

UK Overview of Research and Development.

Progress, Outlook and Needs

Ways forward for connecting
renewables and distributed generation:
UK and European perspectives

N Jenkins

(contributions from the research team in Manchester)

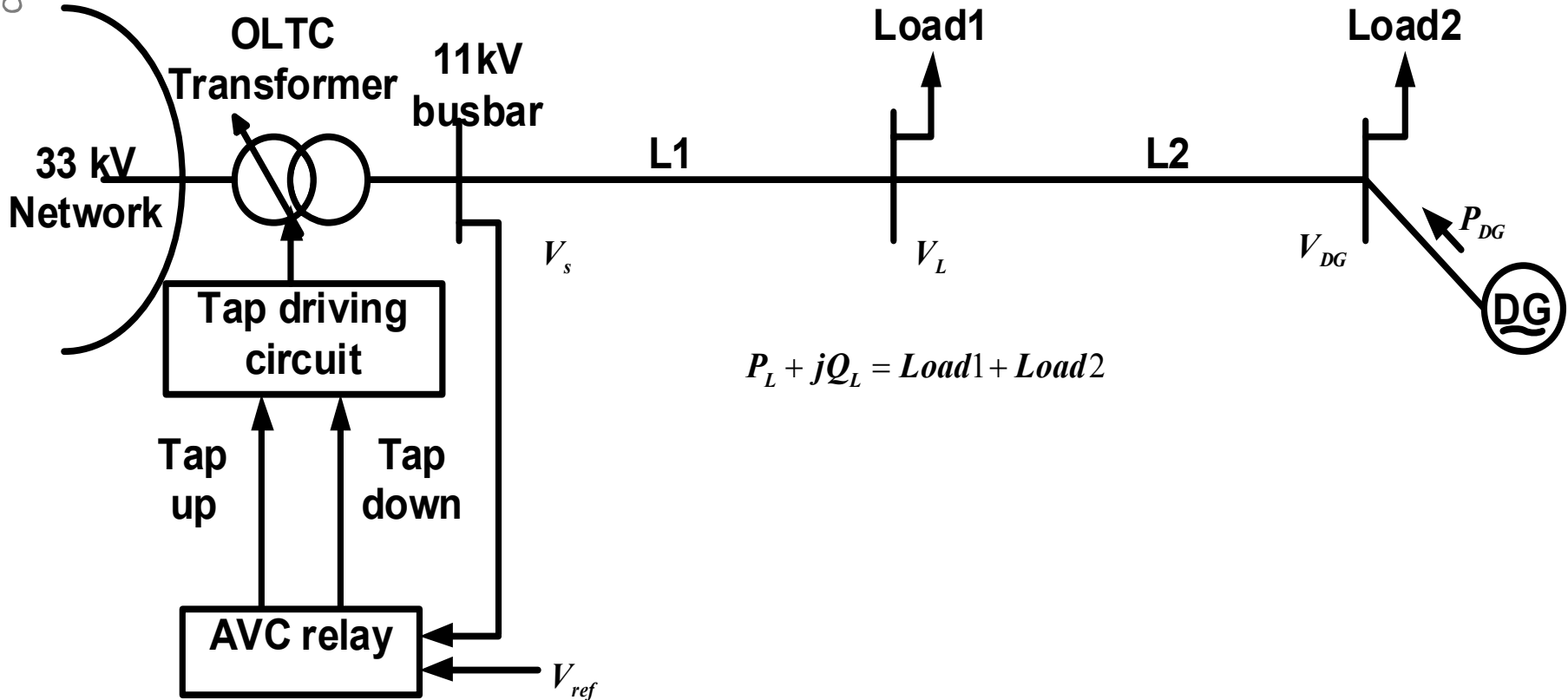
Scope of Presentation

- Research needs
 - Connecting renewables and DG
 - Integrating renewables and DG into the power system
 - Future development of the power system
- Research progress and outlook
 - UK research activity
 - CEU research activity

Research Needs - Connection

- Maximise connection of Renewables and DG at minimum cost
- Minimise investment in new primary plant
- Active management of Distribution Networks
 - Voltage Control
 - Flow Control
 - Fault Level Control

