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Dispatchable renewable generation: A step towards high renewables penetration

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Penetration of renewables in global electricity generation is expected to rise to 30% by 2022, mainly due to growth in wind and solar generation capacity. Power generated from these renewable resources is replacing power from conventional powerplants due to their priority dispatch status and low marginal cost. Integration of renewables in the power system introduces new challenges that arise from variability of generation, reactive power scarcity, change of power injection pattern, fault behavior and asynchronous nature of renewables. This research focuses on the intermittency of the renewable resources. The current practice to utilize the available renewable energy resources for power generation is just as a means to reduce fossil-fuel consumption. This is mainly related to the inherent variability and non-dispatchability of renewable energy resources. Such a practice poses a threat to the power system reliability and requires utilities to maintain power-balancing reserves to match the variable supply from renewable energy resources and demand power levels. Maintaining these reserves for renewable generation imposes additional cost for the utility and jeopardize the economic value of renewable energy projects. Accordingly, enhancing the integration of renewable power generation from wind and solar into the traditional power network requires the mitigation of the vulnerabilities posed to the grid as a result of the intermittent nature of these resources. An Energy Management System (EMS) determines suitable operating points based on the available resources and limitations. EMS may be employed at different levels of the power systems, from the generation level down to the consumer loads. While the dispatch of conventional power generation depends on EMS, such a tool has not been yet developed for renewable energy generation. An EMS for renewable generation should consist of 4 key units, i.e. weather forecaster, power aggregator, scheduler and real time controller. Further elements may also be added to an EMS for renewable generation depending on the applications and available equipment. Employing an EMS in a hybrid wind-solar powerplant with Battery Energy Storage System (BESS) can enable provision of dispatchable power from renewable generation by using the synergy of the wind and solar generation as well as the charge and discharge capability of BESS. EMS, collectively, utilizes forecasting models for wind speed and solar irradiance in addition to optimization techniques to determine suitable power set-points for BESS, wind and solar farms. The main objective of EMS is to make full use of the complementary nature of the wind and solar generation whilst using minimal energy storage capacity to ensure power fluctuation mitigation and high-power supply reliability over a given time interval (settlement period)). As implied, two roles are defined for BESS, in such a configuration, smoothing the power output of the renewable powerplant and alleviating the power curtailment. The former is realized through the real time controller unit and the latter is achieved by the scheduler unit of the EMS. The scheduler unit of the EMS was used to determine power setpoints for an 80 MW hybrid powerplant consisting of 50 MW wind farm, 30 MW of solar farm and 2.5 MWh BESS. Historic solar and wind generation profiles were obtained and assumed as the output of the forecaster and aggregator units of the EMS. These were used as input to the scheduler unit. It can be seen that dispatchable power is achievable using the scheduler unit of EMS while operational limits of equipment are observed. Potential benefits of the proposed approach include realization of dispatchable renewable generation by efficiently using the BESS. This enables reducing reserve costs associated with the integration of renewables. Further, it can lead to the provision of ancillary services from renewables, and ultimately be a leap towards even higher penetration of renewable generation is moderately interconnected system.

Biography

Amer Al-Hinai is the director of the Sustainable Energy Research Center (SERC) and Associate Professor at Sultan Qaboos University. He started his research career as a research assistant at the Advanced Power & Energy Research Center at West Virginia University, Morgantown, the USA during his postgraduate studies. His main research topic was related to the control and operation of distributed generation. In addition, he was part of a research team for several projects unded by different US institutions such as Department of Energy, Department of Defense, and National Energy Technology Laboratory. Dr. Amer has carried out more than 33 industry-funded research projects, with total funds exceeded 3 million USD, related to energy savings, power system analysis, power system quality and transient stability of power systems. His research funding agencies include but not limited to Petroleum Development Oman, Occidental Oman, Petrofac, Authority for Electricity Regulation Oman (AER), Muscat Electricity Distribution Company, Oman Electricity Transmission Company,

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