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Hydropower for Sustainable Energy Development

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Abstract — *Hydropower creates fewer pollution and climate problems than fossil fuel power, as they create reservoirs of clean water, which to some are both pleasing to the eye and a place for tranquil recreation. They promise control of flooding, provide a steady supply of water for irrigation and, with time, a source of fresh fish. Hydroelectric power is a source of green energy because it makes use of water - a free abundant and inherently benign medium. It takes advantage of gravity, transforming energy from flowing water into electricity in a process that is at once clean and carbon free. Hydroelectric projects are the energy source with lowest greenhouse gas (GHG) emissions compared to Thermal Coal, Thermal Natural gas, solar, wind & nuclear. Hydropower is also worldwide recognized as the renewable energy source*

Keywords-Hydropower, electricity, sustainability, economy, development.

I. INTRODUCTION

The term "hydro" is a latin term for water, so hydroelectric power is generated using the flow of water in the river. The hydrologic cycle is a continuous process of flow/movement of water all around the earth without really having a starting point. The four main sub stages of this hydrologic cycle are evaporation, condensation, precipitation and runoff. In passing through these sub-stages, water transforms into different phases of solid, liquid & gas. Sun is the global force for the transportation of water all around the earth by furnishing the energy required for evaporation. While evaporating from sea into the atmosphere, the mass of water gains potential energy, a portion of which is used in the process of precipitation from the clouds while the remainder is dissipated in the course of flow in streams and rivers. The water particle which starts from the hill and runs towards the sea possesses more or less kinetic energy depending upon the changes in the velocity of flow stream. However the amount of kinetic energy is insignificant as compared to the dissipating potential energy; the change in kinetic energy is negligible. Thus the dissipation of potential energy of run-off waters in mountainous and hilly regions, regardless of small and negligible quantities, does not mean gain in kinetic energy. The potential energy of run-off is dissipated to overcome the internal friction of the turbulent water, to supply energy to spiral flows, whirls and eddies, to scour the river bed and to transport bed load. By erecting dams and weirs, a considerable portion of potential energy in any steam or in a river is utilized. This energy is utilized to generate hydroelectric power.

Power Development in Jammu and Kashmir has a long and distinguished history. 9MW Mohra Hydro-electric Plant, among the first of its kind in the subcontinent, was developed as early as 1905. Out of the identified potential, only 3263.46 MW i.e. 19.80 % (of identified potential) has been exploited so far, consisting of 1211.96 MW in State Sector from 21 power projects, 2009 MW in Central Sector from 7 projects and 42.5 MW in private sector from 4 projects.

These projects are techno-economically viable, besides being eco-friendly and socially beneficial. In order to harness this potential in a sustained manner, the Government of J&K established the Jammu & Kashmir State Power Development Corporation Limited (JKSPDCL) which has been incorporated as Private limited company on 16th February 1995. The Corporation was incorporated to takeover, execute, complete, operate and maintain all power stations and power projects of the State.

According to the annexure of Government order No.205-PDD of 2011 dated 07.07.2011, The installed capacity of 21 operational powerhouses of JKSPDCL is 929.70 MW comprising of 754.70 MW of Hydel Stations with the largest being 450 MW Baglihar HEP Stage I and 175 MW of Gas turbines. In addition, installed capacity of the projects under operation with NHPC is 1680 MW from which free power to the extent of 12 % of the installed capacity is available to the State. Currently the state is able to harness only about 15 per cent of this potential with a total installed capacity of around 2438.70MW, out of which more than 1500MW are under central ownership and control, leaving only about 5 percent, that is 758.70 MW with the state.

One of the major constraints in tapping hydro-power in the state besides shortage of resources is the —Indus Water Treaty, to which both India and Pakistan are signatories. The Treaty prohibits reservoir storage of water on major rivers of J&K restricting the scope of generating electricity from hydro power to generation from only run off the river projects. The treaty which was carried out in the best interest of both nations has, however, deprived the Jammu and Kashmir state to use its own water resources and thereby severely affected the developmental process of the state. Conforming to the treaty criteria, State cannot fully exploit the water potentialities of the Indus, Jhelum and Chenab rivers.

