IITB-Monash Research Academy

Indian Institute of Technology Bombay | MONASH University

An Indian-Australian research partnership

Project Title:	**Intelligent pairing of Electric vehicle and Renewable Energy Integration in smart grid**	
Project Number	**IMURA0972**	
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Research Clusters:

Highlight which of the Academy's CLUSTERS this project will address? *(Please nominate JUST **one.** For more information, see www.iitbmonash.org)*	
1	*Material Science/Engineering (including Nano, Metallurgy)*
2	*Energy, Green Chem, Chemistry, Catalysis, Reaction Eng*
3	*Math, CFD, Modelling, Manufacturing*
4	*CSE, IT, Optimisation, Data, Sensors, Systems, Signal Processing, Control*
5	*Earth Sciences and Civil Engineering (Geo, Water, Climate)*
6	*Bio, Stem Cells, Bio Chem, Pharma, Food*
7	*Semi-Conductors, Optics, Photonics, Networks, Telecomm, Power Engineering*
8	*HSS, Design, Management*

Research Themes:

Highlight which of the Academy's Theme(s) this project will address? *(Feel free to nominate more than one. For more information, see www.iitbmonash.org)*	
1	*Advanced computational engineering, simulation and manufacture*
2	*Infrastructure Engineering*
3	*Clean Energy*
4	*Water*
5	*Nanotechnology*
6	*Biotechnology and Stem Cell Research*
7	*Humanities and social sciences*

		8	Design

The research problem

Renewable energy (RE) is being rapidly integrated to power systems with ambitious targets of RE integration set at national/regional levels. Solar PV and wind power are the front-runners among available renewable energy sources. However, as the penetration of renewable generation increases, the impact on power system dynamics is becoming increasingly apparent, and will become an integral part of system planning and renewables integration studies. Historically, power systems were dominated by large synchronous generators connected to a strongly meshed transmission network, with the dynamic characteristics of such systems being well understood. RE integration has several well known advantages, however, due to variability, uncertainty and non-synchronous nature, RE integration introduces several technical challenges in grid operation. Such RE integration related technical challenges range from short term dynamic stability to long term scheduling and balancing issues, with diminish system inertia, frequency stability and operating reserves under high RE penetration being some of the critical concerns for stable grid operation.

On the other hand, the global Electric Vehicle (EV) fleet is poised to increase exponentially in what has been dubbed the electric mobility revolution. The push for EVs is driven by the global climate agenda established under the Paris Agreement to reduce carbon emissions to limit global warming. Importantly, not only would a switch from combustion-engine vehicles to EVs lead to lower emissions, EVs also create a lot less local air pollution. In addition, the deployment of EVs is also driven by national agendas to reduce oil demand and as such dependence on oil imports, as well as the encouragement of a local EV manufacturing industry for job creation. On the other hand, EVs through several grid support services are expected to strengthen the grid and help in accommodating higher renewable energy penetration while maintaining secure and stable grid operation.

Moreover, digitalisation is turning out as a key amplifier of the power sector transformation, enabling the management of large amounts of data and optimising increasingly complex power systems. For the power sector, digitalisation is essentially converting data into value. Digital technologies, such as, artificial intelligence (AI), can support renewable energy integration in several ways, including better monitoring, estimation of grid stability specific parameters, more refined system operations and control closer to real time, and assessment of dynamic security in large scale renewable energy integrated power system.

Therefore, this PhD project is aiming to explore how AI/ML/Data driven approaches can intelligently exploit the complimentary nature of RE integration and Electric vehicle integration in modern smart grid, thus enabling EVs to help accommodating higher penetration of renewable energy and vice versa.

Project aims

1. Impact analysis of EV charging infrastructure on distribution and transmission system (steady state and dynamic operation related aspects)
2. Study the potential interaction of RE generation and EVs in a smart grid
3. Study V2G support services and potential application of AI/ML based technique
4. AI/ML based approaches to explore EV aggregation, assessment and monitoring of grid support services (active and reactive power reserves etc.) from EV fleets at distribution and transmission system level
5. Hardware in loop studies for V2G services from EV charging stations using intelligent (AI) based algorithms

Expected outcomes

1. Propose an intelligent approach for increased RE penetration with the EV support considering various aspects related to secure grid operation (Unit commitment, economic dispatch, frequency and voltage stability)
2. Propose AI/ML based technique for intelligent control for EV charging station (multiple chargers of different types, such as, CHAdeMO, CCS2, type 2, slow Ac chargers etc.)
3. Propose intelligent algorithms for grid support from EV charging stations in a given distribution system considering congestion management, virtual power plant (EV based), increased RE penetration, standard communication protocols etc.
4. Propose an AI/ML based approach to aggregate the EV fleets in the context of EV and RE integration

Capabilities and Degrees Required

A highly motivated applicant with background in Electrical Power engineering and strong commitment to quality research. Masters in electrical power or related area is preferred, however, an outstanding undergraduate applicant will also be considered.