



THE UNIVERSITY
OF AUCKLAND
FACULTY OF ENGINEERING



Advanced Power Electronics

Including: IPT for High Power Converters & EVs

Udaya K. Madawala & Duleepa J Thrimawithana

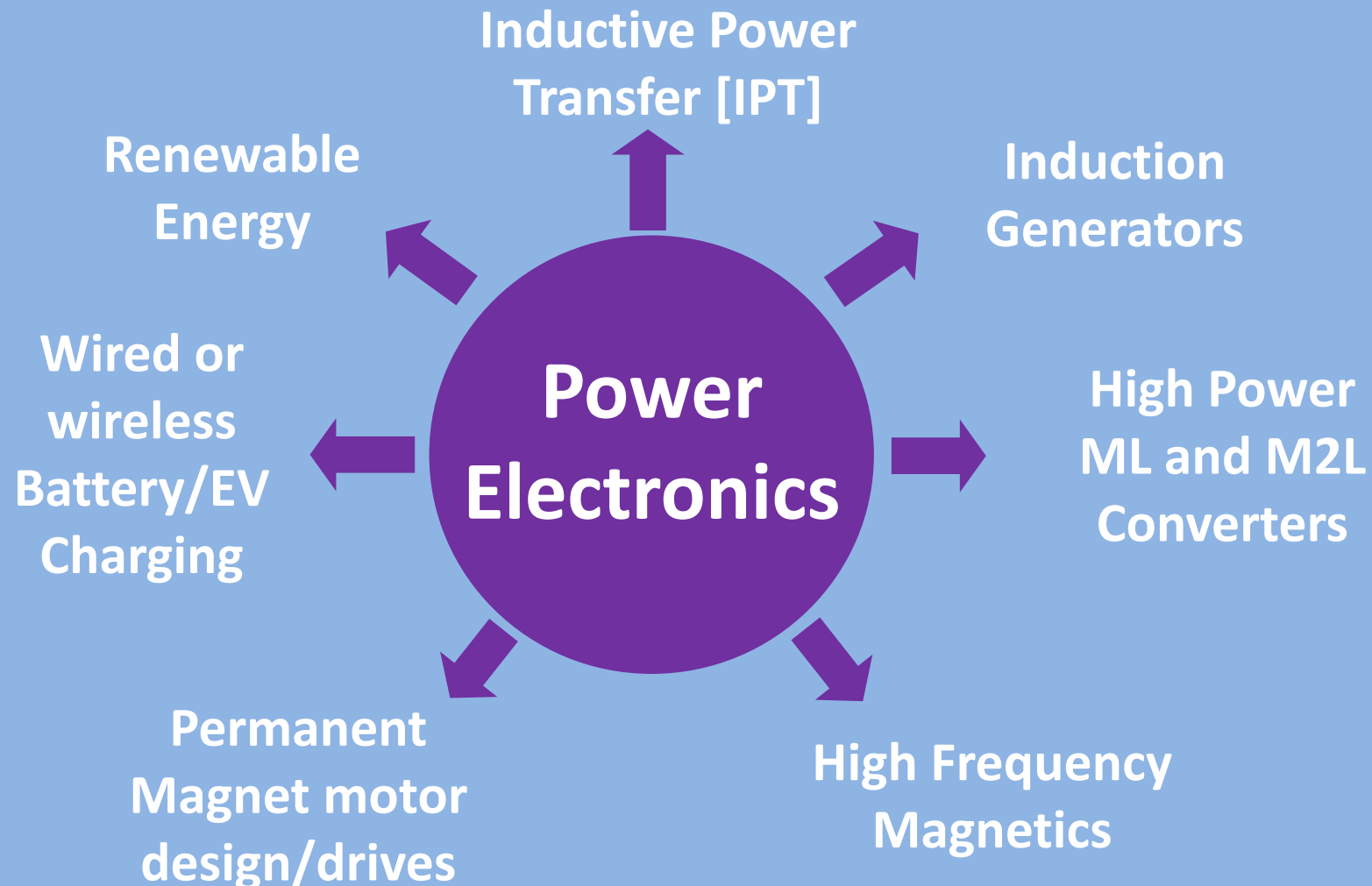
Power Electronics Research Group
Department of Electrical and Computer Engineering
The University of Auckland

