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Modelling of a high-renewable energy system and dispersed energy resources

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DESCRIPTION

The constant depletion of fossil fuels and the continuously rising need for energy require alternative energy sources, which are the solution. The various renewable energy sources employed in medium and low voltage networks as a solution to sustainable clean power are fuel cells, wind turbines, solar modules, biomass gassifier units, etc. These distributed energy resources, sometimes referred to as renewable energy sources, are used in networks as independent, grid-connected systems or as micro-sources in microgrid systems. The most extensively used alternative energy source is photovoltaic solar arrays, or PV arrays. Much study is being done to enhance their effectiveness, dependability, cost, integration, and performance.

The PV system simulation models have developed throughout time to examine both standalone and grid-tied system performance. For PV array modelling and simulation, mathematical methods based on mathematical equations have been studied in the literature. While the circuit-based models used in PSPICE and MATLAB to build the PV circuit model contain parts like resistors and diodes. Installation of PV systems for grid-connected and stand-alone operation has become possible because to the quick innovation in this field. Data driven modelling is an emerging field of research for PV systems that uses simulation's capabilities to investigate a system's behaviour and forecast its response.

Large data is accessible in power systems and can be collected and used to more effectively examine a system's dynamics. The PV system's Maximum Power Point (MPP) tracking is an essential component. There are numerous approaches that have been developed and used, but it can be challenging to decide which maximum power point tracking approach is best for a particular PV system. The Perturb and Observe method's delayed response to atmospheric circumstances is one of the incremental conductance technique's shortcomings. Wind energy is quickly gaining importance among renewable energy sources, and much research is being done to capture it. Worldwide, wind power generation is growing and provides clean, sustainable, and affordable electricity.

The operation of a wind farm determines the cost of using wind energy. i.e., how powerful the wind farm is. Only around 59% of the power drawn from wind, even when there is no loss in the turbine, gets transformed to useful electrical energy. The power extracted from wind is determined by the strength of the wind and the generator's operating point. Maximum Power Point Tracking (MPPT) is necessary for maximum power extraction from wind turbines, which may have vertical or horizontal axes. The MPPT modifies the turbine rotor speed in response to changes in wind speed. Small power generators called micro-turbines turn an electrical generator with outputs ranging from 30 to 400kW by burning gaseous and liquid fuels at high speeds.

They are a factor in tiny gas turbine evaluation and have long played a significant role in the field of micro-generation. Microturbine models come in two main varieties: split shaft design and high speed single shaft type, both of which are useful for dynamic simulations. The increased use of renewable energy sources raises concerns about their intermittent nature, which highlights the significance of energy storage. Energy storage facilities significantly increase the effectiveness of distributed generation and aid in maintaining substation voltage and frequency levels. Utilizing resources effectively aids in solving issues affecting the quality of uninterrupted supply for both consumers and the utility. Energy storage systems are categorised according to the type of energy they utilise.

Electrical energy can be stored using the following energy sources: electrical (super conducting magnetic coil and double layer capacitor), mechanical (pumped storage system, flywheel storage, and compressed air), thermal (heat storage), chemical & electrochemical (hydrogen, secondary batteries, and flow batteries), and nuclear. In addition to discussing the components of battery modelling and the energy system model for evaluating the value of batteries, the appropriate size of an energy storage system with cost evaluation is offered.