

# Hydropower Development in the Green Power and Competitive Era

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## 1 HYDROPOWER DEVELOPMENT FACED WITH NEW BARRIERS OF ENVIRONMENTAL FACTORS

Traditionally, the world power industry has been demand-oriented and driven by the need to resolve electricity shortages. The industry is now evolving as the global emphasis has shifted towards socially sustainable development and the use of clean and proven technologies. The power industry is now subject to strict environmental requirements, and hydropower has become a highly contentious issue under these new conditions. Elementary estimates show that hydropower developments account for 19.9% of total electricity produced worldwide. This corresponds to a reduction of approximately 603 million tons of carbon dioxide emissions. Despite this, some hydropower is not considered to be sustainable energy due to the lack of measures to ensure that its exploitation does not offset the harmony anywhere within the river basin. While opinions vary widely, some countries have formed very rigorous licensing requirements, which make it very difficult or nearly impossible to gain approval for a hydropower project. These policies hinder hydropower development overall. They have resulted in a reduced proportion of large hydropower capacity relative to total installed hydropower capacity. In addition, they have also reduced the percentage of hydropower relative to total electric installed capacity of the world. A new phase has begun where environmental requirements pose barriers to hydropower development.

## 2 UTILIZATION OF HYDROPOWER POTENTIAL IN MODERATION IS A DISTINGUISHING FEATURE OF HYDROPOWER DEVELOPMENT IN A NEW ERA

The exploitation of hydropower potential mainly refers to hydropower generation. A country's hydropower potential is determined by the geographical characteristics of its territory, specifically river runoff and land rise. Hydropower possesses the following characteristics:

- a) Hydropower potential is a physical phenomenon, rather than a material resource such as coal, oil, natural gas, land, forestry, and other mineral resources. Hydropower potential exists when the topography is such that the river runoff occurs over a land gradient. Hydropower generation is only possible when hydropower potential exists. Hydropower potential is thus substantially different from other material resources that have been traditionally macro managed by the state.
- b) Hydropower is a form of renewable energy. Its' potential varies with the seasons as river flow volume changes. However, as long as the river does not dry out, the water will be able to produce electricity if it is subject to a drop in elevation. Hydropower is not like material resources that diminish over time and are eventually exhausted. As a result, hydropower potential can be considered sustainable.
- c) Hydropower potential is not finite. The reserves of other resources are fixed, whereas the amount of hydropower potential that can be harnessed can change. Engineering measures can improve hydropower generation efficiency. Activities, such as developing logical layouts, optimizing the

design and carefully planning construction, operation and maintenance can ensure that hydropower potential is maximized and exploited appropriately.

- d) The existence of hydropower potential does not necessarily mean that it can be harnessed. The amount that can be harnessed is dependent upon several factors such as river runoff, topography, geography, economics, hardware, and environment. In addition, the amount of hydropower than can be harnessed is a function of time, which is another property that distinguishes it from other resources.

As a result of these features, hydropower potential can be considered in the following ways:

- 1) Hydropower potential should not be owned by any individual and should be exploited to benefit of all society. However, some companies and related industries have pursued economic profit blindly, without considering the results of their actions, and this will lead to an inappropriate distribution of public resources. In order to avoid the inappropriate distribution of 'social' resources, such as electricity, the government should take an active role in the management of the resource.
- 2) The hydropower generation process should be optimized to ensure maximized use of water resources. However, this does not mean that all technically and economically feasible hydro-energy resources should be exploited. In fact, there are many other energy extraction processes that are both technically and economically viable, such as coal power generation, which could be undertaken but would impose a large social and environmental cost. Similarly, if all available hydropower potential were harnessed, it would upset the natural ecological balance of the river. It is therefore desirable to maintain some river runoff and thus forego some of the electricity that could be generated. Some northern European countries have mandated the amount of river runoff that must be maintained. In addition, the United States takes into account the predicted affect on river zoology and the local environment prior to approving a new hydropower project. These factors are also reconsidered on an annual basis and in granting operation licenses for old systems. The decision to undertake a hydropower project should be apolitical, and not be motivated by the self-interest of industry and companies. Competition should be encouraged for hydropower generation and system operation. However, it is critical that these elements remain under the active management of the government. The combination of allowing competition while maintaining government authority and control over resources would take advantage of market efficiencies while ensuring that the ecological environment is preserved.
- 3) Public health and safety is another primary concern in hydropower development.

Hydropower development and generation is interlinked with issues such as flood protection, drought resistance, water resource protection, water supply, wastewater treatment, water pollution, tourism, and shipping. All phase and affected areas of the development process must therefore be considered, including the affects both up and down-stream, the social and environmental affects, regional biodiversity, and local economic development. Allowing the full process to be governed solely by market forces would neglect many of the elements discussed above.

The various aspects of hydropower development, discussed above, suggest that exploitation should be undertaken cautiously and in moderation. This is also a requirement for sustainable development, which reflects the Scientific Outlook on Development for building an environmental-friendly society.

### **3 HYDROPOWER RESOURCES SHALL BE UNDER CONSOLIDATED PLANNING & MANAGEMENT BY THE GOVERNMENT**

Hydropower designs should be optimized to ensure efficient use of resources. River runoff varies over time. It changes yearly, monthly and even daily and therefore cannot be predicted with precision. There is thus some inherent risk in undertaking hydro-energy projects. The determination of potential hydropower capacity is done using statistics and probabilities. Hydrological data should therefore be compiled and

recorded. This data can be used to improve accuracy and reduce risks in hydropower projects, which will maximize the ensuing benefits and improve safety.

