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ORIGINAL CONTRIBUTION

HYDRO-POWER DEVELOPMENT FOR SUSTAINABLE GROWTH IN INDIA

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ABSTRACT

Growth and prosperity of a civilization primarily depend on the availability of two inter-related commodities – water and power. Water and energy policy makers, governed by the principles of environmental caution, poverty alleviation and sustainable development are obliged to promote the optimum use of water including its utilization in hydro-power generation. Developing countries, for which these issues are urgent, have a pressing and ever-intensifying need for power and water development in a comprehensive manner. As India has significant unused hydro potential, its development for power generation can play a critical role in meeting these needs while safeguarding the criteria of sustainable development.

KEYWORDS— BBHE, DSIHE, MMBEBHE, AMBE, dynamic range

GROWTH AND PROSPERITY OF CIVILIZATION

This depends on the availability of two inter-related commodities.

- Water
- Power

Water and energy policy makers, governed by the principles of environmental caution, poverty alleviation and sustainable development, are obliged to promote the optimum use of water and power. Developing countries are facing the following challenges.

- They are facing formidable challenges in meeting their energy needs in agricultural, industrial and domestic sectors; and providing adequate energy of desired quality on a sustainable manner and at reasonable costs.
- Economic growth calls for increasing use of energy.
- For the growth that we aspire our energy needs will increase correspondingly.
- There is a direct correlation of energy consumption and economic growth of a country.
- Per capita consumption of energy in developing countries is very low in comparison to the world.
- Electricity consumption is about 1/5th of the world average.

ENERGY SCENARIO IN INDIA

- Total population - 106 crore
- Rural population - 70 crore
- Total villages - 6.10 lakh
- Unelectrified villages - 1.25 lakh
- Unelectrified households- 45% total 56% rural
- Cattle population- 310 mill (highest in world)
- % non-commercial energy use in rural areas - 70 – 80%
- Waste land in the country - 60 mill ha

CAUSES FOR NON-ELECTRIFICATION

There are around 2000 villages that are still deprived of grid electric power in India. There

are many reasons for this non-electrification. Major causes are given below:

- Remoteness and low population density of the region makes the grid electrification economically unviable.
- Many habitations are situated at such remote locations that repair and maintenance of the existing lines is always a problem. Therefore most of the time quality of electricity is very poor. It is either not available at all or available at very low voltage.
- Some locations are covered with dense forests but these forests restrict the entry of power lines for small villages within the forests. There are many villages that are not far away from the grid but due to their situation inside the forest, these are deprived of grid electricity.
- In many cases main villages are electrified by the grid connectivity but many toks associated with the village are neglected because of their distance from the village.
- Installation and maintenance cost of grid lines at high altitude areas makes it a very expensive proposal.

POWER SCENARIO IN INDIA

- Total installed capacity - 127056 MW
- Hydro - 33194 MW (25.4%)
- Thermal - 82508 MW (64.8%)
- Nuclear - 3310 MW (7.2%)
- Gross Generation - 620 Bus
- Per capita consumption - 606 KWh/Annum
- Energy Shortage - about 7%
- Peaking Shortage - about 13%

POWER GROWTH PERSPECTIVE IN INDIA

- Electricity demand growing @8% annually
- Increasing demand in agricultural sector
- Capacity addition of about 1,00,000 MW required in the next 10 years
- Challenge is to meet the energy needs in a sustainable manner

DISTRIBUTION OF PROPOSED CAPACITY ADDITION IN THE NEXT 10 YEARS

- TOTAL - 1,00,000 MW
- Hydel - 36%
- Renewable - 10%
- Thermal - 46.7%
- Nuclear - 7.3%

NATIONAL ELECTRICITY POLICY

It is as follows:

- Availability of power-demand to be fully met by 2012
- Supply of reliable and quality power
- Access to electricity – available for all households in the next five years
- Per capita availability of electricity to be increased to 1000 units by 2012
- Minimum lifeline consumption of 1unit/household/day by 2012

REGIONWISE SCENARIO OF HYDROPOWER IN INDIA

- Total - 33194 MW
  - Northern - 11190 MW
  - Western - 6307 MW
  - Southern - 11101 MW
  - Eastern - 2952 MW
  - North Eastern - 1644 MW

