and Pykara (Madras) and 5.6 pies at Tatas (Bombay). One can imagine the huge prospects of the Ken and Betva river projects which will generate electricity - 1.5 pies per unit - cheaper even than the Rihand Dam Project.

As regards the capital cost in the development of transmission lines, Uttar Pradesh has some scope for reducing it by using support and fittings from materials locally available, and by allowing less rigid standards of construction in rural areas. In this State, there are many good forests which supply wood-poles which are not only economical but give much better operation. The Forest Research Institute has been successful in making the poles fungus-proof. It would help in rural electrification to a great extent. Besides, they would cease to depend upon imported steel poles.

1. Bose, S.N., Electrification in India, 1949, pp. 11-12
   Also Hindustan Times, October 28, 1952.
Another means of reducing costs is by standardisation. On extra tension lines, several States are getting designs of towers from outside the country, each state paying heavily for such designs to foreign countries. Once a State has adopted a set of designs, it should stick to such designs for future construction for the purpose of uniformity and reduction of spares, etc. By co-ordinating the work of different States, for example the Bhakra-Nangal Scheme, the Kosi and the Chambal Schemes, it will also be advantageous for one State to take advantage of the operating experience of the other State, and make improvements on the basis of such experience.

Electricity and water-pumping. Electricity should extensively be used in the State for pumping and irrigation purposes. Pumping stations can be installed on the Ram Ganga and other rivers in the State, like those on the Kalinadi. Considering the benefits of electrification on the field output, e.g. sugarcane and wheat production which took the advantage of tube well irrigation, experiments can be performed, if any fruit plantation or fruit culture yields good results. The little fruit garden at Banbassa (Pilibhit District) at least does not bear discouraging testimony. Banana plantation can also flourish in the whole of the Rohilkhand, Kumaun and Oudh areas. The Government should grant subsidies and facility for electric power to install tube wells to develop fruit culture.

1. A feature of the Sarda Canal Project is that the steel fabricated towers, required for transmission lines, will mostly be manufactured according to departmental designs for the first time in this country.
Small isolated townships and villages, which have some cottage industries and which cannot, within reasonable time, be served from the grid, should be supplied electricity either by establishing small diesel stations or by obtaining bulk power from the nearest licensees' generating station.

The criteria adopted for establishment of small diesel stations should be that the total number of houses in the town be about 2,000 or more. Secondly, there should be cottage industries like hand-weaving, oil-pressing, cane-crushing, etc. of reasonable magnitude.

Rural Electrification

As an immediate and practical way of supplying power for a programme of rural electrification, the establishment of small power stations using steam or oil prime movers may be suggested. These 'Nursery Power Stations' will help to build up demand for the large scale plants, when they come into operation. Each nursery station would radiate power to cover a maximum radius of 10 to 12 miles distribution, so designed and constructed as readily to merge in the ultimate grid net-work.

As far as possible, only those rural industries need be launched for which raw-materials are locally available or marketed within an easy range. The power supplied to the rural community should help the farmer in converting his raw products into some finished shape either for his own consumption or for easy sale. Dairy machines like pasteurizers, churners, cream separators, ginning machines, flour mills, rice-hulling, nut-cutting, oil-pressing and cane-crushing are some that may be run by power. These, in addition to creating new opportunities for employment, will also serve to produce a better value
for the produce. By using small fractional horse power, motors in ginning, spinning and weaving, with suitably designed spindles and looms, industry can be made more attractive and remunerative and complementary to basic mills. This would provide large quantities of cake manure for use in the region. Moreover, the export from the villages will consist mainly of semi-finished products which are much less bulky than the raw materials themselves. Electricity, therefore, will not only promote the growth of industries in the villages but also eliminate waste in transport. So rural electrification has a bright future in the State. Once it takes root, the consumption would go on increasing.

Wind-mills - During summer months, the wind movements are considerably stronger to work a wind-mill. In order to assess the practical value of a wind-mill and a wind-charger, it is necessary to maintain a scientific data of wind velocities as related to water discharges or the energy produced, as the case may be. Wind-mills can be installed like the one at Hardwar by the Municipal Board, in valley of the Kumaun Himalayas, where wind force is considerable as it chimes up along the valley. If the results come out successful, power can be utilised in industries as well, as has been in other countries like Holland and Germany, where pure hydrogen, cheap light metals, fertilisers, etc. are manufactured with the help of wind power.

The chief disadvantage of wind will be that it is not constant either in strength or in direction, but this difficulty can be

1. During the field survey the author visited a few windmills and found them working successfully.
surmounted by removing power plants to heights where wind power becomes remarkably uniform, in fact, even more uniform than the existing hydraulic stations\(^1\). The prospects of producer gas plants should be explored in the State (page 124). If it be economic, producer gas may be imported from the Bihar coal mines where it is generally wasted, through pipe lines to be constructed from coal mines to the important towns of the State.

Industries - Industries, which await provision of cheap electricity, are many and varied - such as electric welding, the production of aluminium, the manufacture of calcium carbide and innumerable derivatives, the direct fixation of atmospheric nitrogen into nitrates of commerce, the electrical production of chlorine gas and preparation of phosphorus. At the completion of the Hirand Dam, the varied industries described on page 128 may be started to develop the load. Most of the textile mills in the state of Madhya Pradesh have closed down their steam or oil engine plants and charged over to Pykara and the Mettur hydel schemes. A similar growth of textile mills can take place in this State as well.

Power to sugar-cane crushing industry, developed on co-operative basis, in villages will release the bullocks for ploughing, carting and also for longer periods of rest. Industries like brass turning and polishing have shown a marked development as a result of the availability of power. In spite of so much progress, vast scope of development is still left uncovered. The All India Spinners Association does not

\(^1\) Indian and Eastern Engineer, Vol. 71, p. 350.
class the woollen yarn and cloth in the definition of Khadi, if even the carding of wool is done by machine. If all types of power are to be avoided, the cottage industries will be deprived of all mechanical inventions of the age without which they cannot thrive. All facilities derived from introduction of machine must be provided.

The power that will be produced after the completion of all the plans in the State may be enough to meet all the possible demands that may arise in the future. In fact, it is feared that the power produced may be even in surplus of the demands. So, the maladjustment between production of power and its planned utilisation should be guarded against. The power development plans should be taken up simultaneously with the industrial expansion of the State. In these circumstances, it is but natural that either the power must be distributed over as wide an area as possible or all uneconomic schemes be eliminated from our development plans.

It is only by such co-ordinated planning over wide areas, by marrying urban with rural loads, that the blessings of electricity can be extended to the backward and undeveloped areas at a cost which would not be too onerous a burden on the general tax-payer. Side by side with development of power care has also to be taken to push up manufacture of machinery and equipment required for such production in this country. The engineers should devise electrical equipment suited to the needs of villagers. In this way the agricultural state may be turned into an agricultural-cum-industrial one.

Thus, it is solution to prove the equation: Electricity plus Enterprise = Prosperity.