Phone : (+64) 9 373 7599 Ext. 86496, Email : u.madawala@auckland.ac.nz

Field of Research



THE UNIVERSITY
OF AUCKLAND
FACULTY OF ENGINEERING



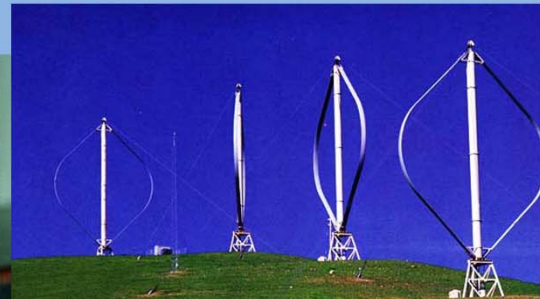
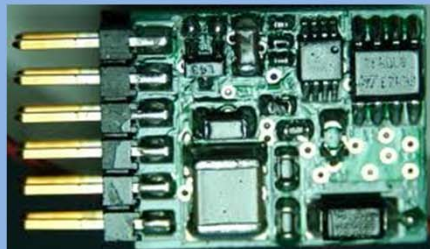
Objectives



THE UNIVERSITY
OF AUCKLAND
FACULTY OF ENGINEERING

Implement systems :

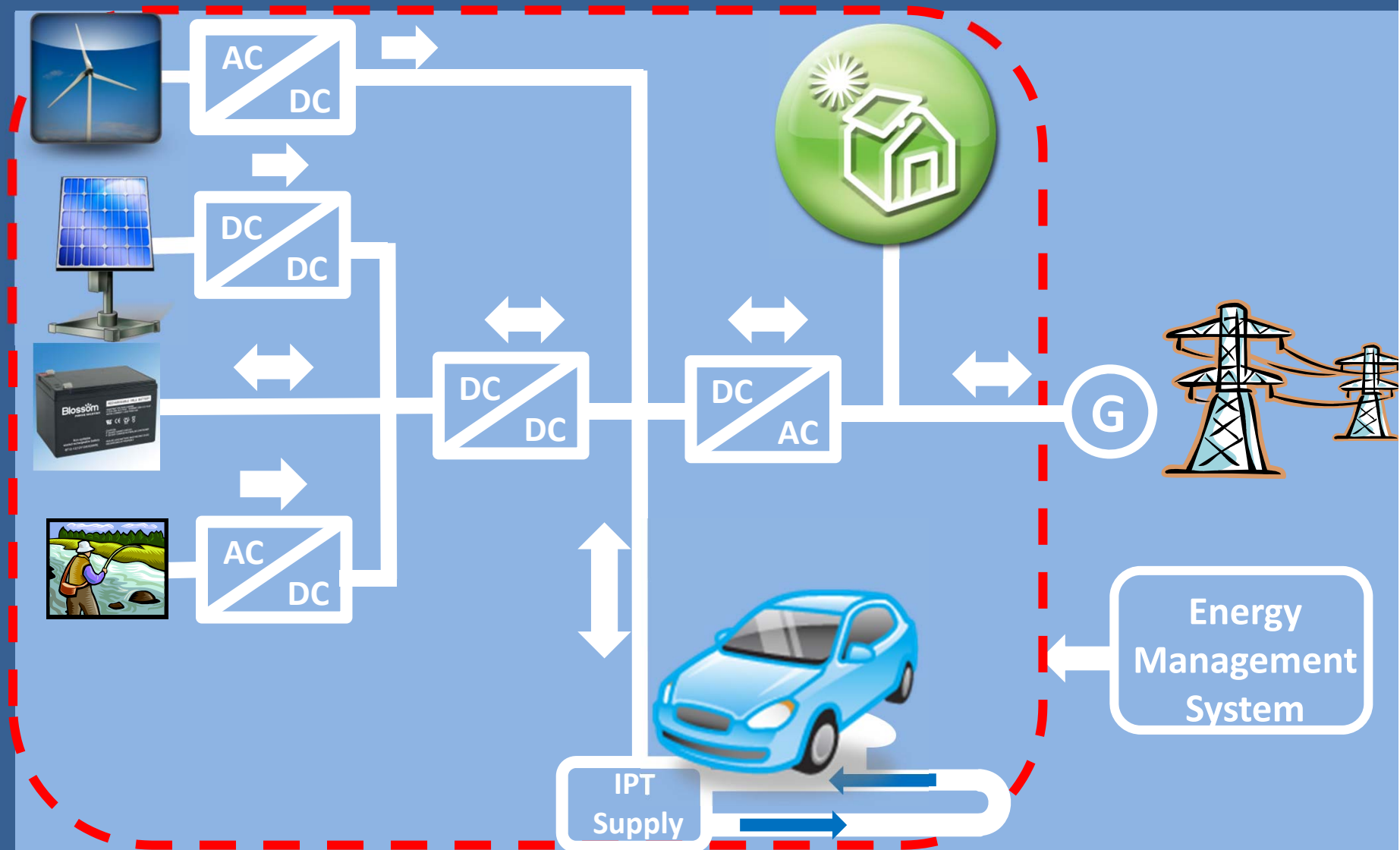
- *Resolving related societal issues/concerns*
- *Commercial*: *cost-effective, viable, attractive*
- *Efficient*: *save energy*
- *Innovative*: *Intellectual Property [IP]*