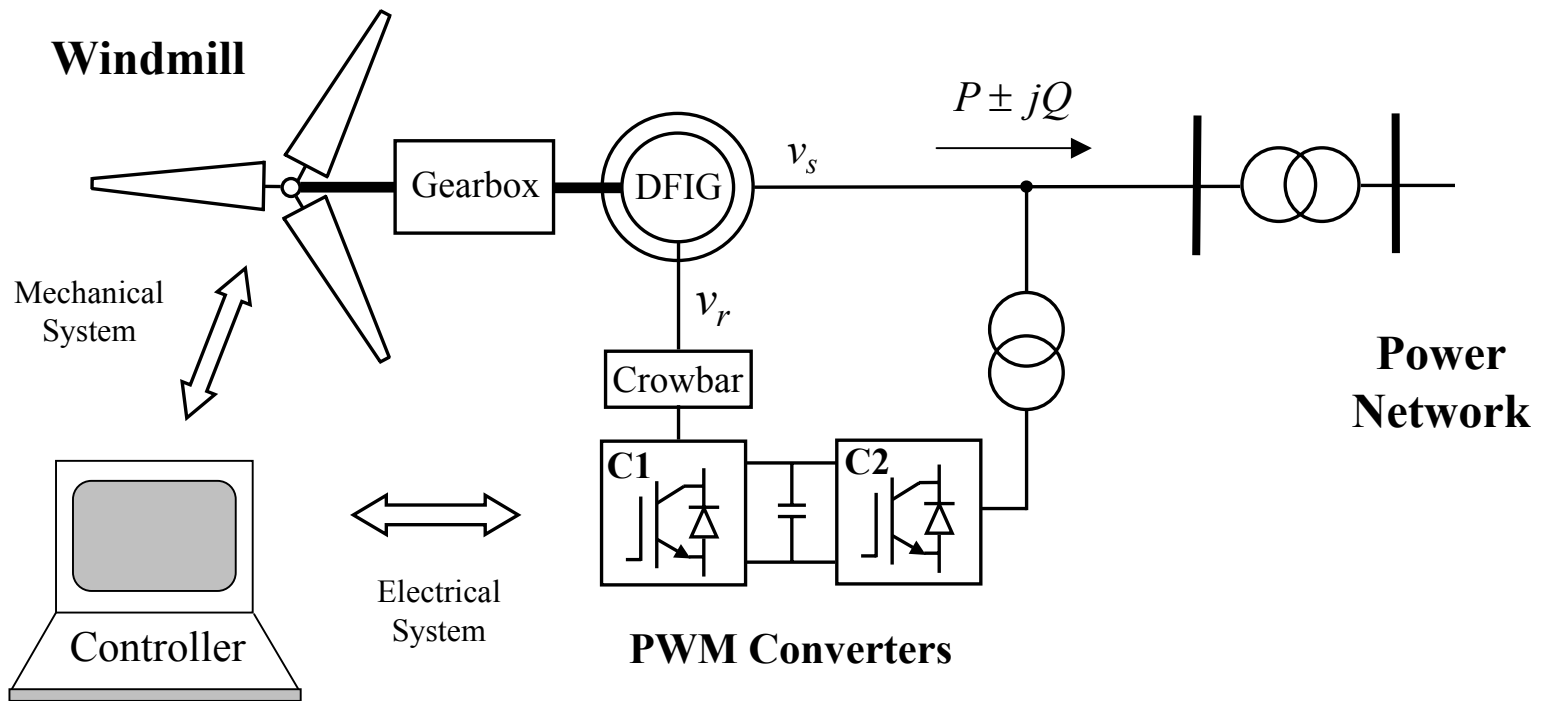
A simple feeder voltage control model



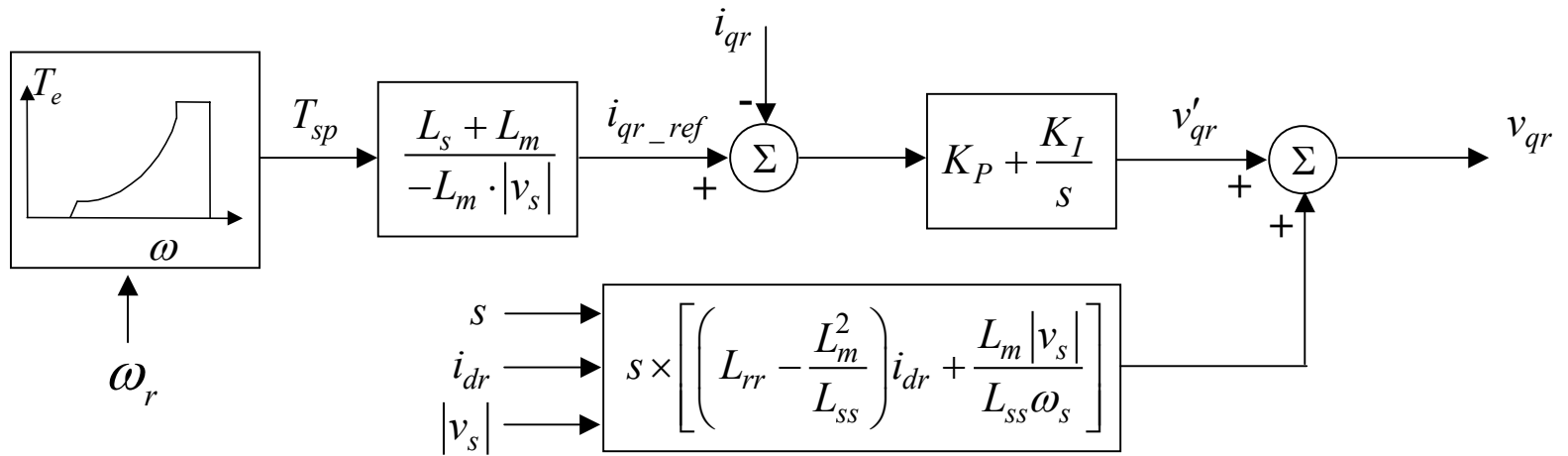
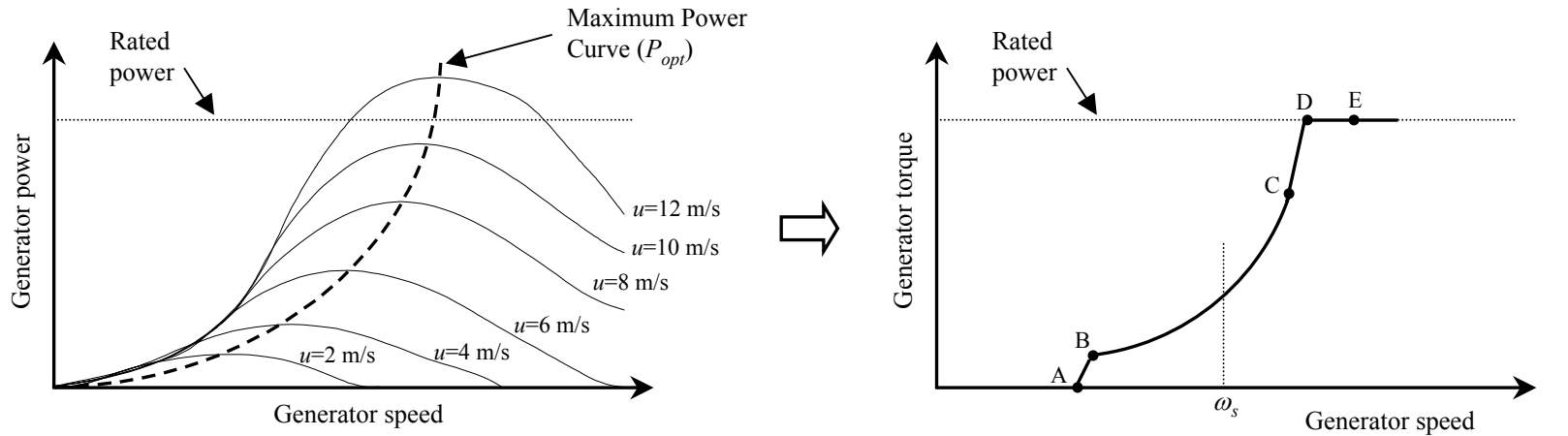
Research Needs - Integration

- Large Wind Farms
 - Grid Codes
 - Capacity Requirement
 - Operating implications - forecasting
- Other forms of Distributed Generation e.g. micro CHP
 - Contribution to frequency and voltage control
 - Virtual Power Plants

