Integrated Wind, Solar And Energy Storage

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ABSTRACT :

Energy is the golden thread, a crucial factor that is connecting economic growth, social equity and develops a environment that allows world to thrive. Integrated wind, solar and energy storage is co-locating renewable energy source of wind and solar and thus integrating them into a single plant. The recent state of art hybrid energy system technological development is the result of activities in a number of research areas, such as Advances in electrical power conversion through the availability of new power electronic semiconductor devices, have led to improved efficiency, system quality and reliability. Development of versatile hybrid energy system simulation software; continuing advances in the manufacturing process and improve efficiency of photovoltaic modules. The task for the hybrid energy system controller is to control the interaction of various system components and control power flow within the system to provide a stable and reliable source of energy.

Keywords : **e**nergy , Integrated , efficiency , electronic semiconductor devices

INTRODUCTION

COLOCATING WIND AND SOLAR GENERATION with battery energy storage is a concept garnering much attention lately. An integrated wind, solar, and energy storage(IWSES) plant has a far better generation profile than standalone wind or solar plants .It results in better use of transmission evacuation system, which , in turn ,provides a lower overall plant cost compared to standalone wind and solar plants of same generating capacity. These plants are particularly suitable for regions that have set high targets for wind and solar generation but have limited land available for project development.

Renewable energy sources, such as photovoltaic, wind energy, or small scale hydro provide a realistic alternative to engine-driven generators for electricity generation in remote areas . It has been demonstrated that IWSES systems can significantly reduce the total lifecycle cost of standalone power supplies in many situations, while at the same time providing a more reliable supply of electricity through the combination of energy sources.

Separate wind and solar plants connected to same point of interconnection do not constitute an integrated wind and solar plant. In an IWSES plant , wind turbines, (PV)solar arrays , and a battery energy storage system(BESS) are integrated into a single plant using state-of-the-art controls, These integration can be performed at different levels.

The aim of this paper is to review the current state of design and operation of integrated energy system ,and to present future developments , which will allow a future expansion of markets, both in industrialized and developing countries.

NEED OF INTEGRATING RESOURCES

According to renewable energy experts, a small IWSES electric system that combines wind electric and solar electric (photovoltaic or PV) technologies offers several advantages over either single system. In much of the United States, wind speeds are low in the summer when the sun shines brightest and longest. The wind is strong in the winter when less sunlight is available. Because the peak operating times for wind and solar systems occur at different times of the day and year, hybrid systems are more likely to produce power when you need it. They are Complementary to each other. Intermittent in nature. For the times when neither the wind nor the solar system is producing, IWSES provide power through batteries and/or an engine generator powered by conventional fuels, such as diesel. If the batteries run low, the engine generator can provide power and recharge the batteries. The solar and wind both require robust electrical and power evacuation infrastructure. The storage

capacity of these systems must be large enough to supply electrical needs during non-charging periods. Battery banks are typically sized to supply the electric load for one to three days. Thus combining these resources is more convenient as they complement each other, requirements such as for land, equipments, machinery labor and skill sets required is almost the same .As well as there is reduction in cost which is elaborated further.

WORKING

The IWSES as stated earlier does not have wind and solar plant connected to the same point of interconnection .In IWSES plant; wind turbines, photovoltaic solar arrays, and battery energy storage system (BESS) are integrated into a single plant using state-of-art controls.

This integration is carried out in two ways

1. Wind turbine/PV array level.
2. Farm level.

- In farm level integration, balance-of-plant(BOP)equipment such as transformers and switchgears ,as well as the upstream transmission evacuation system ,is shared by wind, solar and BESS. In turbine level integration, each converter may be potentially shared by a wind, solar and BESS resource.

Thus in favorable conditions these plants generate energy. The electric energy generated from wind needs to be converted from AC to DC ,for purpose of transmission .The PV panel already generate DC supply where as the stored energy in batteries is chopped into favorable DC. This DC output's from all the sources is connected to a DC bus from where it is converted into AC supply for regular household and industrial applications.

