IITB-Monash Research Academy

Indian Institute of Technology Bombay | MONASH University

An Indian-Australian research partnership

Project Title:	**Artificial intelligence enabled large-scale Renewable energy integration into power system**	
Project Number	**IMURA0891**	
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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, 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. Within the context of the Innovation landscape for a renewable-powered future report, the main focus of this PhD work will be on secure and stable integration of renewable energy to power system. More specifically, this work will explore how AI can support in online estimation and monitoring of frequency stability in RE integrated grid, particularly under high share of RE, and potential countermeasures to improve the stability. AI can be a powerful tool to estimate frequency stability specific parameters, such as, system inertial including inertial contribution from RE sources, frequency nadir, and optimal frequency reserves required for secure and stable grid operation under high share of RE. Moreover, AI can be used to predict frequency stability indicators for a given contingency , which can be a powerful tool for system operators to take predictive action to avoid grid instability.

Project aims

1. Impact analysis of large-scale RE penetration on different operational aspects of grid, such as, system inertia, maximum rate of change of frequency, frequency nadir, operating reserves etc.
2. Study of different AI based techniques to assess and monitor frequency stability indicators, including system inertia, maximum rate of change of frequency, frequency nadir, operating reserves
3. Propose AI based approach to estimate optimal frequency ancillary service reserves for stable grid operation.
4. Propose an AI based approach to predict frequency stability indicators in advance and

suggest preventive actions required for maintaining stability for a given grid disturbance.

Expected outcomes

1. An AI based tool to assess and monitor frequency stability indicators in RE integrated power system
2. Propose an AI based optimal approach to estimate frequency reserves required for stable grid operation of RE integrated power system
3. An AI based tool to predict frequency stability and suggest preventive countermeasures for grid
4. A tool to assess frequency reserves available under low voltage distribution system

How will the project address the Goals of the above Themes?

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.

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Potential Collaborators

Please visit the IITB website www.iitb.ac.in OR Monash Website www.monash.edu to highlight some potential collaborators that would be best suited for the area of research you are intending to float.

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.