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GRID INTEGRATION OF WIND AND SMALL HYDRO POWER GENERATION SYSTEM: A REVIEW

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Abstract: To limit the carbon emission in a manner to save the earth from the consequences of global warming, penetration of renewable energy resources into the power system are increasing. Integrated wind- small hydro power generation is one such system with almost zero carbon traces. Indian subcontinent has favorable geographical conditions for small hydro and wind generation system. This paper presents a review on various technologies available to harness the electricity from wind- small hydro power generation system. A lot of research has been done on wind power generation system and small, mini, micro hydal generation but a more has to be done for integrated wind-small hydro generation. A topological survey is presented in this paper for combine generation of power from such a integrated system. A brief note on issues and challenges for grid integration of integrated wind-small hydro project is also given.

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Introduction:

In India energy utilization in the advancement of the residential, horticulture, mechanical social orders and for other essential needs is expanding step by step to an abnormal state with a specific end goal to accomplish an impeccable living. Because of increment in the utilization of electricity in different power frameworks demand is expanding, this in turn increasing the discharge of the green-house gas which is contaminating the environment and atmosphere [1]. Since there are distinctive kinds of energy frameworks which are being utilized for supplying electrical energy, however hybrid power frameworks are the best methodologies for energizing the rustic territories and small scattered demand [2]. These diverse power frameworks aresunlight based photovoltaic cells, wind vitality, hydroelectric power, warm power, atomic power, wave and tidal vitality and so forth, yet this paper is speaking to the examination about the wind with small hydroelectric power plants. So when at least two or more than two power generation systems are joined than they are called hybrid/integrated control frameworks. At the point when at least two than two power networks are interconnected theutilization of electrical vitality and request at the peak stack can be accomplished, this guarantees the better quality of electrical energy. Utilization of integrated power network also reduces the carbon emission and dependency on fossil fuels for conventional power generation system [3]. The installed capacity of power generation from diverse sources as on 31st march 2018 is shown in fig-1. At the top is coal burnt thermal plant with 50% of power dependency, than comes hydal power, solar energy and wind. But as the time catching pace we are increasing solar, wind and small hydro power generation system to cut short the use of fossil fuel so that environment can be protected against the harmful effect of carbon dioxide.

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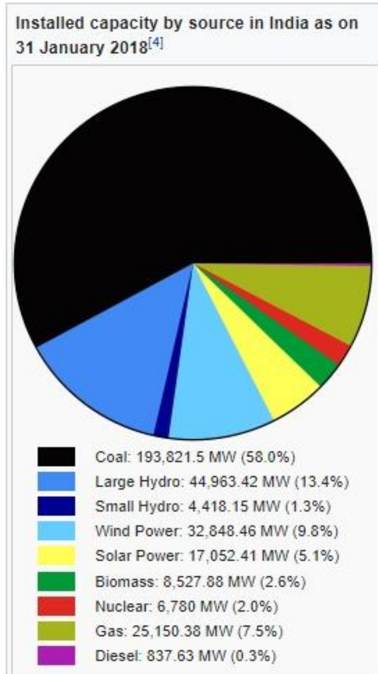

Fig-1 installed capacity from diverse power generation sources of India as on 31st march 2018.

Hydro power plants are best suited for supply power at peak hours since it can be brought to running state with-in 2-3 minutes. A hydroelectric plant generates enough electrical power which is adequate for use. But when transmission is done, than on account of transmission limitations it isn't conceivable to utilize full produced power. As populace is expanding, so in past years because of increment in populace the utilization of electrical energy is going up step by step. This is bringing about to the load on the transient stability points of confinement of the power networks. So by incorporating wind control with little hydroelectric power plant, including a half breed hydroelectric control plant and wind control plant the transient stability of the integrated system can be improved. Despite the fact that accessibility of wind control isn't persistent so hydroelectric power plants are utilized for saving vitality as water in store. Water can be discharged when there is have to create power. This paper is the examination about wind power combination with the small hydroelectric power plants.