REGIONWISE HYDROPOWER POTENTIAL IN INDIA

- Total Estimated Potential- 84044 MW
  - Northern region - 30155 MW (35.88%)
  - Western region - 5679 MW (6.76%)
  - Southern region - 10763 MW (12.81%)
  - Eastern region - 5590 MW (6.65%)
  - North Eastern region- 31857 MW (37.90%)

YEARWISE HYDROPOWER INSTALLED CAPACITY IN INDIA

Year	Hydro (MW)	% of Total
1947	508	37.30
1962-63	2936	50.61
1973-74	6966	41.80
1984-85	14460	33.96
1999-2000	23857	24.37
2005-06	33194	25.40

NATIONAL HYDROPOWER POLICY

- India has a policy on "Hydropower development" which lays special emphasis on small hydropower development.
- About 50,000 MW hydroprojects are likely to be installed during the next 15 years in India.
- Expected capacity in addition:
- 10^{th} plan - 10,000 MW
- 11^{th} plan - 20,000 MW
- 12^{th} plan - 20,000 MW

SMALL HYDROPOWER

- Hydropower up to 25MW station capacity is classified as small hydropower
- Ministry of non-conventional energy sources is responsible for the development and deployment of small hydropower.
- About 2% of the capacity addition in the power sector is aimed to come from small hydropower.
- No techno-economic clearance is required for projects up to Rs.250 crore investments.

NEED FOR VERY SMALL HYDROPLANTS IN INDIA

- There are thousands of sites available which can be tapped for the production of at least 10 KW of electric power, just at the close vicinity of the villages. Some of the remote villages in India does not require more than 10KW of electricity for their lighting requirements.
- Traditional watermills may be converted into very small hydropower plants, because in their conventional form traditional watermills are losing their charm among the village youths. But, usefulness, enterprising nature and avenues for income, may attract the unemployed youths.
- Installation of very small hydro plants of the capacity ranging between 10 KW to 20 KW, in large numbers, can contribute a small but insignificant way towards state's energy needs.
- Installation of such plants is best option to achieve hundred percent electrification of rural high altitude region. Where a suitable very small hydropower location is available in the vicinity of the village.
- Such plants are meant for providing electricity for lighting and limited community television during nights only, therefore mechanical power output during day time can be used to run the small industrial set up for the further enhancement of the income of the watermill owner.

DIVISION OF SMALL HYDRO SYSTEM

The division of small hydro system is as follows:-

- Micro hydro - Capacity up to 100 KW
- Mini or very small hydro - Capacity 101 KW to 200 KW
- Small hydro - Capacity 2001 KW to 25000 KW

Micro hydro systems, which are designed for the output from few watts to around 20 KW

The small hydropower is also classified basing on head:

- Ultra low head - Below 3 meters
- Low head - Less than 40 meters
- Medium / High head - Above 40 meters

SMALL HYDROPOWER POTENTIAL IN INDIA

- Potential - 15000 MW
- Identified potential - 10477 MW (4404 sites)
- Installed capacity - 1826 MW (556 projects)
- Under Implementation- 468 (203 projects)

STRATEGY FOR SMALL HYDROPOWER DEVELOPMENT

Small hydropower development is envisaged through

- Private Sector presentation
- State Government / Electricity Board
- Central Public Sector Undertakings
- Local bodies and NGO

PRIVATE SECTOR INITIATIVES

Over 100 small hydro projects aggregating 450 MW are commissioned by the private sector in the following states of India

Karnataka	- 280 MW
Andhra Pradesh	- 110 MW
Himachal Pradesh	- 28.5 MW
Maharashtra	- 6.00 MW
Uttranchal	- 6.00 MW
Punjab	- 7.75 MW
West Bengal	- 6.00 MW

Table1: Details of some hydropower potential states of India

State	Sites (nos.)	Potential (MW)	Achievement (MW)
Himachal Pradesh	423	1624	132.08
Uttranchal	354	1478	75.45
J&K	201	1207	109.74
Karnataka	230	652	329.63
Maharashtra	234	600	207.08
Kerala	198	466	84.62
Tamil Nadu	147	338	77.70
Madhya Pradesh	85	336	41.16
Uttar Pradesh	211	267	25.10
Andhra Pradesh	286	254	178.81