Harnessing hydropower requires that electro-mechanical equipment be placed in the river flow. This will change some of the characteristics of the river and cause new challenges to emerge that will need to be resolved. In addition, river development often requires multi-purpose programming. For example, hydropower projects are typically integrated with flood prevention planning. Reservoirs may exist in several locations, either up or down-stream, in the main channel or in the branches that extend from it. The hydrological characteristics of the river and each reservoir must be known in order to ensure that all river programming is integrated and done in harmony with the river environment.

Once an effective government framework has been developed, a government department, such as the Ministry of Water Resources in China, should develop a national plan for hydro-energy generation. The capacity of water resource departments should thus be strengthened in order to allow them to assume these duties effectively. This is essential, as the duties are too comprehensive and specialized to be incorporated into other government departments that typically manage other material resources.

#### **4 TO REALIZE ORDERED DEVELOPMENT OF HYDROPOWER RESOURCES UNDER CONSOLIDATED PLANNING**

There is heated discussion within and between countries regarding how to best manage hydropower energy. The strategic use of resources and their management has become more important as competition increases. In addition, global environmental issues are attracting greater attention. This has caused public pressure in favor of using 'green' renewable energy and to achieve reductions in carbon dioxide emissions, which has posed new challenges and increased requirements for hydropower generation projects. It is therefore now even more important that hydropower projects be planned and executed very carefully.

China has an abundance of hydro-energy potential. However, climatic conditions, such as the monsoon, causes flow volumes to vary significantly throughout the year and this poses the greatest barrier to harnessing its full potential. The runoff is greatest during the 4-5 months that constitute the summer, and the energy that can be generated during this time accounts for between 60-70% of the total. This results in a regular seasonal surplus of electricity during the summer. In the winter months, the flow decreases substantially and can become very small. One suggestion has been to build reservoirs in order to control and adjust the flow throughout the year. However, the construction of a reservoir would cause some degree of flooding, which often causes some damage. In addition, if the reservoir were to be constructed in gorges or valleys, it would need to be quite high. This would decrease the damage from flooding but would be very difficult to achieve.

Hydropower potential is also not equally distributed throughout the country, with the majority of capacity concentrated in west and central China. Hydropower potential in the east accounts for only 9.39% of total potential in the country. In contrast, the potential in central area accounts for 11.93%; northwestern area 11.93%; and southwest accounts for the rest at 66.72%. The social, economic and environmental impacts of this distribution must also be considered. It is therefore important to consider hydropower capacity from a national perspective and develop a national strategy, which will take into consideration the sequence of projects.

Traditionally, local governments and state-owned enterprises have undertaken past hydro-energy development. This conforms to the social equity principle, which allows the state to use public funds for activities whose benefits are shared throughout the whole society. However, many independent power producers have now emerged. These independent developers are primarily motivated by commercial interests and driven by profit, and this will likely cause significant exploitation of public resources. This will produce negative consequences throughout society if the supervision and management capacity of the government is not strengthened. Thus controlled exploitation of resources become especially important.

## **5 REASONABLE COMPENSATION FOR UTILIZATION HYDROPOWER RESOURCES IS INEVITABLE TREND IN THE GREEN POWER AND COMPETITIVE ERA**

Hydropower potential is a national public resource. Despite this, it is reasonable to charge developers a fee to permit their exploitation of the resource. In China, the cost to developers currently includes payment of a water resource fee and a river exploitation permit fee. Hydropower potential is a function of time, which is indeterminate. The fees discussed above only relate to exploitation and do not include charges for generation. Hydropower capacity is also a function of water head and discharge. As a result, additional charges should be imposed on stations based on their output. Hydro-energy development causes damage to the environment, both within a river basin and in its surrounding region. At present, the international convention to evaluate damage is based on the calculation of flooded and affected area per MW, and carbon dioxide emissions. These damages must be compensated, and are included in the Clean Development Mechanism. However, if costs were raised significantly, they would raise exploitation and operation costs and thus also hinder further hydropower development. Reduced hydropower development would result in an increase in acid rain and greenhouse gas emissions, which is also unacceptable. As a result, further discussion is necessary regarding the design of the expense and costs structure.

It is essential that penalties be enforced for violations when using a compensation system. If engineering measures deviate from the authorized plan, or the power plant breaches operation rules, it should be penalized. Enforcement of rules should ensure that social equality is maintained and the damage to the environment is minimized. Some countries achieve this by implementing a licensing renewal system for existing stations. This may mean that stations that were commissioned many years ago and still meet the standard under which they were developed, may fail to meet the current conditions for license renewal. Current conditions include criteria related to biological diversity, affect on fish, climate, local residents, and agricultural production.

When a problem is identified, a resolution must be found and implemented within a specific time frame. Under extreme conditions, it may be necessary to re-design the project. With these stricter conditions, it is inevitable to establish reasonable compensation system for utilizing hydropower resources in the Green Power and Competitive Era.

Hence, it's necessary to introduce and promote the Clean Development Mechanisms in hydropower development in China, to establish reasonable compensation system for utilizing resources and to develop the abundant hydropower resources in moderation and appropriately, so as to achieve sustainable development in China's hydropower sector.