The limitation of intermittency of wind energy conversion system can be ruled off by combine power generation of wind and hydro. There are various factors which affects the integrity of the proposed integrated system with the grid [5]. The advantages of unwavering quality by the coordination of hydro control plant and wind energy to supply the peak demand are in extensive. In future wind and hydro coordination could be stretched out to break down the unwavering quality of wind control connected with frameworks like pumped capacity extensive scale batteries and so forth [6]. An examination on the secluded wind hydro integrated network with the permanent magnet synchronous generator operated by a Wind turbine of variable speed with three phase load and a squirrel cage induction generator is done in [7]. The execution of the anticipated integrated control framework is demonstrated bringing about determination that a integrated control framework execution under these conditions is acceptable with the steady estimation of voltage and recurrence.

[8] Comprehensive study on technical aspects of combine operation of integrated hydro-wind plant. For concentrate the usage of the system in regards to integrated wind-hydro control plants is exhibited in this paper. The examination on the integrated control framework is done, which was modeled in PSCAD programming. Diverse qualities of the integrated system were investigated for finding that how system operates to incorporate voltage stability and automatic load sharing capability control framework. To expand the supply administrations to the rustic groups an innovative approach is displayed in this paper [9]. In Indian condition a mix of wind and hydro control plant is done keeping in mind the end goal to enter the Renewable vitality source in India by decreasing the cost of electrical power. In the conclusion it was demonstrated that the blend of wind and hydro control plant comes about into a productive activity of Integrated control framework [10]. A portrayal of technological development in installationand generation of power from wind and hydro plants is presented. This paper clarifies about the future extents of concentrate the wind control incorporation in an electrical power framework.Author has demonstrated an ideal control of sources and loads to acquire control synchronism in the integrated system with the grid.

Integrated wind and small power generation system

A integrated power system is developed by combining various conventional and non-conventional power sources, for reducing green houseemission from the consumption of fossil fuels and to increasethe stability of the power system so that a reliable operation ofelectricity is gained.Indian subcontinent has potential for lots of wind power generation system but intermittent nature is a limitation to completely rely on it. Hence a integrated system has to be opted to over- come this limitation. This paper presents a review on integrated small hydro and wind power generation. In literature lots of topologies are available for power production from wind energy and hydal energy this section presents a short review on these topologies.

A. Hydro power generation system

In hydroelectric power station the active power is created because of gravity in falling water from higher to bring down head is used to turn a turbine to deliver power. The potential energy put away in the water at upper water level will discharge as dynamic energy when it tumbles to the lower water level [11]. This turbine turns when the accompanying water strikes the turbine sharp edges. To accomplish a head contrast of water hydroelectric electric power station are for the most part built in uneven zones. In the method for the waterway in uneven zones, a manufactured dam is built to make required water head. From this dam water is permitted to fall toward downstream controllably to turbine sharp edges. Therefore, the turbine pivots because of the water constrain connected to its edges and thus the alternator turns since the turbine shaft is combined with alternator shaft. The structural diagram of hydro power plant is shown in Fig-2 [12]. The primary preferred standpoint of an electric power plant is that it doesn't require any fuel. It just requires water head which is normally accessible after the development of the required dam.A hydal plant generating power in a range of 1-20 MW for supplying local community or industry or as apart of distributed energy generation system for grid integration can be termed as small hydro power plant. This rating may vary application to application and nation to nation, the classification is shown in Fig-3. Impoundment is a type of hydro plant in which a dam is built to store water. In diversion type flow of river through a penstock is utilized to rotate turbine, no dam is built in this type of plant. Another type of hydropower called pumped storage works like a battery, storing the electricity generated by other power sources like solar, wind, and nuclear for later use.In a region where cost of power transmission could be high or where utility system can’t be reached small hydro power plant can be installed.