A Green Energy System: Research Focus



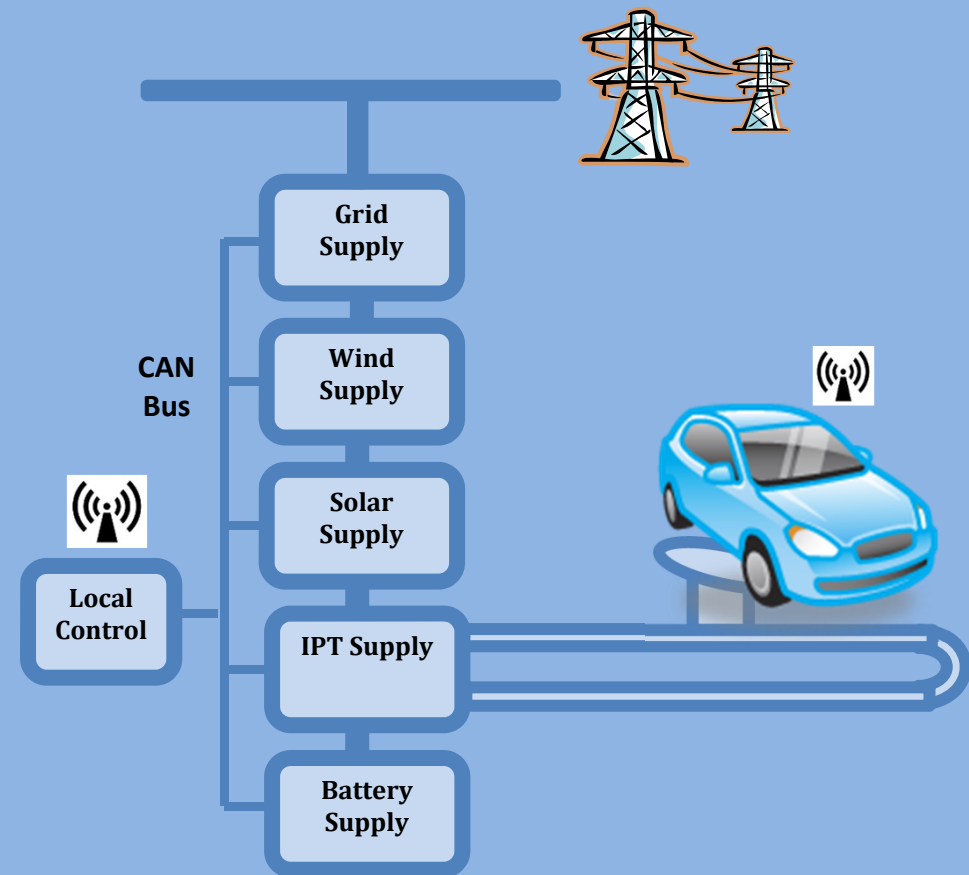
THE UNIVERSITY
OF AUCKLAND
FACULTY OF ENGINEERING