In this way the J&K state has been converted into serious energy deficient economy with repercussions on various sectors, especially industrial sector, of the economy

II. PURPOSE OF STUDY

With most of the world's hydropower potential available for near future development, it is finally the local interests and sovereign states that decide how to manage their water resource base. Hydropower projects require extended planning and construction time period. During that time span, Governments change, electricity needs shift and increase but the basic physical conditions tend to carry on their physical characteristics for a predictable time span. Given the enhanced environmental awareness, why and how do hydropower systems continue to find social and political acceptance in diverse social systems? How sustainable and environment friendly are the projects of hydropower? How does hydropower project planning address issues beyond electricity generation? How does hydropower generate the economy and contribute to the wealth of a nation or state? How compatible is hydropower with the changing energy matrix? What are the risks involved with the changing weather & climate data.

III. CLIMATE RESILIENCE

Climate resilience refers to the capacity of a system to adjust or withstand the possible impacts of Climate change. One of the concerns in Hydro-power is the repercussions due to the change in climate. Although hydro-power facilities provide adaptive capacity against flood and drought regulation and rapid response to the variation of load. The changes in the climatic conditions have a perceptible effect on the hydro-power sector and probably these effects will become more articulate in the near future. Developers, designers & operators may essentially have to make changes in the schemes & systems of design and operation to improve resilience or adapt to new conditions. The climate change may also result in bringing new opportunities for the hydro power sector which may include higher hydro-power potential due to increase in precipitation as well as the roles & responsibilities which storage projects can play in helping societies adapt to climate change. According to the 2016 hydro-power status report published by International hydro-power association (IHA), IHA survey was the first to examine the hydro-power sector's views on climate resilience from the perspective of industry. Further research in this direction is required to examine how governments view this risk and how are they preparing themselves to manage this risk. IHA undertook the survey of more than 50 companies active in the hydro-power sector to determine how they view climate risks and what actions they are or are not taking to address those risks. The results of that survey is tabulated below.

Table 1 IHA SURVEY OUTLOOK

No. of Companies participated in survey.	50
% of companies which felt that main impacts of climate change felt in their organization.	63
% of companies which took steps to increase climate change resilience	22
% of companies which felt that climate change may bring potential opportunities for their business	70

IHA, in concurrence with partner organizations, continue to examine climate resilience in the hydro-power sector and is engaging with International organization such as the World Bank Group, the European Bank for Reconstruction and Development and others who are active in this space.

IV. SUSTAINABLE HYDROPOWER PROJECT

The International Hydropower Association (IHA) released the Sustainability Guidelines for hydropower projects in 2004 & revised in 2010. This guideline and the subsequent sustainability assessment protocol have defined the criteria of sustainability assessment of hydropower developments (see Table below). Table III indicates the hydropower development needs to pay attention to all three dimensions of sustainability but clearly there are more criteria for environmental and social sustainability compared to economical sustainability.

The Hydropower Sustainability Assessment Protocol, launched in 2011, is a framework for assessing project sustainability across a range of social, environmental, technical and economic considerations. It was developed by a multi-stakeholder community of governments, commercial and development banks, social and environmental NGOs, and industry. The principles underlying this Hydropower Sustainability Assessment Protocol, combined with results of a Protocol assessment, provide an important framework for considering questions about the sustainability of any particular hydropower project. There is a common view across a diversity of sectors (e.g. governments, NGO's, civil society, industry, banks) on the important sustainability considerations that need to be taken into account to form a view on hydropower project sustainability.

The Protocol captures these considerations in a structural framework, and provides a platform from which to produce a sustainability profile for a project. All countries and organizations adopting and supporting this Protocol respect the need