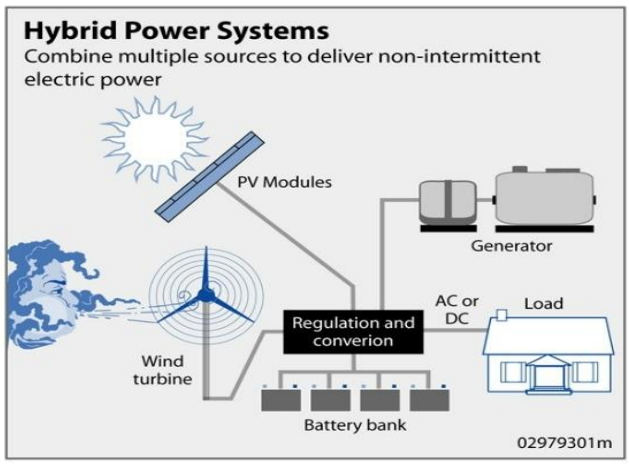

Figure.1:Block diagram of integrated system

DESIGN

According to the IEEE references ,a techno-economic feasibility study for IWSES plants was completed for two sites in India i.e. in Anathpur, Andhra pradesh; and Kutch, Gujrat.This study was performed for the Infrastructure Leasing & Financial Services Energy Development Company Limited,a developer and financier of renewable projects in India under a technical assistance grant from the U.S. Trade and development agency.

The deliverables of this study were as follows:

✓ Developing the technical design of the IWSES plant ,including the transmission evacuation plan

✓ Developing use cases for integrated energy storage appropriate for the Indian system

✓ Sizing energy storage to provide multiple plant and system-level services

✓ Performing cost-benefit analyses of IWSES plants under existing and proposed regulations

✓Preparing high-level environmental and social impact analysis guidelines

✓ Outlining the financing plan for the projects using viability gap funding and other incentives to supporting infrastructure projects that are economically justified but fall short of financial viability

✓ Recommending regulatory and policy changes required to integrate energy storage in India

✓ Conducting a reverse trade mission for Indian regulators and policy makers to learn about the energy storage business in the United States.

DESIGNING CONSIDERATIONS FOR AN INTEGRATED WIND-SOLAR PLANT

When designing an integrated plant, it is important to ensure that the interaction between the wind and solar plants is captured and taken into consideration. There are two principal types of interactions that must be modeled: 1)The effect of the turbines on the PV arrays . 2) The effect of the PV arrays on the wind-flow field.

The siting of the turbines was carried out first because the wind resource was more variable across the site than the solar resource; therefore, the optimum configuration of wind turbines is more sensitive to their siting than that of the solar array.

The presence of the PV panels can impact the surface roughness and affect the wind flow through the turbine array. An array of solar panels can be similar to other topographic or locational features (trees, buildings, etc.) ,in that it alters the surface roughness and affects wind flow through the array. Increased surface roughness changes the profile of the atmospheric boundary layer as it flows across the array, increasing the shear effect.

The approach for roughness modeling, turbine wakes, and the impact on wind flow is based on a theory advanced by Sten Frandsen. Frandsen stipulates that an infinite array of wind turbines is represented as a region of uniform high-surface roughness. The roughness imposes drag on the atmosphere, causing both a downstream change in the structure of the boundary layer and a reduction in the free-stream wind speed at the turbine hub height. At the project sites, the effect was comparable to that of the local vegetation.

Figure.2:Site favourable for IWSES (only for reference purpose)

BENEFITS OF IWSES

- ***Benefits from Integrating Wind and Solar Generation:***

The key benefits of an integrated wind-solar plant relative to standalone wind and solar plants with the same cumulative capacity are as follows:

1. Decrease in Project development cost:

Many factors are to be considered while designing solar or wind , like its impacts on markets , impact on environment , also some legal factors are to be considered. Which are as follows;

- Licence /permits
- Power purchase agreements
- Land lease
- Construction permits

Thus effective decrease in the cost is possible due to integration because tje legal procedures for both plants is the same.

