INTERNET OF ENERGY WITH ADVANCED ANALYTICS, MODELLING, OPTIMISATION AND DIGITISATION FOR ESS AND RENEWABLE ENERGY SOURCES

PROJECT SUMMARY

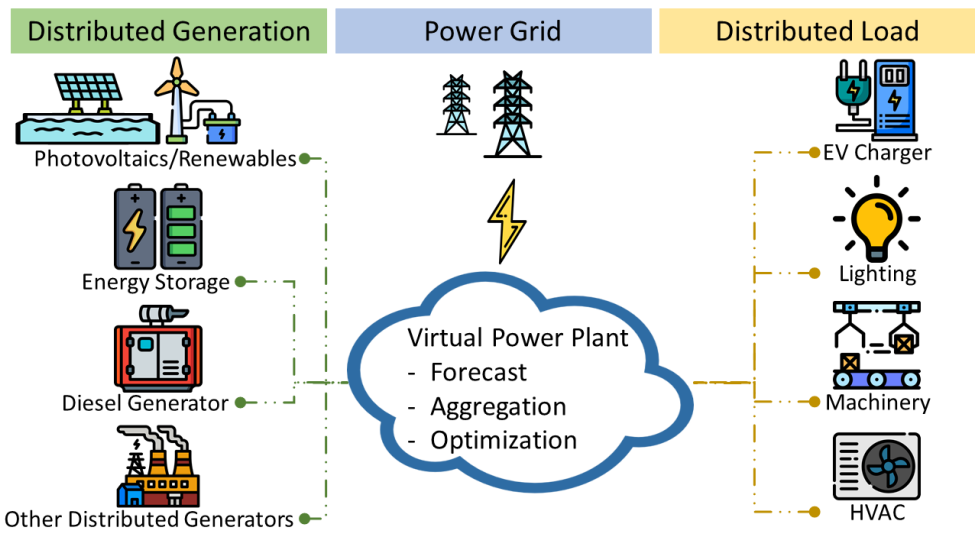
The increasing cost-competitiveness of renewable energy sources and environmental concerns on energy generation have led to an increase in deployment of distributed energy resources (DERs) such as photovoltaics (PV) and energy storage systems (ESS) to complement traditional power plants which generate electricity centrally. Electricity produced from these DERs at end users' premises can be coordinated and aggregated intelligently like a "single utility-scale power station". Such an Internet of Energy (IoE) concept is commonly known as a Virtual Power Plant (VPP).

VPPs bring about many advantages such as ***flexibility***, ***scalability*** and improved ***power grid resilience***:

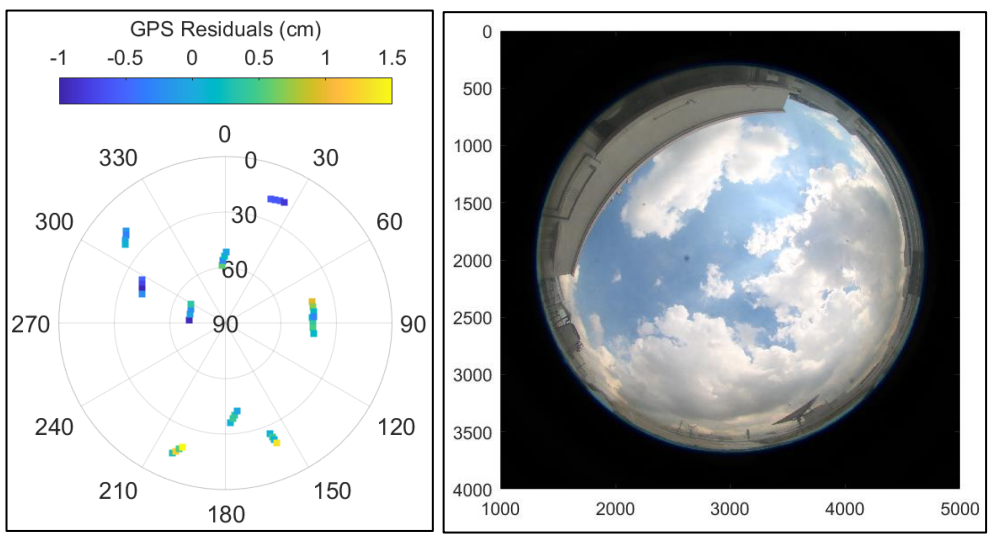
- A VPP operator could monitor and control various DER, ensuring supply and demand balance.
- The distributed architecture of VPP reduces concentrated risks associated with single point of failures.
- A VPP creates new revenue streams for DERs by aggregating their output to provide ancillary services to the energy market such as frequency regulation and demand response.

This project features:

- Forecasts for energy and grid ancillary prices, load demand and PV generation.
- Stochastic co-optimisation algorithm for optimum utilisation of DERs for multiple services
- Use-cases of the ESS for optimum energy dispatch and energy market participation.
- A physical testbed with two clusters of residential PV generation and ESS, and one industrial site with a grid-scale ESS.



Communication links between the VPP and the DERs, the loads and the grid system (including energy market) to aggregate, forecast and optimise DER generation and utilisation.