Typical DFIG Wind Turbine

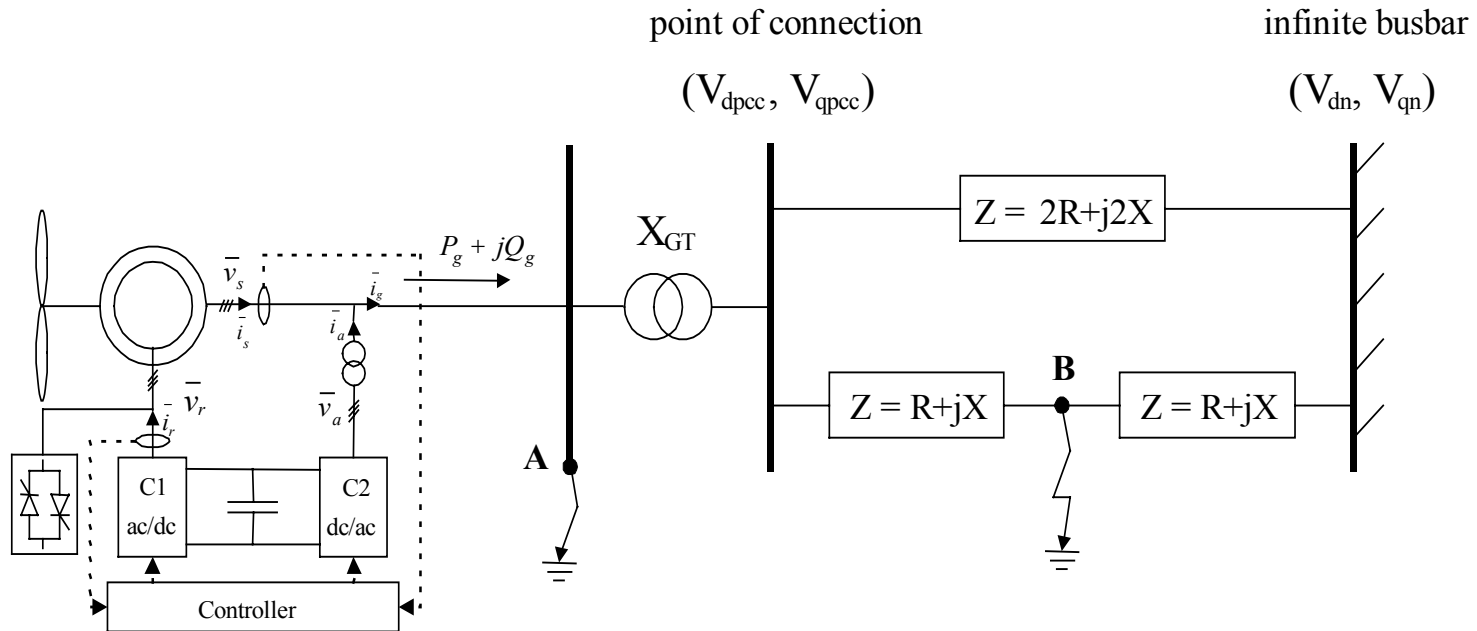


DFIG torque/speed control strategy



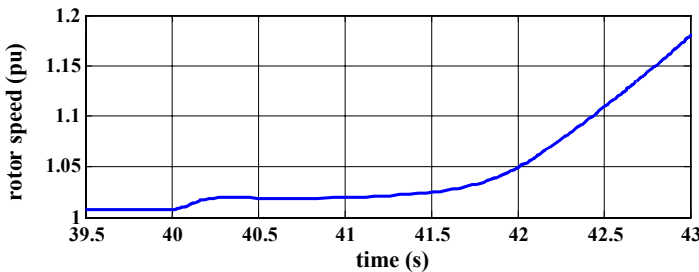
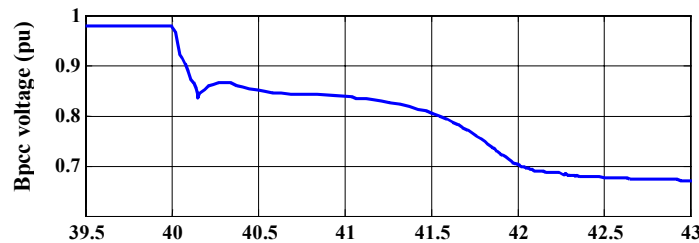
Simulink™ implementation

Power system model used to conduct DFIG transient analysis.