2. Better use of available land:

- Collocating wind and solar power plants conserves space and increases the energy density (i.e., the amount of energy produced per acre of land).
- In many wind plants, the land between the turbines is often left unused. To make better use of space, wind and solar plants can be collocated, provided that conditions for both wind and solar power generation are favorable at the same location. Alternatively, if wind and solar plants can be sited adjacent to one another, they can share the same transmission evacuation infrastructure.

3. Complementary generation profile:

A further benefit of integrating wind and solar generation stems from the complementary nature of both the diurnal and seasonal patterns of their generation.

- the average hourly generation during selected months for a wind-solar plant made up of roughly 500-MW each of wind and solar generation capacity.

wind generation dips during the day and increases late in the evening. On the other hand, solar generation follows the sun and is highest during the middle of the day. Combining wind with solar reduces the difference between the generation levels during daytime and night time periods.

4 .Potential savings in transmission evacuation costs:

- An integrated wind-solar plant also has the potential for savings in evacuation and transmission upgrade costs.
- Typically, in a wind or solar plant, the collector system is designed to carry the maximum output of the plant. For example, standalone 100-MW wind or solar plants would each have 100 MW of evacuation capability.
- However, an integrated plant can make do with an evacuation capability lower than 200 MW because wind and solar generation will not peak at the same time. a range of cumulative hourly generation during selected months for a 1,000-MW wind-solar plant. Here the average cumulative hourly generation bounds within which the cumulative generation for each hour would occur 95% of the time.
- It is, thus, possible to design the evacuation system with a rating lower than the sum of the maximum capacities of the wind and solar plants.

CONCLUSION:

With increasing demand for energy and hikes in prices of non-conventional energy resource ,a future perspective should be considered .Even though the initial cost of set up is high ,long term savings and energy conservation is achieved.

It also supplies continuous power to the load with optimum design to control cost.

The IWSES energy systems are recognized as a viable alternative to grid supply or conventional, fuel-based, remote area power supplies all over the world. The literature review reveals that, renewable energy based low emission hybrid systems are not cost competitive against conventional fossil fuel power systems .However, the need for cleaner power and improvements in alternative energy technologies bear good potential for widespread use of such systems. Moreover, the rural households in industrialized and less developed countries attach high value to a reliable, limited supply of electricity. Community facilities such as rural hospitals, schools, telecommunication and water pumping stations can contribute significantly to the welfare of people and rural development. While it is recognized that technology can only be one aspect of community development, the renewable energy systems have demonstrated the potential to provide support in some of the basic infrastructure needs in remote and urban areas for different application.

Next steps for IWSES in India

The Ministry of New & Renewable Energy in India plans to add yet another record-breaking project in its portfolio .

Mega project capacity :160MW

Area:1000 acres

Investment:1000 crore(155 million $)

Developed by: Solar Energy Corporation of India (SECI), the renewable energy agency of Andhra Pradesh, Andhra Pradesh Transco.

120MW solar and 40MW wind power

Future of IWSES in other countries,

FORT HOOD, Texas (Jan. 28, 2016) -- Fort Hood, federal and local officials broke ground here during a ceremony for a massive energy project for the installation, Jan. 28.

The project, the largest and first of its kind, will include both an on-post solar farm and an off-site wind turbine farm, which has the capacity to generate 65 megawatts of electricity for the installation, saving taxpayer money during the duration of the contract. The upstart capital of the project will be $100 million.

Its main objective is to free up money to be able to make better Soldiers here on Fort Hood. So, if it's cheaper energy, it gives us more money to the military to spend on training up the best warriors in world.

REFERENCES:

Report/journal/papers:

1. Sundar Venkataraman,Chris Ziesler, Peter Johnson, and Stephanie Van Kempen , "Integrated wind, solar and energy storage" Institute of Electrical and Electronics engineers(IEEE) power and energy magazine published on 18 April 2018.

2. Pragya Nema, RK Nema, Saroj Rangnekar "A current and future state of art development of hybrid energy system using wind and solar: a review" Published at International Journal of Science and Research in 2014.

Websites:

1.www.energy.gov/energysaver/buying-and-making-electricity/hybrid-wind-and-solar-electric-systemses

www.army.mil/article/161585/ground_breaks_at_fort_hood_for_largest_renewable_energy_project_in_army