IITB-Monash Research Academy

Indian Institute of Technology Bombay | MONASH University

An Indian-Australian research partnership

Project Title:	**Control and operation of Converter-only Renewable Energy Integrated Grid Using Artificial Intelligence Techniques**	
Project Number	**IMURA0973**	
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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.

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 help in managing secure and stable operation of converter-only grid with ultra-high penetration (80-100%) of renewable energy.

Project aims

1. Study the impact of 100% inverter interfaced generation on system inertia, frequency dynamics, and operating reserves in the system
2. Investigate the importance/need for inertia in converter-only grid
3. Investigate how AI abased techniques can be used to intelligently manage generation-load balance in converter-only low inertia/inertia less system
4. Study the optimal pricing mechanism for inertial and reactive power/voltage control ancillary services
5. Analyse the most critical challenges in inverter-only grid under ultra-high instantaneous penetration of RE

Expected outcomes

1. A detailed study on technical feasibility of achieving inverter-only power system with 100% RE penetration.
2. Propose ancillary service products required for secure and stable operation of inverter-only RE integrated grid
3. Propose AI based approach to estimate and monitor volume of the identified ancillary service products required for generation-load balance in converter-only power system
4. Propose optimal pricing mechanism for inertia and reactive power based ancillary services
5. Propose optimal size and volume of inertia and reactive power based ancillary services
6. Propose AI enabled technique to estimate the size and location of a disturbance (generation and load disturbance) in inverter-only grid
7. Propose a methodology to estimate the minimum required grid forming inverters in converter-only

system for secure and stable grid operation.

8. Propose key recommendations for achieving 100% RE integrated converter-only system

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.

Select up to **(4)** keywords from the Academy's approved keyword list **(available at http://www.iitbmonash.org/becoming-a-research-supervisor/)** relating to this project to make it easier for the students to apply.