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Hydro - Electric Power Potential of Arunachal Pradesh and Options to Harness It

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Arunachal Pradesh is endowed with rich Hydro-electric power potential of the order of 2,11,756 MW at 60% LF if the Hydro-electric potential that can be harnessed jointly by China and India are taken in to account. Lack of conventional electricity demand in the region is the main reason not to harness even a fraction of this potential. This paper outlines how this vast Hydro-electric power potential can be put to use economically to benefit key sectors of Indian economy such as Metallurgical, Agriculture, Petro-Chemical and Power sectors.

ARUNACHAL PRADESH (A.P.) IS THE NORTH EASTERN STATE of India having international boundary with China in the north and Burma in the east. The river Brahamaputra known as Dihang in this state descends to 800 m altitude while entering in this state from the World's highest Tibetien Plateau from an altitude of 3350 m after taking a 'U' bend (Fig. 1). The hydro-electric power (HEP) potential of A. P. is assessed as 26,756 MW at 60% load factor (LF) which is 32% of the total HEP potential of India. However this figure does not ide the HEP potential that can be harnessed jointly by India and China. Eminent engineer and water resources planner, Dr. KL Rao in the book "India's water wealth" authored by him writes as follows regarding HEP potential of Dihang river.

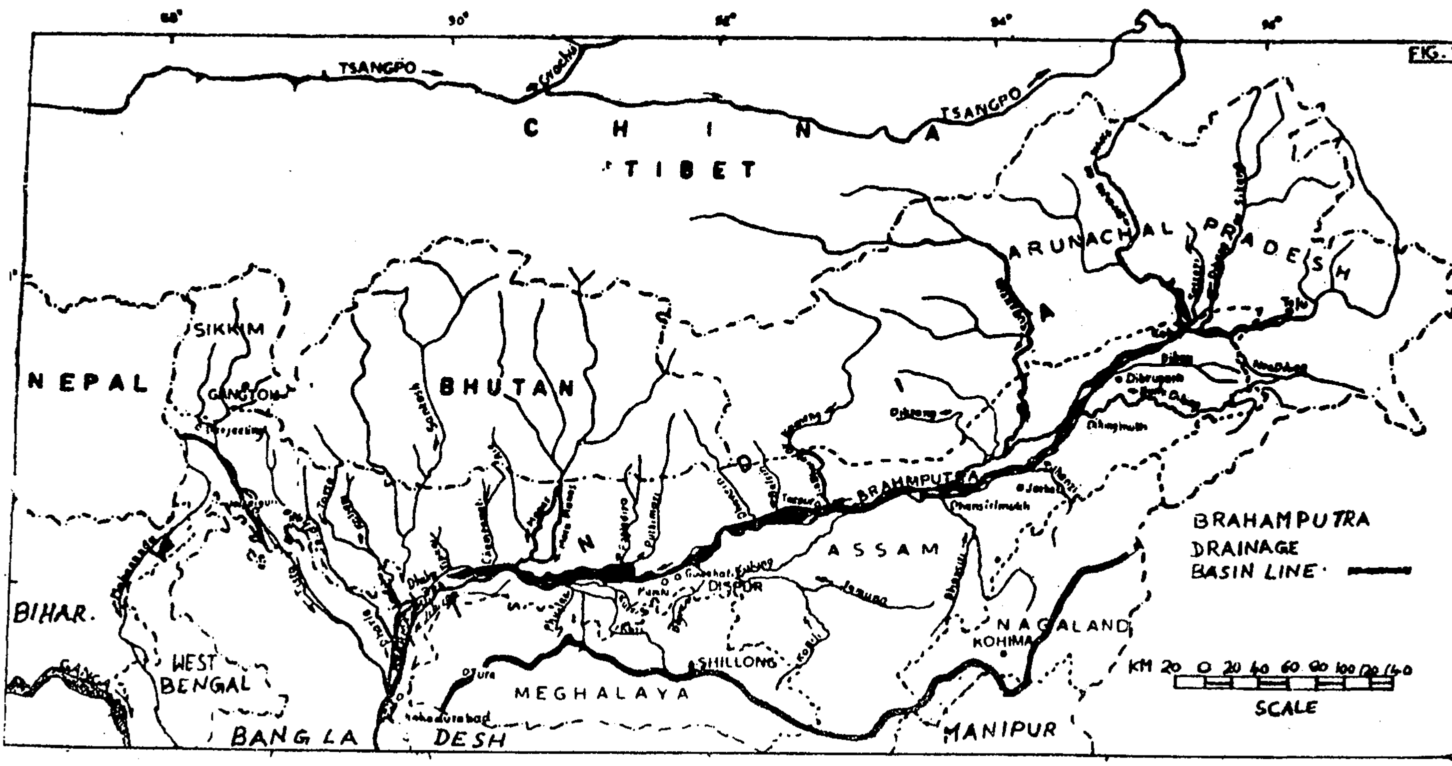

FIG. 1

"Where Brahmaputra (Known as Dihang here) takes a 'U' bend and enters India from Tibet, the river drops from Tibetan Plateau from 3,350m to 800 m in India giving a head of 2,200 to 2,500 m. The minimum discharge in the river at this point of diversion is 1000 cumecs. About 30 million KW energy can be developed by diverting the run-of-the river from that plateau to join straight in to the river again by a 20 km long tunnel. Upstream storages will further enhance the quantity of power.

The valley characteristics are favourable for this. As the river at the point of diversion is in China, and site of power house in India, it requires the co-operative effort of both countries to generate energy from this colossal power store house."

At the point of diversion, the river's average yearly flow is approximately 20 million hector meters (6300 cumecs) and 11 million hector meters (3500 Cumecs) in 90% dependable year. The HEP potential of this scheme based on average yearly flow works out to 1,23,350 MW at 90% LF or 1,85,000 MW at 60% LF. Based on 90% dependable flows, the HEP potential works out to 67,850MW at 90% LF or 1,02,000 MW at 60% LF. So the total HEP potential of A.P. Works out to be of the order of 2,11,756 MW at 60% LF if HEP potential lying on both sides of international boarder is considered. This is 78% of the total India's HEP potential of 2,68,876 MW at 60% LF.