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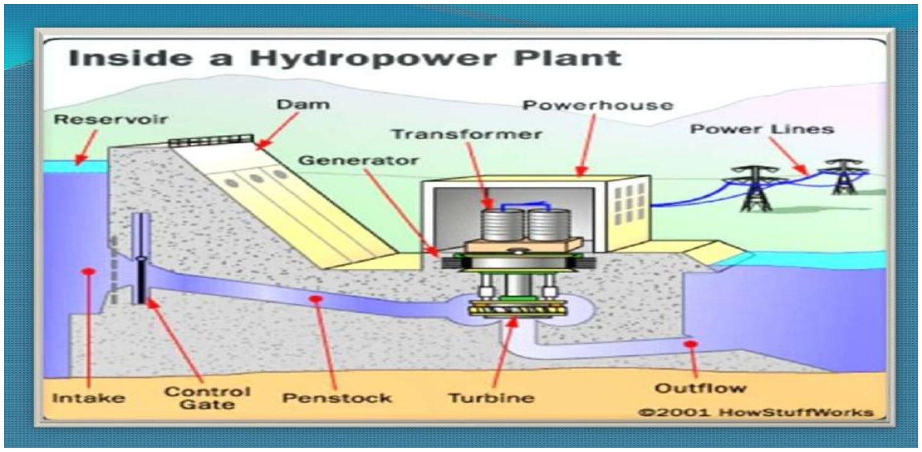

Fig-2 hydro power plant layout.

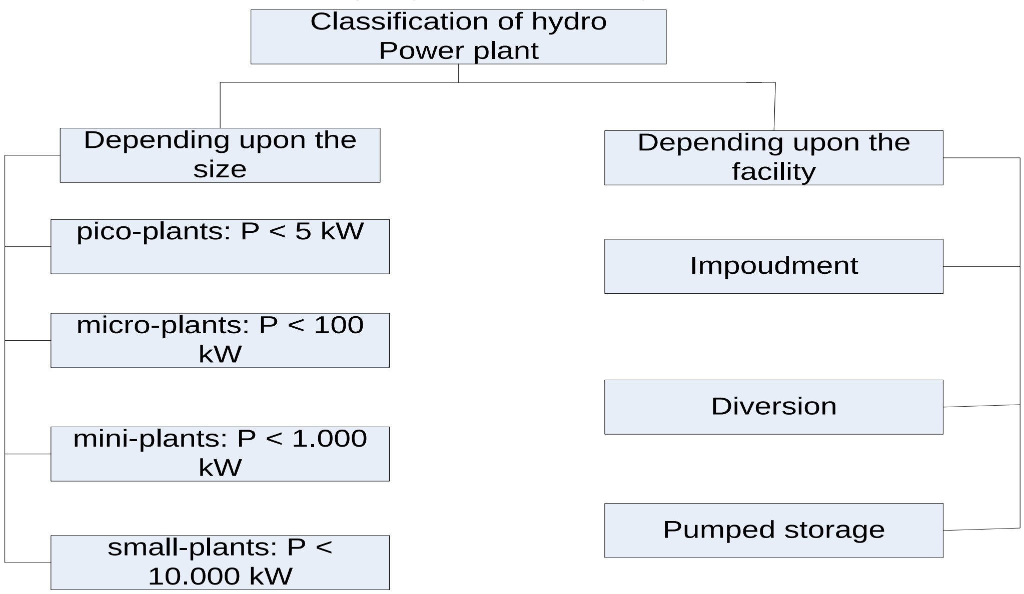

Fig-3 Classification of hydro power plant.

B. Wind power generation system

A wind turbine changes over the kinetic energy in the breeze to electrical energy by means of a generator. Generators with more dependable, proficient, and minimal plans ought to be utilized as a part of wind turbines to augment the breeze control catch and create a higher quality yield control[13]. To decide the fitting generator outlines for onshore and offshorewind turbines, diverse kinds of wind turbine generators that have been examined in the writing are talked about in this paper, with the criteria in light of the speed extend, cost, weight, size, and power quality of the integrated system. The wind turbine generators are analyzed, and points of interest and drawbacks of various outlines are condensed with more broad criteria. In general wind turbines are classified as horizontal axis and vertical axis wind turbine (HAWT and VAWT). The choice depends upon the application, efficiency and cost. The role of generator is to convert the rotating energy of turbine into electrical energy. Wind generation system can be equipped with any three phase generation classified as;

(1) Asynchronous (induction) generator:

(i) Squirrel cage induction generator (SCIG) [15, 16];

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(ii) Wound rotor induction generator (WRIG) [14, 17, 18];
(2) Synchronous generator:
(i) Permanent magnet synchronous generator (PMSG) [19];
(ii) Wound rotor synchronous generator (WRSG) [20];
(3) Other types of potential interest:
(i) High-voltage generator (HVG) [21, 22],
(ii) switch reluctance generator (SRG) [23, 24],
(iii) transverse flux generator (TFG) [25, 26].