Inter-Communication



THE UNIVERSITY
OF AUCKLAND
FACULTY OF ENGINEERING



Bi-Directional IPT Systems



THE UNIVERSITY
OF AUCKLAND
FACULTY OF ENGINEERING

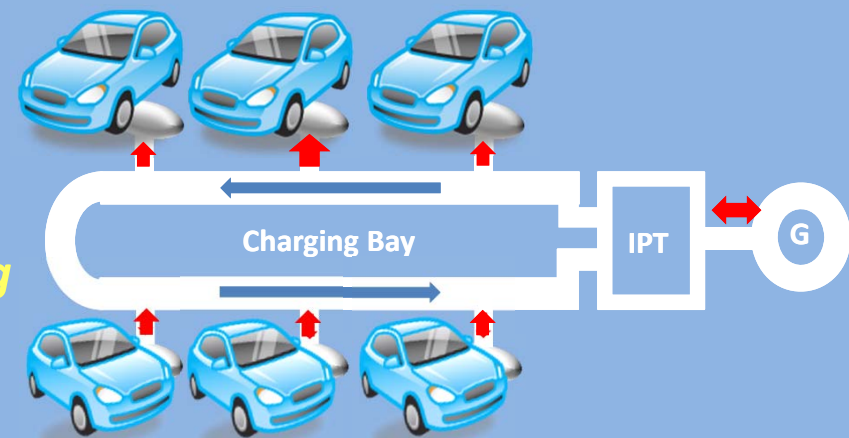


Patented techniques (some in commercial use)

1. Leading research in the world
2. Bidirectional power flow with high efficiency
3. High frequency operation – up to 6.4 MHz
4. Novel control & grid integration techniques
5. High power systems for dynamic charging (roadway)

Ideal for:

- ✓ *EVs and V2G & G2V systems*
- ✓ *Energy recovery systems*
- ✓ *Systems that require energy balancing*
- ✓ *Safety [galvanic] isolation*
- ✓ *High power systems*



Low Cost Generation: wind, micro-hydro etc



THE UNIVERSITY
OF AUCKLAND
FACULTY OF ENGINEERING



→ Field trials

Patented system, laboratory proven

1. Standard three-phase induction machine
 - a. One winding separately excited under inverter control
2. Low cost electronics: ratings below generator capacity
3. Sophisticated control software

Success with **renewable electricity generation** calls for:

- ✓ **Low cost** – suitable for small-scale systems
- ✓ Reliability & availability
- ✓ **Constant frequency**
- ✓ Grid integration and stand-alone