The major HEP schemes under consideration are Dihang dam project and Subansiri dam project in this state with following details.

Dihang dam project The scheme envisages to install 20,000 MW (40x500MW) at the toe of the dam to utilise 220 M of head drop with and estimated cost (excluding transmission lines) of Rs. 12,171 crores at 1988 prices with generation cost 55P/KWH. The firm power and energy benefits in 90% dependable year has been worked out as 6270 MW and 55,800 GWH respectively.

Subansiri dam project The scheme envisages to install 4800 MW (12x400 MW) in an underground power house to utilise 150

M head drop with an estimated cost (excluding transmission lines) of Rs. 4,201 crores at 1988 prices with generation cost of 57P/KWH. The firm power and energy benefits in 90% dependable year have been worked out as 1,789 MW and 15,672 GWH respectively.

Special features

The following are the special features of HEP schemes of A.P.

Advantages

The projects are of gigantic capacity which reduces infrastructure and dam cost per MW drastically.

The schemes are of high head and high flow rate type which will facilitate to select high speed turbine units of very big MW. capacity to reduce installation cost per MW.

The flow regime of the Dihang river in its upper reaches is not of wide seaonal fluctuation unlike other rivers of India since the source of water is mainly from snow melt with minimum flow in winter months. This feature enables even relatively small storage capacity reservoirs to flatten the flow regime considerably in their down stream.

Due to enormous HEP potential and lack of conventional electricity demand, these HEP schemes shall not be envisaged to operate as peak load stations. However if these schemes are to operate at 90% LF as base load stations, (options to induce base load demand is dealt in forthcoming paragraphs) it will optimise the electricity generation per MW reducing the cost of generation and total investment drastically though installed cost/MW may rise slightly. Viz: If the Dihang dam project is envisaged to have 6270 MW capacity instead of 20,000 MW to operate as base load station at 90% LF, the generation cost would be 22P/KWH assuming Rs. 5000/KW as installation cost on turbine units, Rs. 2000 crores towards dam and infrastructure costs and yearly O&M cost as 1% of total investment. It can be observed that generation cost in base load schemes is only 50% of that of peak load schemes. The operational availability of HEP turbines is more than 90%.

A.P. is sparsely populated area which will not create problems such as human displacement on large scale and heavy financial burden to compensate the loss of immovable assets and livelihood when HEP schemes are implemented.

The storage reservoirs created to harness the HEP potential will also ensure better availability of water, for irrigation throughout the year, develop inland navigation, moderate the floods which frequently occure in Assam and neighbouring Bangladesh and develop pisciculture as secondary benefits.

