

## Chapter 2

# Hydropower Plant

**Abstract** The water based power plants are found to be the most reliable but least expensive forms of energy among the available source of renewables. The efficiency of hydropower plants depend on potential energy of water which when converted to kinetic energy can rotate a turbine to produce electricity. As the power plants depend upon discharge and hydraulic head both of which again depends upon climatic parameters like rainfall and evaporation, vulnerability of climate change will definitely effect the performance of the hydropower plants.

**Keywords** Water based energy · Plant efficiency · Climatic impacts

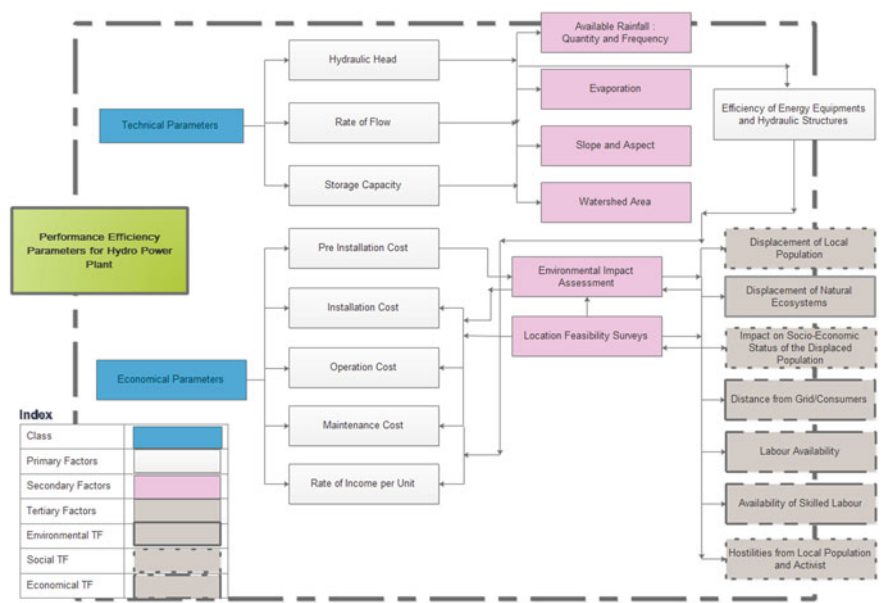
The hydropower plants utilize water as fuel to produce energy. Such kind of power plants are recommended to be the least expensive but most reliable among all forms of renewable energy sources which has resulted into an approximate contribution of 19 % of the total world's electricity demand and "accounted for over 63 % of electricity from renewable sources" (LV 2009).

The performance of hydropower plants depends on many related parameters like hydraulic head, rate of flow, efficiency of equipments and structures etc. as described in Fig. 2.1.

The same figure depicts the parameters which influence the performance efficiency of HPPs in respect to their degree of impact on the efficiency of the plant. There are four types of parameter which can influence the performance. Class, Primary, Secondary and Tertiary Parameters. Class parameters are the group of parameters which are similar in nature. The tertiary parameters are the independent parameters of the secondary and all the secondary parameters can influence the primary parameters. For example hydraulic head, rate of flow and storage capacity is a primary parameter under the technical parameter class and it is being influenced by the rainfall, evaporation, slope and total catchment area.

That is why the latter factors are denoted as secondary parameters.

Hydropower plants are not only influenced by the Technical and Economical class of parameters. The plants get affected by Environmental (destruction of natural ecosystems), Social and Political interference (Displacement of population,



**Fig. 2.1** Figure showing the factors that influence the performance efficiency of hydropower plant

impact on their socio-economic status,, hostility that may arise etc.) as well. These factors will impact on the installation as well as operational and maintenance cost of power plants. The cost will influence the rate of income per unit from the consumers.

The water based power plants can be classified into different groups based on available head, generated power and nature of load as described in the next Sect. 2.1.

