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HYDEL GENERATION AND ITS ROLE IN TACKLING PAKISTAN'S POWER CRISIS

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BY

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Civilizations depend on energy to flourish. Technical progress and development are often measured in terms of quantity of energy used. For this very reason, the accelerated technological progress by many regions of globe has been coupled with large increase in global energy use, especially in last 4 to 5 decades. Conventional energy sources provide more than 75% of the overall quantity of energy and they are being consumed at the rate of knots. Moreover, the energy demand is growing and the conventional energy resources are limited and not to be found everywhere.

The great increase in energy demand, danger of conventional resources being fully consumed and problem of finding alternative sources at a quicker pace have made energy, power sector, renewable energy sources, energy efficiency etc. the most talked about topics in the world.As regards renewable energy sources, hydel power technology tops the list. Hydel power plays a vital role in power generation sector of Pakistan as it does globally. The available un-tapped hydelpotential warrants due consideration.

ADVENT OF HYDEL TECHNOLOGY AND PRESENT STATUS

Since initiation with first ever commercial hydropower plant at Vulcan Street (known as Vulcan Street Plant) in Wisconsin State USA (Installed Capacity 12.5 KW) on September 30, 1882; hydropower technology has undergone radical changes during transitional phases of project development before acquiring the present status of being a sustainable, environment friendly, economical and most established renewable energy source. Today hydropower accounts for nearly 20% of world's power generation and two-thirds of global renewable power.

Once realized the benefits that could be extracted from Hydel power technology (including the additional to power generation); an avalanche of new hydropower development was observed throughout the world in 1920's to 60's with largest of the establishments attaining an installed capacity within the range 2000-3000 MW and water storage upto 90 MAF (Aswan High Dam in Egypt, 2100 MW, constructed from 1960 to 65). Equally noticeable is the rapid increase in size of hydel developments just after 20 years of initiation of technology. Aswan Low Dam in Egypt, which was constructed in 1902-1907 provides a glaring example (4.3 MAF reservoir and 562 MW installed capacity). However, due to the growing concerns of environmental issues and social impacts that started to carry more weight in a post-solved energy crisis and energy sufficient Western Worldscenario witnessed mostly in 1970's and afterwards; the speed of hydel technology's roller-coaster was reduced to some extent. The seasonal nature of the hydropower technology added to the aforesaid outrage when pitted against the vacuum of generation capacity created by low flow seasons. The exponential growth in proportion of "capital intensive" hydropower developments was reduced considerably in face of:

- A disturbed energy mix
- Communities unhappy with their disposition after resettlement
- Threatened ecosystem
- Strict Regulatory environment i.e. very low environmental and social impact became important for securing funding from financial institutions; who had put their weight behind

environmentalists. Many governments also decided to follow the suite in hostile political environment

- Pressure on high capital requirements and long process of implementation of hydropower establishments due to competition with improved conventional (thermal) technologies i.e. introduction of Combined Cycle thermal power generation.

Consequent upon the abovementioned reasons, the developed regions of the world find themselves restricted to development of small, medium and very few large hydel projects. However, it is worth mentioning that the natural indifference to the abovementioned factors by some of the "Energy Starved Nations" e.g. China, Pakistan & India resulted in adherence to the policy of continuing with hydropower development as a perfectly justified solution to their water & power needs. Equally important is the fact that such countries were not completely in phase with so called "hydropower boom" earlier on due to struggling economies and lack of funding; and were facing problems with flood control and oil import pressures in addition to energy requirements. Such nations were able to attract the attention of hydel technology related industry, mostly based in west and looking for expansion in business.