Disadvantages

This HEP potential is located far away from the load centres. This feature necessitates massive extra high voltage transmission lines to transmit this power to the load centres which will incur additional capital investment. Since the generation cost is very low, the electricity cost near load centres will be attractive even with additional investment towards associated transmission lines and associated transmission losses. Viz: The electricity cost in the plains of West Bengal, Bihar and Orissa works out to 42P/KWH to bring electricity generated (22P/KWH) by dihang dam project if a 1200 km transmission line @ Rs. 35 lakhs per MW capacity is needed and 25% electricity transmitted is lost during transmission. 42P/KWH is only 40% of the generation cost of present day pit head coal fired power stations. The generation cost of electricity from the vast HEP potential situated on both sides of international boarder will be further less due to very high head and high capacity features.

The HEP potential of A.P. is situated in high seismic activity area. However dam technology is verywell developed and proven to meet this challenge. Check dam with sufficient storage capacity may be envisaged as an extra safety measure to contain the water deluge due to failure of any dam located in its upstream area such that thickly populated areas along the river path is not effected in case of very high intensity earthquake or man made distraction. These additional safety measures will increase the cost of generation marginally only due to gigantic HEP potential. Additionally, this check dam whose reservoir is normally empty may be utilised for moderating the floods in the region.

As pointed out earlier, most of HEP potential of A.P. is situated on both sides of the boarder between India & China. Unfortunately the whole state falls in the disputed territory between India and China. Recently relations between India and China are showing sign of consistent improvement. China has nearly 37,555 sq. km. of Indian territory in Jammu and kashmir under illegal occupation which is strategic to her interests. If China is made to agree to cede India the area (approximately 5000 sq. km.) within the 'U' bend situated north of Mac-Mohan line and also cede rights to construct a storage dam of capacity not less than 20% of the yearly average river flow in return to recognition of China's legitimacy over the occupied Indian territory, it will serve the interests of both countries and restore normal relations between the two countries. China may not be willing to Claim share in this HEP potential since transmitting this power economically across the harsh terrain of Tibet to reach its load centres is not within the reach of present day technology.

Options to utilise the HEP potential

The reason not to harness, even a fraction of this vast HEP potential inspite of very attractive generation cost is mainly due to lack of conventional electricity demand in this state or the entire northeastern region. However this HEP potential can be harnessed fully over a period of time by installing electricity intensive industries as enumerated below to achieve faster growth in development of whole nation.

Pig iron and steel production

In our country presently the bulk of steel production is by Blast Furnace - Basic Oxygen Furnace (BF-BOF) route which is characterised by high installation cost (Rs. 24,000 per ton of steel) and requirement of good quality coking coals. Though India has abundant quantity of good quality iron ore, good quality coking coal is scarce and need to be imported. Recently steel production is envisaged on major scale by Direct Reduction - Electric Arc Furnance (DR-EAF) route. In this route, sponge iron is produced with natural gas as reduction agent and further converted in to steel in the electric arc furnace. Though the installation cost (Rs. 19,000 per ton of steel) is less compared to BF-BOF route, if has more production cost than t' of BF-BOF route due to expensive natural gas and electricity.

When cheap and abundant electrical energy is available, pig iron can be produced economically by electric smelting process of iron ore. Table - 1 gives the electricity requirement to produce one ton of various metals by electrolysis or in electric furnaces. Pig iron production through electric smelting process is not only less capital intensive but also has better choice of raw materials such as anthracite coal, charcoal, coke breez etc. in place of good quality coke. The raw materials cost is also less due to requirement of lesser quantity of coal per ton of Pig iron produced and utilisation of cheaply and indigenously available anthracite coal etc. Pig iron is further converted into steel in electric arc furnance. Electric smelting route also yeilds best quality pig iron. India has production capacity of 11.5 million tons of salable steel and produced 9 million tons in 1989-90. If 30,000 MW at 90 % LF of HEP potential of A.P. is harnessed and transmitted to the pit head steel factories of eastern India to produce steel in next thirty years. Steel production will increase by five folds achieving tremendous growth in steel sector. Indian engineering products will have brighter export opportunities with the availability of steel at cheaper cost. There is no doubt that India can transform into exporter of finished steel or steel products from the traditional exporter of iro

Table : 1

Metal or Product	KWH/TON
Copper	2,500
Manganese	11,000
Zinc	3,500
Aluminium	18,000
Magnesium	18,000
Ferro-Chrome 70%	8,000
Ferro-Maganese 70%	5,000
Ferro-Molybdenum 50%	8,000
Ferro-Silicon 50%	6,800
Ferro-Tungsten 70%	8,600
Ferro-Vanadium (35-45%)	7,000
Silico-Manganese 70%	6,000
Pig Iron	2,500
Electric Steel	800
Calcium Carbide	3,500
Hydrogen	47,000

Approximate electricity requirement for some of the materials produced either by electrolysis or electric furnaces.

ore by harnessing the HEP potential of A.P.