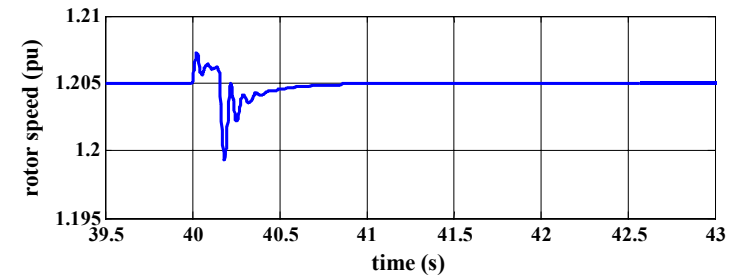
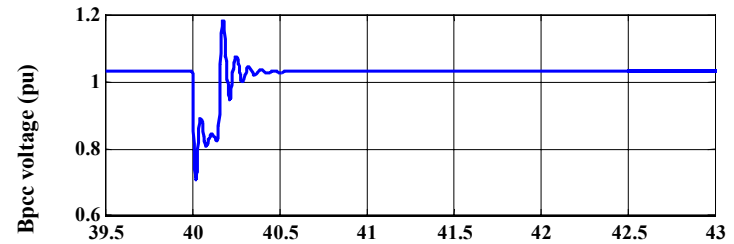


Simulink™ simulation results

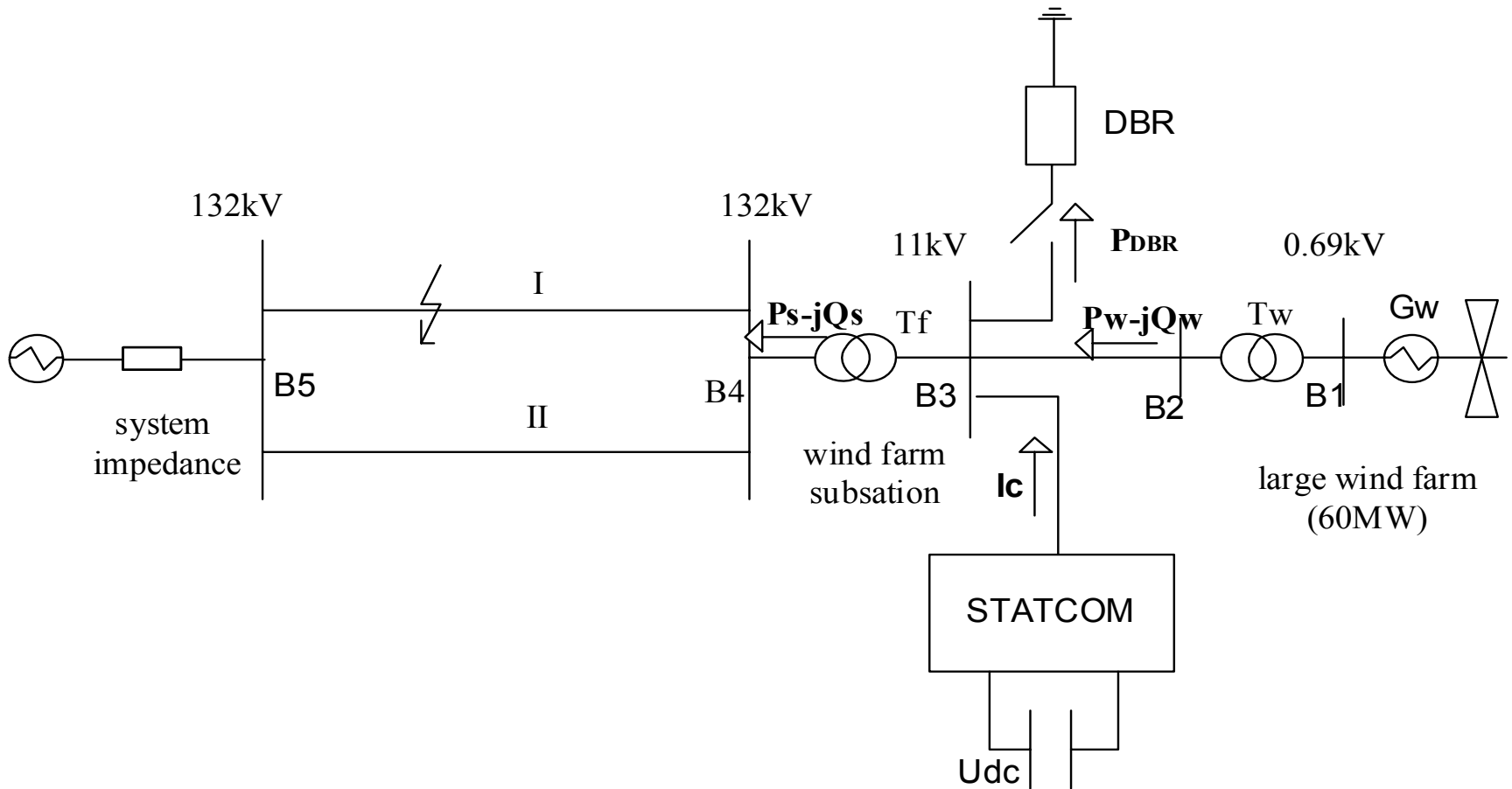
FSIG and DFIG response to a fault applied at point B in the power system model at 40.0 s and cleared after 150 ms.