ADVANTAGES OF HYDEL POWER or HEP

- It is a renewable source of energy, and non-polluting in nature.
- Fuel cost of HEP plant is inflation-free, thereby bringing down the overall per unit cost.
- HEP secures finance readily if communicated appropriately to a motivated financing group or company. Once the project costs are well worked out and amortized, and sustainable hydrology ensured; the revenue stream from HEP is highly favorable.
- HEP plants have a long useful life, extending to 50 years, as compared to the 25 year life-span of a Thermal PowerPlant.
- The long life span of HEP can be further improved by rehabilitation, up-gradation and modernization of existing but aging Hydel power stations at relatively lower cost (about 50% of cost of new project).
- HEP plants can be started or stopped instantaneously, providing for load variation management, and improved reliability of the power system.
- HEP is considered as the best choice for serving peak load.
- It helps in conservation of scarcely available fossil fuels.
- Storage type HEP plants can be used for multiple purposes like flood control, irrigation, provision of drinking and industrial water etc.
- HEP plants are usually set in remote/backward areas, thereby leading to their economic development.
- Comparative cost-benefit analysis proves that Hydro Electric Power Plant (HEP) is cheaper than Thermal Power Plant (TPP) even if other factors like social and environmental benefits are not considered and real time Plant Load Factors (PLF) of 85% for TPP and 45% for HEP are assumed..
- Most of the HEPs put up a satisfactory case for Certified Emission Reductions (CER) or CDM Benefits.
- Modern and developed power sectors tend to have installed capacities within the range of 100,000 to 10,000,000 MW. These power sectors typically incorporate a sizeable proportion of:

- reliable but relatively expensive conventional power plants and
- environment friendly but unpredictable renewable energy sources.

A newly defined but crucial role of "Energy Storage" has been assigned to Reservoir type HEPs and Pumped Storage HEPs. Electricity can not be stored at large scale without massive losses but water carrying an equivalent energy in the form of potential energy can be stored. In addition to generation of cheap power during peak hours generating high revenues, such hydel power station are very effectively being used for frequency modulation, system stability and for power compensation in case a sizeable wind or solar power capacity backs out on bars. HEPs with water storage ability are the most effective and commercially most viable energy storage option as compared to giant battery storages, flywheels etc. that are in experimental stages with no signs of introduction to power market in near future.

DISADVANTAGES OF HEP

In spite of the factors mentioned above, developing HEP does carry certain disadvantages:

- A variety of geological changes occur due to the construction of a dam, especially in the downstream area.
- Various plant and animal ecosystems get affected due to submergence in the water reservoir formed by the dam.
- The soil quality in downstream river declines.
- HEP plants are severely impacted by droughts. For years marred by droughts, hydel generation declines for the full year creating many issues for power system operators.
- Hydel power is seasonal in nature and does not offer a firm high Availability Factor throughout the year.
- Cost / KW installed for HEPs power is significantly higher than TPPs.
- True that opting for hydel power essentially provides sustainable, environment friendly, economical electrical power, but the technology only provides long term solution to power crisis because of long implementation periods (7 to 15 years) in Pakistan.
- Fish population gets affected if fish cannot migrate to the spawning grounds upstream past impoundment dams, or if they cannot migrate downstream to the ocean.

It is worth mentioning that all the disadvantages of Hydel power technology are manageable or occur on rare occasions. The bottom line is that disadvantages associated with Hydel power are few as compared to the huge benefits arising out of an HEP project development.

VITAL CONSIDERATIONS:

- Development of an HEP project is often deterred due to the substantial initial investment required. But this HEP project investment cost needs to be balanced against the longer project life and lower operation and maintenance costs, coupled with no consumption of fuel for energy production. From an economic perspective, keeping in view the quality of the energy produced, the balance shows clear advantage for hydropower.
- From a development and growth perspective, the external benefits and costs associated with the projects need to be considered. If total costs for the lifetimes of the electricity generation options are considered, HEP appears to have the greatest advantage.
- It was concluded at the 17th Congress of the World Energy Council in 1998 in Houston that development and use of appropriate renewable energies should be given clear

priority, with the aim of restricting emissions resulting from the use of fossil fuels. Hydel power is the most established renewable power technology on the planet. It has been found to have longer plant life as compared to other renewable power sources and therefore, is a sustainable energy source.

- Like any other economic activity, HEP project impacts the project area. These changes can be geographical and social like land use transformation, and displacement of people who were living in the reservoir area. However, these projects generate employment and further growth opportunities for the local population. New public services and infrastructure development, including schools, hospitals, roads, etc. come up in the area with the introduction of electricity to the rural/underdeveloped areas, enabling better economic growth and life style of the nation.
- The social effects of HEP schemes are variable and project-specific. However, with planned anticipation and subsequent addressing at the project planning stage, the adverse impacts can be efficiently tackled, and in some cases, evaded altogether. Implementation of an effective public participation program from the early stages of a project becomes crucial. If a project is considered to be a development opportunity for the community, the project affected families (PAFs) will be able to enjoy a higher standard of living through associated infrastructure developments.