Wind turbine is a complex mechatronic system and consists of a varietyof components. For modern wind turbine systems with more than 1MW output power the schematic diagram of wind energy system is shown in Fig-4;

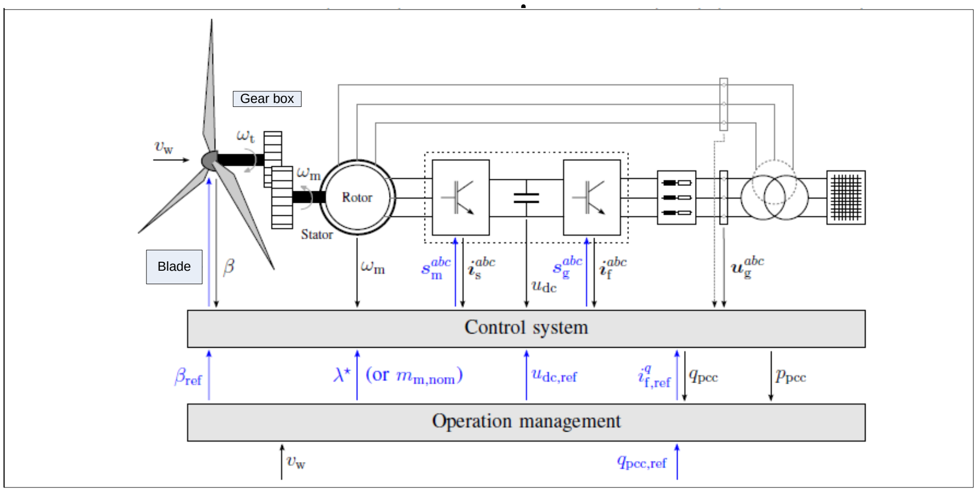

Fig-4 Schematic diagram of wind energy system [13]

C. Integrated wind-small hydro generation system.

For the installation of small hydro power Project River or canal is the first requirement and at such location availability of energy is for sure. The selection of generators,system integration and control algorithm are the major issues for such a integrated system. Tremendous literatures are available for the selection of generator for such a microgrid system [27-30]. Permanent magnet synchronous generator (PMSG) is consideredas a very good option for the wind generator because of its highpower density and hence small size, low maintenance, as proposed by [31-32] for wind energy conversion system (WECS).Application of an induction generator assmall-hydro generator is described in [33-34]the induction generator is a good option for standalonesmall power supplies because of its low cost and high reliability.The self-excited induction generator (SEIG) has a poor voltageand frequency regulation characteristic. There are many different
controllers proposed in the literature. Different types of loadcontrollers for frequency regulation in a SEIG-based generationsystem are discussed in [35–38]. In [39] the combination of self excited with the permanent magnet synchronous generator is presented with the control topology for integrated wind and small hydro power generation system. The system configuration for such a integrated system is shown in Fig-5. The proposed system is analyzed for transient stability condition at various loading.

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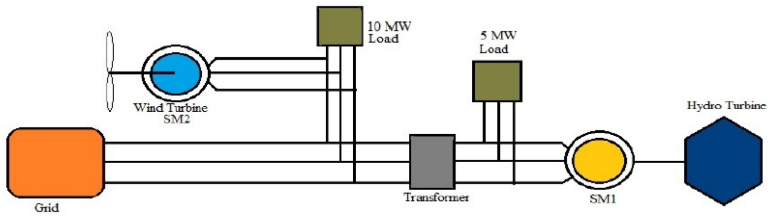

Fig-5 Hydro-electric and wind integrated system.

CONCLUSION

The places where abundant of flowing water is available small hydro projects can be installed to supply local demand. When such hydro plants are integrated with the WECS, reliability and continuity of power supply can be improved. These integrated system are environmental concerned and can overcome the limitation of conventional grid like inaccessible to remote location or energy supply at higher transmission cost. This paper presents a review on various topologies available for wind and small hydro power generation and efforts to install integrated wind and hydro power projects.

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