MINISTRY OF NON-CONVENTIONAL ENERGY SOURCES' SUBSIDY SCHEMES

- Support to states for identifying new sites and preparation of perspective plan for small hydro power
- Subsidy for public, private and NGO small hydropower projects
- Subsidy for renovation and modernization of existing public sector small hydro power projects
- Scheme for languishing public sector projects
- Water Mills

SUBSIDY FOR SMALL HYDROPOWER PROJECTS

- Subsidy for identification of new sites and perspective plan – up to Rs.30 lakhs per State
- Subsidy for renovation & modernization – 75% of R&M cost
- Subsidy for languishing projects – 75% of balance cost
- Watermills
  - Mechanical – up to Rs.30,000
  - Electricity generation – up to Rs.1 lakh

Table 2: Subsidy Scheme for Commercial and Joint Sector Small Hydropower Projects

States	Capacity		
	Up to 100 KW	From 101 KW to 999 KW	From 1 MW to 25 MW
NE Region, Sikkim, J&K, HP and Uttranchal	45% of the project cost up to		
	Rs.30,000 per KW	Rs.30 lakhs plus Rs.21625/KW	Rs.2.25 crores plus Rs.37.5 lakhs/MW
Notified hilly regions of all other states and islands	30% of the project cost up to		
	Rs.20,000 per KW	Rs.20 lakhs plus Rs.14,400/KW	Rs.1.50 crores plus Rs.25 lakhs/MW
Plain & other regions of all other states	20% of the project cost up to		
	Rs.10,000 per KW	Rs.10 lakhs plus Rs.7200/KW	Rs.0.75 crores plus Rs.12.50 lakhs/MW

LOAN ASSISTANCE TO SMALL HYDROPOWER PROJECT BY GOVERNMENT

Indian Renewable Energy Development Agency Limited (IREDA) is a public limited Government Company established on 1987, under the administrative control of Ministry of New and Renewable Energy (MNRE) to promote, develop and extend financial assistance for renewable energy and energy efficiency / conservation projects with the motto "ENERGY FOREVER".

It provides

- Loan assistance for small hydro power projects up to 25 MW stations capacity.
- 132 projects supported aggregating 430 MW
- Total loan sanctioned Rs.1054 crores (US$ 250 million)
- 62 projects aggregating 170 MW commissioned so far.

SMALL HYDROPOWER PERFORMANCE TESTING

- Ministry of Non-conventional energy sources (MNES) has created testing facilities at alternate Hydro Energy Centre (AHEC).
- Three technical institutions are also being strengthen for helping AHEC in testing the projects.
- AHEC has already conducted testing at sixteen different projects.

AHEC is an academic Centre of Excellence for carrying out education, research, development, training and advisory services to provide key inputs for full realization of renewable energy potential with thrust on small Hydropower and conservation of natural resources. The mandate of the centre is to promote power generation through the development of small-hydropower projects in hilly as well as plain areas and development of decentralized integrated energy systems in conjunction with other renewable energy sources e.g. biomass, solar, wind etc.

AHEC has been providing professional services in the field of small-hydropower development specially for following:

- Refurbishment, Renovation and Modernization of small hydropower stations.
- Detailed project reports.
- Detailed Engineering Designs and construction drawings.
- Technical specifications of Turnkey execution/equipment supply.
- Pre-Feasibility reports.
- Planning, Designs and execution.
- Techno-Economic Appraisal.
- R&D / monitoring projects.
- Remote sensing and GIS based applications.

Thrust of small hydropower program

- 2% of capacity addition should come from small hydropower.
- Reliable data for potential sites.
- Improve reliability.
- Reduce cost of power from small hydropower.
- Development of standards / manuals / guidelines etc.
- 1400 MW targeted during 2007-2012.

ISSUES OF ECONOMIC VIABILITY

Very small hydro power is already subdivided into two categories namely:

- Pico-hydro stations with the capacity less than 20 KW.
- Micro hydro stations with the capacity of 50-200 KW.

Pico-Hydro stations are considered well-planned, designed and installed system of 5 KW capacities. This will cost around five lacs of rupees. The following data are assumed.

- Load factor 30%
- Depreciation 10% per annum on the cost of plant and machinery.