THE CLASSIFICATIONOF GLOBAL HYDEL POWER SECTOR

Global Hydel power sector may be divided in three loose classifications:

a. Nations that have substantially exploited their Hydel potential e.g. Scotland (total installed capacity 1379 MW with only 562 MW potential untapped).

b. Nations that want to utilize Hydel potential but have to act vigilantly in handling the resettlement issues, environmental reservations, pro-ecology campaigns etc. e.g. Germany with total Hydel installed capacity of 8900 MW (out of which 4200 MW comes from pumped storage hydel stations). Such countries are more sensitive to meeting certain targets e.g. 20% installed capacity from wind, solar, biofuels etc. by the year 2020 (compulsory by an act of European Parliament). Such obligations have restricted their Hydel power development.

Both a & b categories represent energy sufficient nations.

c. Energy starved nations like Pakistan, China and India who are always in pursuit of adding installed power in their generation systems to meet short-falls. True that there is no shortfall in China at present, but it is under immense pressure to continue with addition of power generation capacity in order to avoid shortfalls in future. The problems of Pakistan and India are known to all and so is the case for many African nations e.g. Cameroon where a DISCO named SONEL receives a share of only 700 MW for distribution purposes. The countries in this category generally care little about philosophical concepts like environmental laws, resettlement issues etc. and are always forced to abide by such laws due to strict stance of financing institutions. It’s a foregone conclusion that most of the countries in this category are always short on funds to undertake hydel projects as most of them are third world countries. In any case, category c presents most of the business opportunities to manufacturers, contractors, consultants and financing institutions in Hydel power sector.

HYDEL POWER IN PAKISTAN

The approved Hydel potential in Pakistan is well over 50, 000 MW (some contend it is more than 100,000 MW). However only 6600 MW (approx.) has been tapped to date. The list starts from Tarbela (3478 MW) and ends with Renala (1.1 MW). Hydel power accounts for a fraction over28% of total power produced. Though commendable efforts were launched for construction of existing hydel projects, much more is yet to be done in order to have a significant proportion of power produced coming from hydel sector. A summary of technology-wise power generation proportion in respect of Pakistan's power sector is as under (Source www.ppib.gov.pk):

Sr. No.	Technology	Installed Capacity (MW)
1	Hydel*	6,516
2	GENCOs	4,885
3	IPPs**	8,650
4	Rental	403
	SUB-TOTAL	20,454
5	KESC	2,594
5	Total	2,3048

* Installed capacity of Jabban (19.6 MW) not included due to de-commissioning

** IPPs are inclusive of Malakand III Hydel Power Station (81 MW), Jagran Hydel Power Station (30 MW) & CHASHNUPP (325 MW)

MAJOR IMPEDIMENTS IN DEVELOPMENT OF PAKISTAN'S HYDEL POTENTIAL

- The foremost hindrance in respect of hydel power development for most third world countries is scarcity of funding, especially from the governments (PSDP etc.). Being a developing country, Pakistan is no different in this regard. However, there are other equally serious issues.
- The lack of experience, skills and qualifications required to supervise / manage the implementation of hydel projects from conception to commissioning is a persistent problem. In absence of the aforementioned traits, the employer or developer is rendered impotent when it comes to monitoring the progress, ensuring the desired quality of works / equipment and identification of lapses in design or construction phase. Training and up-gradation qualification with special reference to the task in hand i.e. hydel power development is critical in this respect.
- Despite being gifted with huge hydel potential, it is a matter of concern that in-house capability for hydropower equipment manufacturing (especially turbines, generators etc.) and construction of hydel power stations (apart from civil works) are non-existent. Though the concerned laws in force provide for a significant contribution from local consultants, contractors etc. in hydel power development as a pre-requisite during preparation of feasibility studies and construction of the projects; the local concerns have not been able to enhance their skills and capability as desired vide promulgation of such laws. The local firms seem contented with their mere existence in paper, preparation and binding of reports, and purchase of daily use items e.g. photocopiers, computers, bikes etc. while securing their cut from revenues, knowing that a foreign firm must form a JV with a local firm to be eligible for award of contract / consultancy agreement.

Political obstructions have not been stressed upon in this paper.