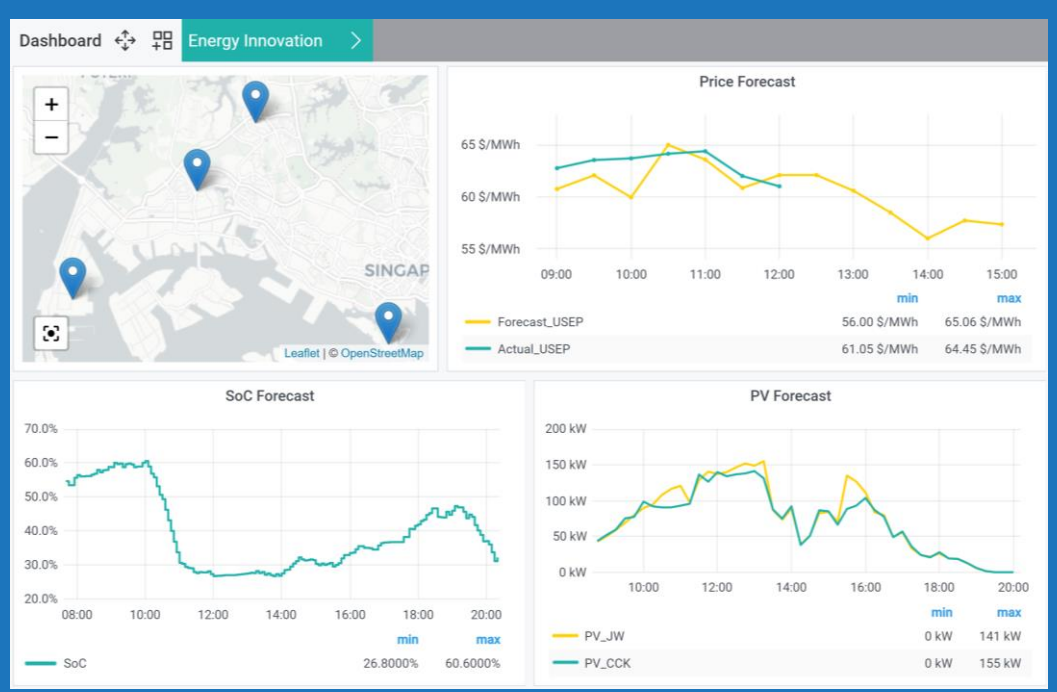


Cloud monitoring for irradiance forecasting using GPS sensor and sky camera

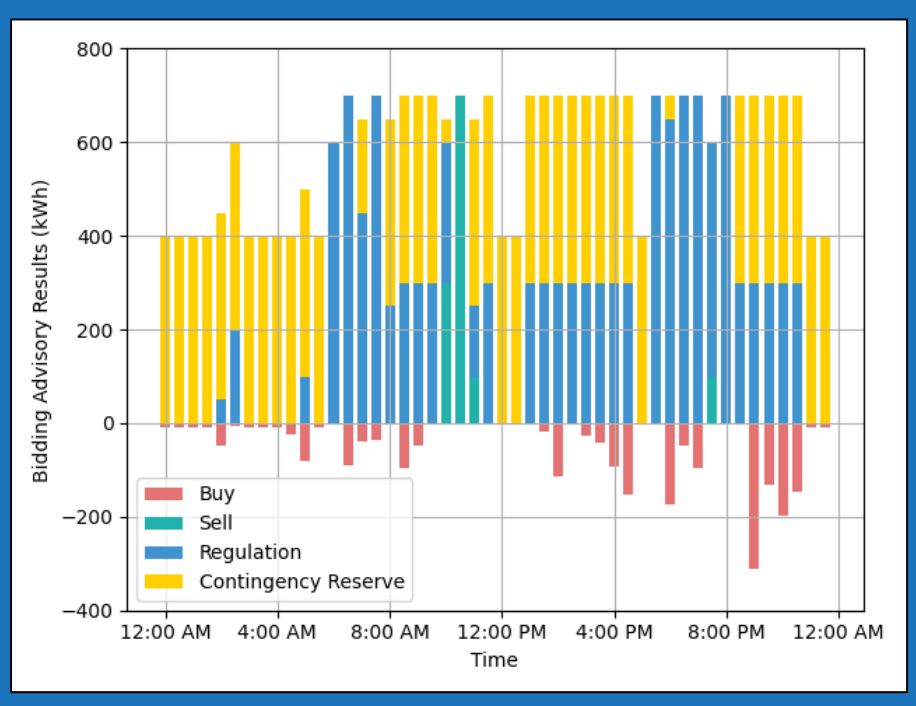
PROJECT OUTCOMES

Under the Sembcorp-EMA Energy Technology Partnership, ERI@N has developed a VPP that applies Machine learning and Artificial Intelligence to construct advanced forecasting and power dispatch optimisation.

- The forecast model takes into consideration the historical and real-time factors to improve the quality of load and energy market prices forecast.
- An innovative irradiance forecast model will be developed by integrating data obtained from various technologies such as sky images and GPS sensors for higher accuracy.
- The real-time stochastic optimisation algorithm is robust and customized to facilitate VPP participation in Singapore's energy and ancillary service market to achieve significantly higher returns for the ESS with stack services. Test runs have shown an increase in daily revenue by more than 15% as compared to deterministic and conservative approaches.
- A user-configurable widget-based Trading Advisory Dashboard has been developed to allow end user to choose what information/data to be shown on the Dashboard and how these are presented - whether in histograms or other graphical forms.



Trading Dashboard to monitor VPP operation status, historical/forecasting accuracy/error, available resources, and others.



Bidding Advisory (Optimal Energy Dispatch) for energy arbitrage and ancillary services such as frequency regulation and contingency reserve.

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