Aluminium production

Aluminium (Al) is produced by electrolysing its ore alumina. In present day Al industry, electricity required to electrolyse Alumina is produced in captive power plants with coal as fuel. More than half of the production cost of Al is attributed to the cost of captive electricity generation which is also highly capital intensive. As per present trends, it is impossible to construct a coal fired power station with generation cost less than one rupee per KWH with moderate returns on investment when run at good plant load factor. Cheap and abundant electricity from A.P. can be transmitted to the pit head Al factories instead of envisaging captive power plant to meet electricity requirement. This method will reduce the cost of Al production drastically. India produced 4.35 lakh tons of Al which is only 2.6% of the World output in 1989-90. The requirement of massive transmission lines while attempting to harness the HEP potential of A.P. will lead to creation of demand for Al which is conducive to the faster growth of Al industry. Indian Al will also have export opportunities due to its attractive production cost. If 10,000 MW at 90% LF of HEP potential of A.P. is utilised for Al production, it can sustain nearly three million tons of production every year.

Fertiliser Production

The bulk (70%) of fertiliser consumed is of nitrogenous fertiliser whose feed stock is generally liquid and gaseous hydro-carbons. If cheap and abundant electricity is available, nitrogenous fertiliser (Urea) can be produced by the hydrogen generated from electrolysing water. This hydrogen can be converted into Ammonia by allowing Hydrogen to react with Nitrogen extracted from air. This Ammonia can be liquified by pressurisation and pumped/transported to manufacture Urea nearer to bulk consuming centres.

If nearly 30,000 MW at 90% LF is harnessed gradually to produce nitrogenous fertiliser, Urea production will increase by five folds from the present 7 million tons per year to 35 million tons per year obliterating the necessity of imports and fertiliser subsidy forever. Phosphate fertilisers can also be produced by electricity when it is cheaply available.

In the process of generating hydrogen through electrolysis of water, Heavy water is produced as by-product which will help to support the nuclear power programme in the regions where abundant HEP of A.P. can not reach economically.

Lift irrigation schemes and peak load electricity demand

A portion of this cheap HEP potential of A.P. can be utilised to divert the surplus waters of Ganga and Brahmaputra to benefit water deficit regions of peninsular India by envisaging lift irrigation schemes such as Ganga - Cauvery project. Till now Ganga - Cauvery project is considered to be uneconomical due to enormous power (7000 MW at 46% LF) requirement to lift the water (1.48 million hector meters by 550 m high) from the Ganga at Patna to be taken across Vindyas during the surplus flow period if the required power is to be generated either by coal fired or nuclear power plants.

With the help of cheap and abundant HEP of A.P. not only surplus water of Ganga but also totally unutilised Brahmaputra water can be diverted to peninsular rivers via Ganga river to benefit the entire nation. This will enable our planners to conceive the idea of extending irrigation facilities to two/three crops in a year throughout India. These pumping stations can be operated as hydro-electric turbines to meet the additional power demand in the grid during peak hours by envisaging reversible turbine/pump features. It should not be assumed that the entire energy consumed in pumping water is lost because these waters while descending in altitude in penin sular rivers generate power in the hydro-electric stations located on these rivers. It will also enhance the HEP potential of peninsular rivers substantially due to enhancement of their minimum flows by additional water from Ganga and Brahmaputra. Nearly 5 million hector meters of water can be diverted to peninsular rivers from the surplus water of Brahmaputra and Ganga by harnessing 15,000 MW at 90% LF of HEP potential of A.P. Another 10,000 MW at 90% LF can be utilised to meet peak demand to the extent of 35,000 MW in northern, eastern, western and north eastern regions.