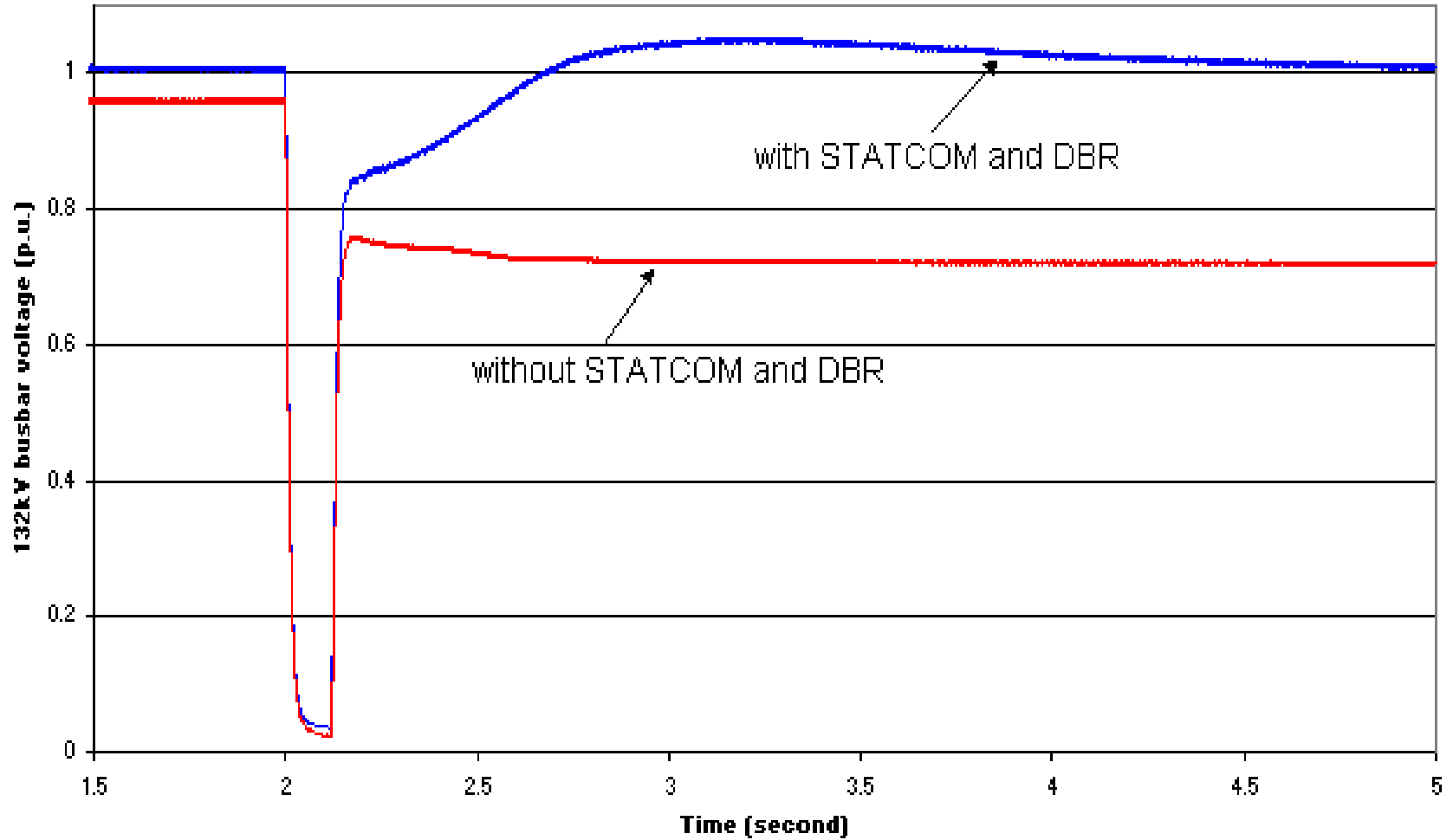
FSIG response



DFIG response



