

# Power Engineering Advanced Research Laboratory

## Research strengths and activities

**Presenter: Dr Behrooz Bahrani**

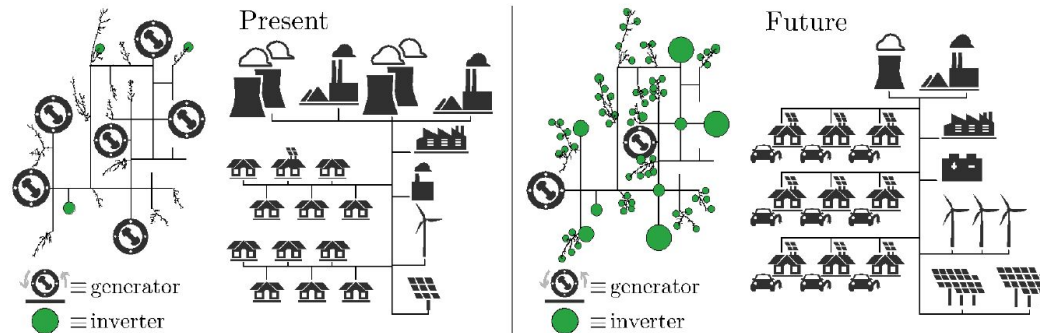
**Assoc. Prof. B. Bahrani**

Department of Electrical & Computer Systems Engineering  
Faculty of Engineering, Monash University  
Melbourne, Australia

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- **Grid Integration of Renewable Energy Resources**
- Electric Motor Development for Electric Mobility

- In the Australian power system, **60%** of the Synchronous-generator-based thermal generation will be **retiring by 2030**.
- **Inverter-based resources (IBRs)** such as wind/solar farms and large-scale batteries are replacing them.
- IBRs provide **faster and more controllable dynamics**, and need alternative methods to control/analyse.
- **Our lab is at the forefront** of designing the required tools and controllers to maximise the benefit of renewables.



The evolving power system

Ref: NREL, "Research Roadmap on Grid-Forming Inverters", Nov. 2020.

- Control design for **emerging inverter**-based resources with a focus on grid-forming inverters
- Developing **grid-forming renewable wind farms**
- Developing **stability analysis tools** for analysis of such inverters

## Notable Projects (\$3M+ in the last three years):

- **Stability Enhancing Measure for Renewables in Weak Grids**, Funded by the Australian Renewable Energy Agency (ARENA), 2020-23, \$1.3M
- **Australian Research Roadmap for the Global Power System Transformation Consortium (GPST)**, Funded by CSIRO, 2021-22, \$160k
- **GPST/CSIRO Research Plan Execution for Topics 1, 2, and 6**, Funded by CSIRO, 2022-23, \$717k
- **Oscillation Management in the Australian Power System**, Funded by ARENA, 2023-2025, \$1.4M

## Future Projects

- **NSF Global Centres led by Prof. Hill**
- **International researcher networks to accelerate clean innovation - Department of Industry (Potentially \$4M)**

- Grid Integration of Renewable Energy Resources
- **Electric Motor Development for Electric Mobility**

## Past Projects

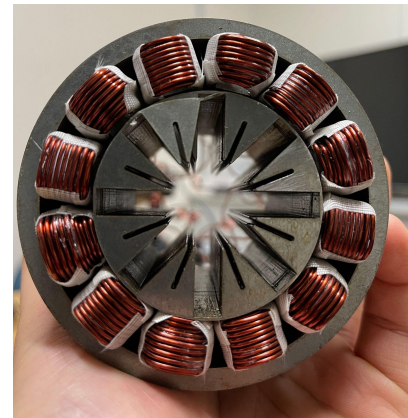
- **Automotive Engineering Graduate Program**, funded by the Department of Industry, \$751k, 2019-21
- Monash MotorSport Powertrain development, 2017-Present

## Current Projects

- **Passenger EVTOL motor with AMSL**, funded by the Department of Transport, \$650k, 2023-24
- **Formula Student custom in-wheel integrated motor/gearbox** and inverters, with Monash MotorSport
- Powertrain for hypersonic EVs (defence)

## Future Projects

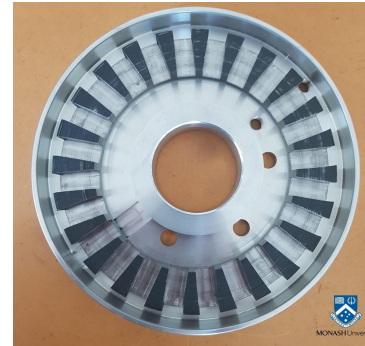
- Trucking and other transport applications
- Collaboration with Defence Science and Technology Group - Propulsion and Energy



Monash Motorsport SiFe Motors  
Manufactured at PEARL

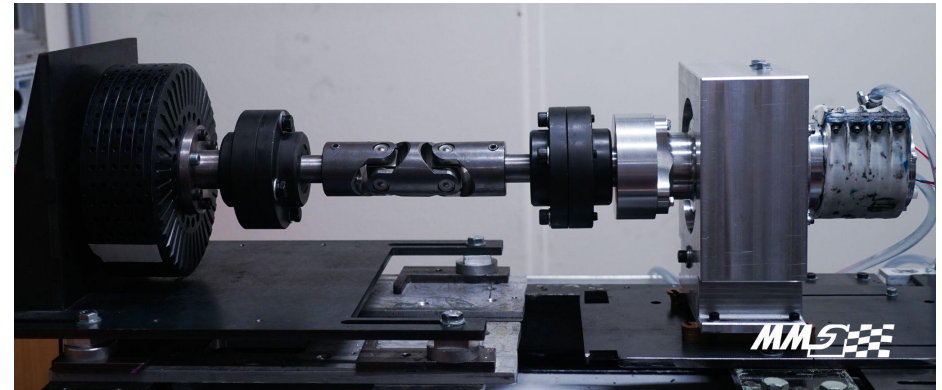
## Manufacturing:

- In house motor core material processing (0.2mm SiFe)
- Coil winding and additive manufacturing
- Coil postprocessing and motor potting
- High tolerance machining and wire cutting (shafts and enclosures)
- PCB manufacturing (Vapour phase reflow)
- Rotor filament winding up to 300mm diameter



## Testing and validation:

- Regenerative dynamometer
  - 500Nm / 20kRPM (Kistler)
  - 20Nm / 50kRPM (Kistler)
  - Yokogawa Power Analyser, NI DAQ
  - 20kW source-sink DC load (Regatron)
  - LEM current sensors (high accuracy)
- Imperix hardware units (controller testing)
- Winding Impulse testing and insulation testing
- General purpose electrical lab equipment



## Silicon Carbide Converter

800V / 300Arms SiC Drive - >50kW/kg and >50kW/L

- Volume, mass and cost optimised
- EMI / parasitics oriented design
- 20kHz - 60kHz switching frequency
- ~99% efficiency at half load
- Low latency control loops