Petro-chemical industry

The primary products of perto-chemical industry are Ethylene, Propylene, Butylene and Butadiene which are produced by steam cracking of any one of Naptha, Propane, Ethane and Natural Gasoline liquid (NGL). Ethane, Propane and NGL are extracted from Natural gas whereas Naptha is a product of petroleum refineries. The above primary products are used to produce innumerable down stream products under groups plastics, synthetic rubbers, synthetic fibres and organic chemicals which have wide application in the present day civilisation. Acetelene being a highly unsaturated hydro-carbon, can also be used as primary product of Petro-Chemical industry provided it is cheaply available. Acetelene can be produced by allowing calcium carbide to react with water. Production of calcium carbide is highly electricity intensive industry whose raw materials are abundantly available calcium oxide and coal. Nearly six million tons of Acetelene can be produced at attractive economics if 10,000 MW at 90% LF of HEP potential is harnessed to meet the demand of primary products of Petro-Chemical industry in next 30 years. This will enable the Petro-chemical industry not to depend on the basic raw materials such as crude & Natural gas whose availability is highly doubtful on long run and associated very high capital intensive technologies to produce the primary products.

Base load electricity demand : In our country bulk of base load electricity demand is met by coal fired thermal power stations. Electricity is either generated in pit head power stations and then transmitted to load centres or coal is transported by rail nearer to load centres and then electricity is generated in load centre power stations to meet its demand. However the basic fuel is coal whose deposits are mainly located in eastern and central India. Feasibility of load centre power stations are becoming difficult day by day due to limited availability of railway lines to transport coal to power stations. As per present trends, new pit head coal based power plant's generation cost is nearly one rupee per KWH when operated at good (70%) plant load factor. Moreover coal fired stations are highly capital (Rs. 18,000/KW) intensive. Whereas the cost of generation works out to 42P/KWH to make available one KWH in the coal mine areas of Bihar, Bengal and UP from the hydro-electric stations of A.P. So it would be advantageous and economical to transmit this hydro-electricity further to various load centres by transmission lines whose cost in mine areas is only 40% of the generation cost of pit head coal stations. In other words every unit to be produced by a new pit head station if replaced by electricity available from the HEP potential of A.P., there will be saving of the order of 58P/KWH. The generation cost of hydro-electric stations is not susceptible to inflationary tendencies unlike the generation cost of coal fired stations due to absence of recurring expenditure such as coal cost and coal transportation cost. So the gap between generation cost of hydro-electric stations and coal fired stations will widen further in future. It can be concluded that utilisation of HEP potential of A.P. to meet the base load demand in north-eastern, eastern, northern and some parts of western regions is highly economical and less capital intensive.

The electricity generated from abundant HEP potential of A.P. can also be exported to Bangladesh at very attractive prices which will earn foreign exchange and improve bilateral relations.

Capital investment requirement

Let us examine the capital investment required to harness the HEP potential of A.P. to know whether nation can afford it. If Rs. 20,000 crores at present day prices are invested in next seven years to create a capacity of 18,000 MW with their associated transmission lines and the price (413P/KWH) of electricity is fixed such that gross yearly profit before depreciation (37.6 P/KWH) is 20% of the investment, the internal resources generated will be sufficient to harness the entire HEP potential (1,41,170 MW at 90% LF) in next 23 years assuming 7% yearly escalation in the construction cost. If 10% escalation is taken on the O&M charges, the cost of electricity (71P/KWH) at the end of 30 years period will be less than present day coal fired power station generation cost.

In the VIII five year plan nearly Rs. 1,20,000 crores is envisaged to be spent of creation of 38,000 MW additional capacity and power transmission which is nearly 20% of the total plan outlay. So it would not be difficult to allot Rs. 20,000 crores over next seven years to harness the HEP potential of A.P. which will have dreamed our contribution to all major sectors of Indian economy.

Conclusion

From the above it is clear that the vast HEP potential of A.P. if harnessed will vitalise the major sectors of Indian economy such as metallurgical, power, agriculature, petro-chemicals and fertiliser industries imparting long term viability, attractive production costs, less capital oriented technologies and less dependence on imports. The major advantages of hydro-electric energy resources are its undepletability, pollution free and production cost independent of inflationary tendencies.

Electricity is the most coveted from of energy which can be transmitted/transported and put to end use directly with clean and cheap implements like electric furnaces, drives etc. unlike other energy resources. There is no doubt that electricity from HEP potential of India, can become backbone of her energy sector. So a concerted and multifaceted serious attempt has to be made to utilise the HEP potential of A.P. to achieve quicker pace of development of entire nation by our planners.

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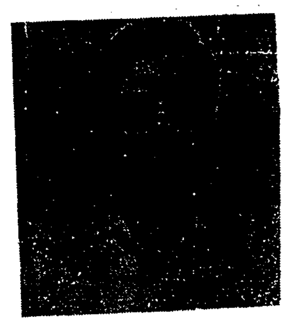

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