Then the per unit generation cost will be around Rs.3.50. If other overheads and profit margins are added to it, this cost will rise to around Rs.4.50 to Rs.5.00. This price is higher than the one charged by the state power corporation but is much less than the actual cost of power to the corporation in isolated locations. These power plants cannot obviously be connected to the state grid and will need to work in isolation or it is

also possible to make a local 400V/230V grid of these nearby plants working in a group.

The Micro-Hydro Stations with capacities more than 100 KW, on the other hand, can be connected to grid and can both draw and feed power to it. The estimated costs of the installation of such plants will be of the order of Rs.70,000 to 1,00,000 per KW. However, with grid connectivity a much higher load factor of the order of 60-70% (subject to availability of water) is possible. This will make generation cost around Rs.2-2.50 per kWh.

All these considerations have prompted Indians to propose a new approach in the next section.

POWER DISTRIBUTION AND REVENUE COLLECTION STRATEGY

In low capacity power plants it is always desirable that misuse on theft of electricity is minimized. To achieve this goal, multi star distribution strategy should be adopted.

- At this scheme, independent cables are laid from generation point to various load center.
- At each load center, a different person will be responsible for distribution of electricity to the households of that cluster and responsible for collection of monthly charge from each user.
- Each user will be fed with an independent line so that monitoring of individual load may be performed at each load center and in case of any misuse or fault, the line of the particular consumer may only trip and other users may get uninterrupted supply.
- Use of lamps with different ratings on use of other appliances may arise, but one way of minimizing such problems would be to adopt a turn-key approach for house wiring with special holders and provision of efficient lighting sources is done by the cluster operator.
- Since very small hydropower will be used for lighting during nights only, hence mechanical power so generated during days, can be used for other purposes such as power looms, rice huller, oil expeller, cotton combers on wooden lathes, submersible pumps used in agricultural sector etc.

CONCEPT OF LOCAL GRID

Rivers at high altitude are capable of running more than one watermill within a span of around 1 KM. There may be a few such installations which can be used in synchronization with each other and bulk of electric power can be sold to other nearby locality for use in agricultural sector. For this, the concept of hydropower development is sustainable growth in India.

LARGER PLANTS CONCEPT

For plants generating 50 KW or more, the plants should be operated by a community group as individual operator may not be able to have the resources for it. This group will enter into arrangement with Power Corporation for buying and selling of power. It will also sell power to individual entrepreneurs in each of the villages in the neighborhood. These, in turn, will work on the model proposed for small plants.

NEED OF THE SUPPORT OF GOVERNMENT FOR THE EXTENSION OF SUPPLY

To implement the concepts of local grid and larger plants, the Central/State Governments can do the following:

- Modification in Electricity Act and Rules to accommodate installation of very low power electricity generation and distribution within certain area, possible.
- Modification in water act.
- Realization of local grid at low voltage.
- Identification of at least 50 sites suitable for producing 15 KW to 20 KW of Electric power with least civil work requirement.
- Standardization of core equipments such as Turbine, Generators and Load Controller suitable for production capacities up to 20 KW only.
- Standardization of high lumens low wattage luminaries.
- Identification of organization to train the interested youths willing to undertake such enterprise.
- Installation and commissioning of such systems to demonstrate the utility of such power plants.

CONCLUSION

It is observed that depending upon the appropriate energy solutions and opportunities for productive use, an integrated support program would be developed encompassing well-defined components:

- Installation, demonstration and promotion of selected energy technology option(s), with a high degree of local empowerment.
- Assistance to local entrepreneurs using renewable energy for productive use, especially in agriculture sector; and
- Implementation of a package of services that facilitate the processing and marketing of products.

The implementation of such strategy should be accompanied by the establishment of appropriate support networks for rural (micro and small) enterprise development, as well as a solid system for the provision of repair and maintenance services. For this purpose, practical and effective methodologies and tools are required with a view to tailoring the business and technical skill development programs to fit the needs and the absorption capacity of entrepreneurs and the support institutions. With improved accessibility of energy resources, these services will help entrepreneurs to improve their production processes and management techniques and increasing their prospects for, expanding and diversifying enterprises. India has significant unused hydro potential. Its development for power generation can play a critical role in meeting these needs while safeguarding the criteria of sustainable development.

With a proper vision and action, water can be converted into power and power into prosperity. Vision without action is a day dream and action without vision is a nightmare.

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