**2.1 Types of Hydropower Plant**

According to USDOE (2015) hydropower facilities can be divided into three distinct classes as discussed below based on the type of storage utilized to store the flowing water. The three different classes are impoundment, diversion, and pumped storage.

**2.1.1 Impoundment**

The most widespread type of hydroelectric power plant is the impoundment facility. An impoundment facility, typically a large hydropower system, uses a dam to store river water in a reservoir.

### ***2.1.2 Diversion***

A diversion or run-of-river hydropower plants do not use a reservoir and route a portion of the river through a canal or penstock.

### ***2.1.3 Pumped Storage***

Another group of hydropower facility which is popularly known as pumped storage plants “works like a battery”. It accumulates the energy by pumping water uphill to a higher elevation reservoir from a lower elevation reservoir. When the electricity demand is off peak or low the pump is utilized to carry the water from lower to upper reservoir and during peak hours pump is utilized as turbine and produces energy by channeling the water flowed through the system from the upper to lower reservoir.

Hydropower Facilities can be grouped with respect to size of the power plant. The size can be represented by available head, discharge or plant capacity.

### ***2.1.4 Large Hydropower***

Department Of Energy “defines large hydropower as facilities that have a capacity of more than 30 MW”. The available hydraulic head will be more than 1000 m.

### ***2.1.5 Small Hydropower***

The class of small hydropower groups the facilities that have a capacity of 100 kW–30 MW. The available head is 30–300 m.

### ***2.1.6 Micro Hydropower***

A micro hydropower plant will have a capacity of up to 100 kW and head available will be less than 30 m. This kind of hydroelectric systems can satisfy the demand from domestic or agricultural consumers.

The hydropower plants can also be classified based on nature of load. There are two groups:

- (i) Base load plants: A base load power plant provides a steady and intermittent supply of power not considering the total power demand by the grid.
- (ii) Peak load plants: This kind of power plants for electricity generation is “used to cover the peak load”.

## 2.2 Strength and Weakness

The strength of hydropower plants lies on:

- (i) Minimum Operation and maintenance cost. Once the dam is built, the energy is virtually free.
- (ii) Combustion of fuel is not required. The power source is completely renewable.
- (iii) Zero or minimum pollution.
- (iv) Long lifetime.
- (v) Unscheduled breakdowns are relatively infrequent and short in duration since the equipment is relatively simple.
- (vi) Rapid initialization of energy equipments

The weakness or limitation of the power plants is:

- (i) Flooding probabilities
- (ii) Installation cost for large hydropower plants are very high compared to wind or wave.
- (iii) Transmission loss is also high as such plants are located in remote places far away from the electricity grid or consumers.
- (iv) Temperature along with other water quality parameters and quantity downstream may be affected.
- (v) Amount of displacement for both human and natural ecosystem is largest among all the renewable energy sources.

The main problem with water based power plants is the irregularity in the availability of head and discharge in desired magnitude.

As discharge depends upon the climatic parameters, like precipitation, evapo-transpiration etc.; the rate of discharge is always vulnerable to climate change. And if rate of discharge changes then the level of production will also be modulated.

## 2.3 Climatic Vulnerabilities

As discussed in previous section, the hydropower plants are susceptible to climate change (van Vliet et al. 2016).

The rate of discharge is mostly affected by climatic variables and change in climatic pattern modifies the climatic parameters to behave abnormally. As generation of energy directly depends on discharge the production from the power plants get distorted.

## References

- Listverse (LV) (2009) Top 10 renewable energy sources. <http://listverse.com/2009/05/01/top-10-renewable-energy-sources/>. Accessed 9 Jan 2016
- USDOE (2015) Types of hydropower plants. <http://energy.gov/eere/water/types-hydropower-plants>. Accessed 9 Jan 2016
- van Vliet MTH, Wiberg D, Leduc S, Riahi K (2016) Power-generation system vulnerability and adaptation to changes in climate and water resources. Nat Climate Change

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