IMPORTANCE OF INDIGENOUS RESOURCE DEVELOPMENT

The economic-expansive mix (or hydel-thermal mix) should represent at least 50% or more of hydel and coal based generation in Pakistan's case. Traditionally, the indigenous resources for power generation have allowed the operators to put a lid on power prices. Pakistan's power sector is being dominated by oil and gas based thermal generation. Depletion in existing gas resources and increased oil import pressures have paralyzed the operating authorities and eliminated whatever little flexibility or choice existed. Fulfilling the power demand requires huge chunks of national exchequer while declining to do so hits the economy badly at grass root levels, effects of which are felt by all and sundry in the county. There is a dire need to exploit indigenous resources for power generation. These resources include massive Hydel potential (50,000 MW+), 4th largest coal reserve of the world (186 Billion Tons) and possibly significant quantities of oil and gas. This is the only way Pakistan can overcome the persistent and ominous looking power crisis while exercising a significant control on power prices.

RECOMMENDATIONS FOR EFFICIENT AND QUICK HYDEL POWER DEVELOPMENT

- Well defined objectives and components lead to a successful implementation of Hydel power project.
- Considerable attention should be paid to the risks related to possible delays caused by the project approval by the government agencies, as well as delays during preparation and holding of procurement tender.
- Very good technical skills, strong project ownership and commitment to results on the side of the project stakeholder are critical success factors.
- Inadequate technical project preparation has led to unnecessary delays during implementation and more thorough project planning, from feasibility studies leading to project inception, specification, procurement and implementation, is paramount.
- Construction of Hydel power projects can provide workers with excellent training through close cooperation with the contractors.
- Careful planning of Hydel projects and site activities is essential to minimizing problems at site and preventing or minimizing site schedule delays.
- Timely mid-term reviews are important in large hydel projects with long implementation periods
- The process of reviewing Initial Technical Evaluation by Standing Review Committees (SRC) for hiring of consultancy services needs to be revisited to ensure timely execution of the process. At present the "review" generally focuses on starting the evaluation process from the scratch without any consideration to initial evaluation report. The exercise is laborious, time consuming and produces very little output as two initial evaluations take place and the concept of review is completely sidelined.
- A well-defined specification will avoid conflicts during the project execution phase.
- Issues such as sediment transport and its effect on equipment should not be underestimated or treated lightly in the design stage.
- Complex financing arrangement can require considerable effort from Owner's team.
- IFI financing requires careful attention following the appropriate procedures to ensure that delays or cancellation of funding do not result.

- Keep hydel projects as focused as possible. An overly complex “Christmas tree” design, with multiple (co-) financiers, and a very ambitious, but woefully under-budgeted, program will only overcomplicate an already complex endeavor.
- Effective management of equipment and parts supply from foreign sources especially tools, equipment and materials with storage issues requires special attention.
- EPC Contracting has proved to be the most efficient and quick project implementation mode throughout the world while ensuring the desired level of quality. EPC contracting should be opted for implementation of Hydel projects. However, the said contracting should be quality based and not executed on lowest cost bidding.
- Owners must ensure they have a clear understanding of the requirements on how their unit(s) must perform on the transmission grid and these must be adequately passed on to the equipment supplier and equipment contractor.
- Contractors need to effectively research a project and understand how the work is to be executed and the number of personnel required to undertake the work before commencing and contract conditions should be changed such that contractors carry the financial risk of not correctly estimating their costs of meeting schedule. The aforesaid is a prominent feature of EPC Contracting.
- Limit the number of contract packages for the different works to a manageable level.

CONCLUSION

We are fortunate to have loads of hydel potential in Pakistan. Hydropower is renewable, sustainable and profitable source of power generation. Hydel development in Pakistan can play a major role in solving the prevalent power crisis while ensuring plummeted electricity costs. Since 1980s, the prices of oil, gas etc. have shown an upward trend and there is no indication of them being coming down at reasonable or pre-1980s’ level; a fact that supports continuous hydel development. Hydel development will ensure fuel-freeaddition of installed power in the National Grid, thereby reducing the oil-import pressure and saving nation’s hard earned money. Need is there to speed-up the process of implementation of hydel power projects (especially the large power houses with capacities over 1000 MW) and funding from IFIs and GoP while ensuring that our work-force acquires the desired level of qualification in order to supervise the projects more effectively and efficiently.