Battery Charging:

renewables, EVs, data centres, telecoms, traction



THE UNIVERSITY
OF AUCKLAND
FACULTY OF ENGINEERING



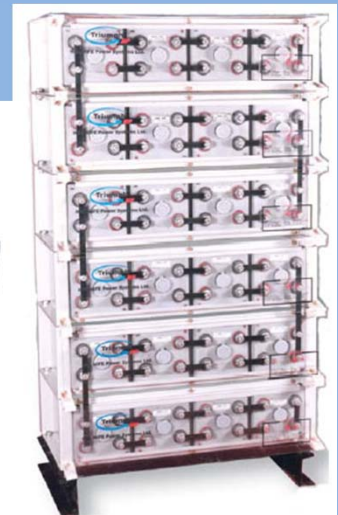
Field trials

Patented techniques, some in commercial use

1. Bidirectional power flow for efficiency, speed: reduced high-frequency electronics complexity
2. No large passive components [capacitors, inductors]
3. Multiple inputs/outputs: high voltages, cell balancing
4. Sophisticated control software

Charge control for **sophisticated batteries** needs:

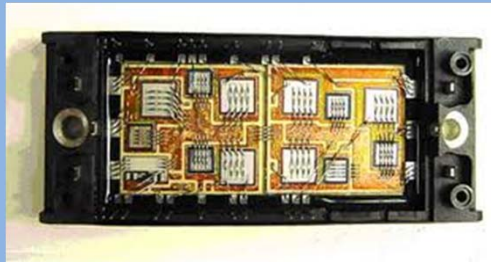
- ✓ **Efficiency & low cost**
- ✓ Low distortion
- ✓ **Cell balancing capability**
- ✓ **Safety** [galvanic] isolation
- ✓ Modular design



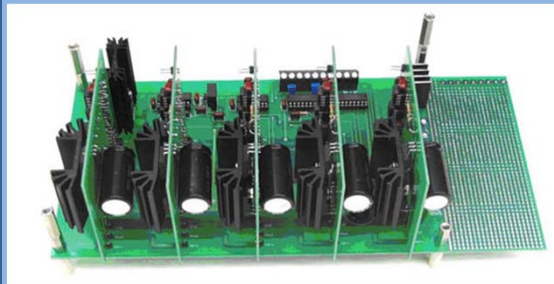
High Power Converters : modular, multilevel, bi-directional



THE UNIVERSITY
OF AUCKLAND
FACULTY OF ENGINEERING



Field trials



Patented techniques, some in commercial use

1. Module control, balancing and protection
2. Boundary conditions: start-up, shutdown
3. Loss reduction [efficiency improvement]
4. Best-in-class distortion
5. New, simplified control algorithms

Modular, multilevel converters:

- ✓ **Not limited by individual device ratings**
- ✓ Motor control; static compensators; HVDC; batteries
- ✓ **Integration;** redundancy; fault tolerance
- ✓ Low distortion; small passive devices, **reduced costs**

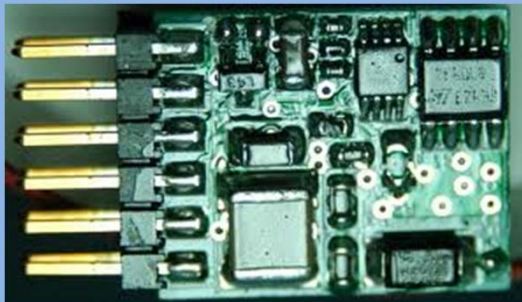


Magnetic Components : SMPS efficiency improvement



THE UNIVERSITY
OF AUCKLAND
FACULTY OF ENGINEERING

→ Service offer



New techniques

1. For characterization of magnetic components under DC bias
2. New phenomena identified: practical applications
3. New magnetic modelling process
4. New algorithmic core design procedure

Switched-Mode Power Supplies need:

- ✓ **High efficiency:** small size; low cost
- ✓ Excellent magnetic performance
- ✓ **Magnetics under DC bias**



Concluding Remarks



THE UNIVERSITY
OF AUCKLAND
FACULTY OF ENGINEERING

- Power electronics is a key component of the modern, connected society.
- My Group has a leading position in international academic circles, and a record of commercial success.
- Strong patent portfolio.
- We plan to build further on the above with your group.

* Thank you *