IITB-Monash Research Academy

Indian Institute of Technology Bombay | MONASH University

An Indian-Australian research partnership

Project Title:	**Intelligent control and operation of large scale renewable energy integrated power system using Synchrophasor measurement system**	
Project Number	**IMURA0847**	
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Research Clusters:

Research Themes:

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

The research problem

Renewable energy is being progressively integrated with ambitious targets of renewable energy 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 a more integral part of system planning and renewables integration studies. Historically, power systems have been based around large synchronous generators connected to a strongly meshed transmission network, with the dynamic characteristics of such systems being well understood. However, renewable generation, particularly in the form of wind and solar generation, is increasingly universally connected via power electronics interfaces, may well be connected to the distribution network, or weaker parts of the network, may offer new control capabilities, and, of course, is subject to the variability and uncertainty associated with local and regional weather patterns. The time variability and non-dispatchable nature of wind generation may pose substantial challenges, particularly at higher levels of penetration, including an increase in regulation costs and incremental operating reserves, but can also lead to increased opportunities for energy storage, demand- side response, cross- border interconnections, and other flexibility measures.

On the other hand, evolution of synchrophasor measurement technology, using Phasor Measurement Units (PMUs) for data measurement has opened a vast number of potential applications in the power system world, ranging from monitoring, protection, and control to enhance the smartness and efficiency of power systems. PMU-based Wide Area Monitoring Protection and Control (WAMPAC) can play a vital role in secure and stable integration of renewable energy, particularly in grid operation under high share of renewables.

In the backdrop of above, the main focus of this PhD project is to establish PMU based monitoring, assessing and control methodologies for stable grid operation under high share of variable renewable sources, through following tasks.

1. Exhaustive literature survey on application/role of PMUs WAMPAC methodologies in handling renewable energy integration.
2. Study and identify the major existing and emerging issues with large scale renewable energy integration.
3. Develop PMU based methodologies/tools for real time monitoring of renewable energy

penetration, frequency reserves, system flexibility and stability margin.

4. Develop automated control of solar PV plant using PMU measurement data and feedback.
5. Develop PMU based methodologies for automated generation control and voltage control in renewable energy integrated systems.

Project aims

1. Study and identify the major existing and emerging issues with large scale renewable energy integration.
2. Develop PMU based methodologies/tools for real time monitoring of renewable energy penetration, frequency reserves, system flexibility and stability margin.
3. Develop automated control of solar PV plant using SMU measurement data and feedback.
4. Develop SMU based methodologies for automated generation control and voltage control in renewable energy integrated system.
5. Perform hardware in the loop tests to validate the developed methodologies

Expected outcomes

1. Detailed literature survey on application/role of SMUs/PMUs, wide are monitoring and control methodologies in handling renewable energy integration
2. Development of a power system model in real time simulator and hardware in the loop tests using emulated and physical PMUs
3. Validation of the developed models using PMU field measurement data
4. Tools/methodologies for real time monitoring of renewable energy penetration, frequency reserves, system flexibility and stability margin.
5. SMU based methodologies for Automatic generation control and voltage control in renewable energy integrated system.
6. Methodologies for enhancing grid stability with grid support from renewable enrgy using SMU/PMU data collection and feedback

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.

Following points, though not mandatory, will be of added value:
Hands on with electrical power related tools, such as, DigSILENT PowerFactory, PSS/E, OPAL-RT, RTDS, Labview, MATLAB, PSCAD, and Optimisation tools, such as, GAMS etc.

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.