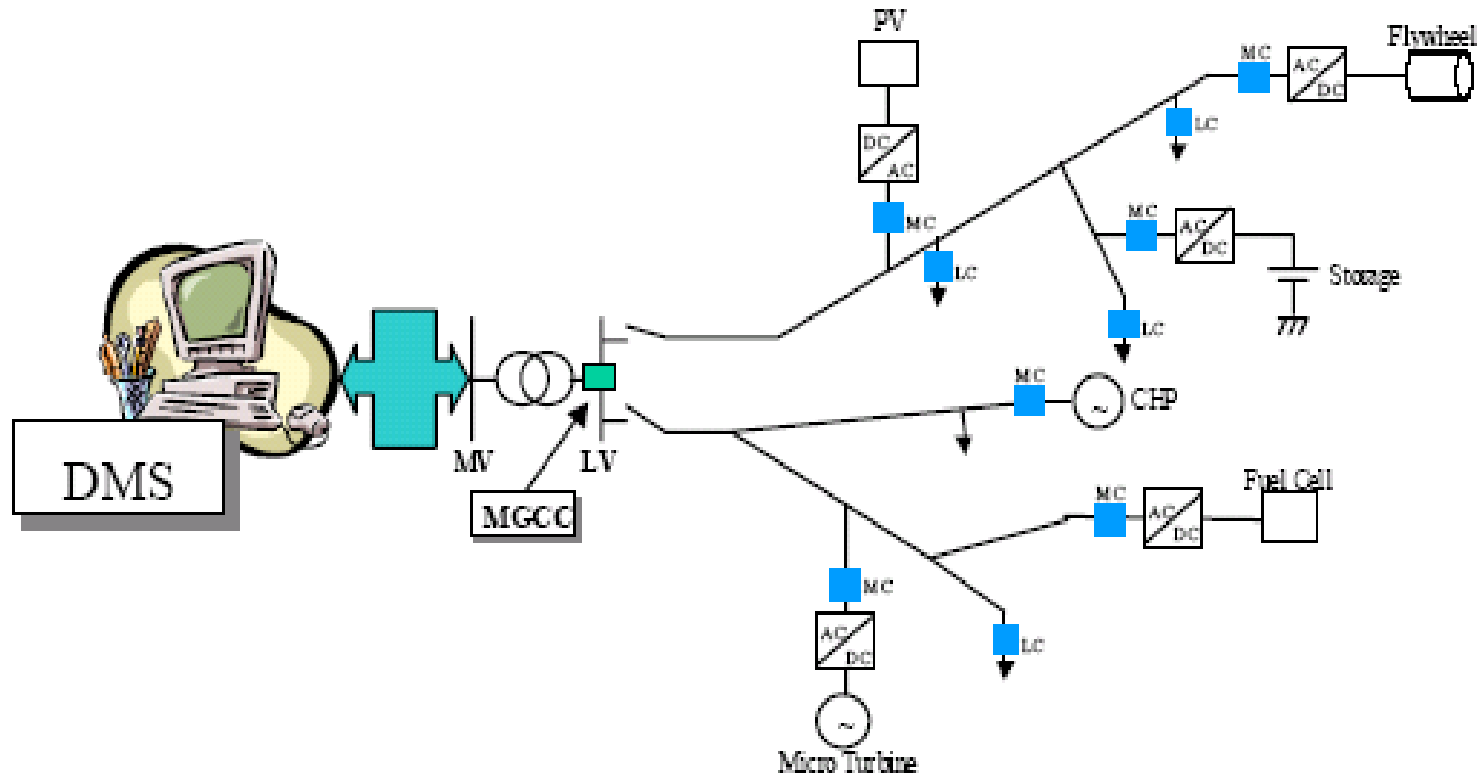
A large offshore wind farm with a STATCOM and DBR



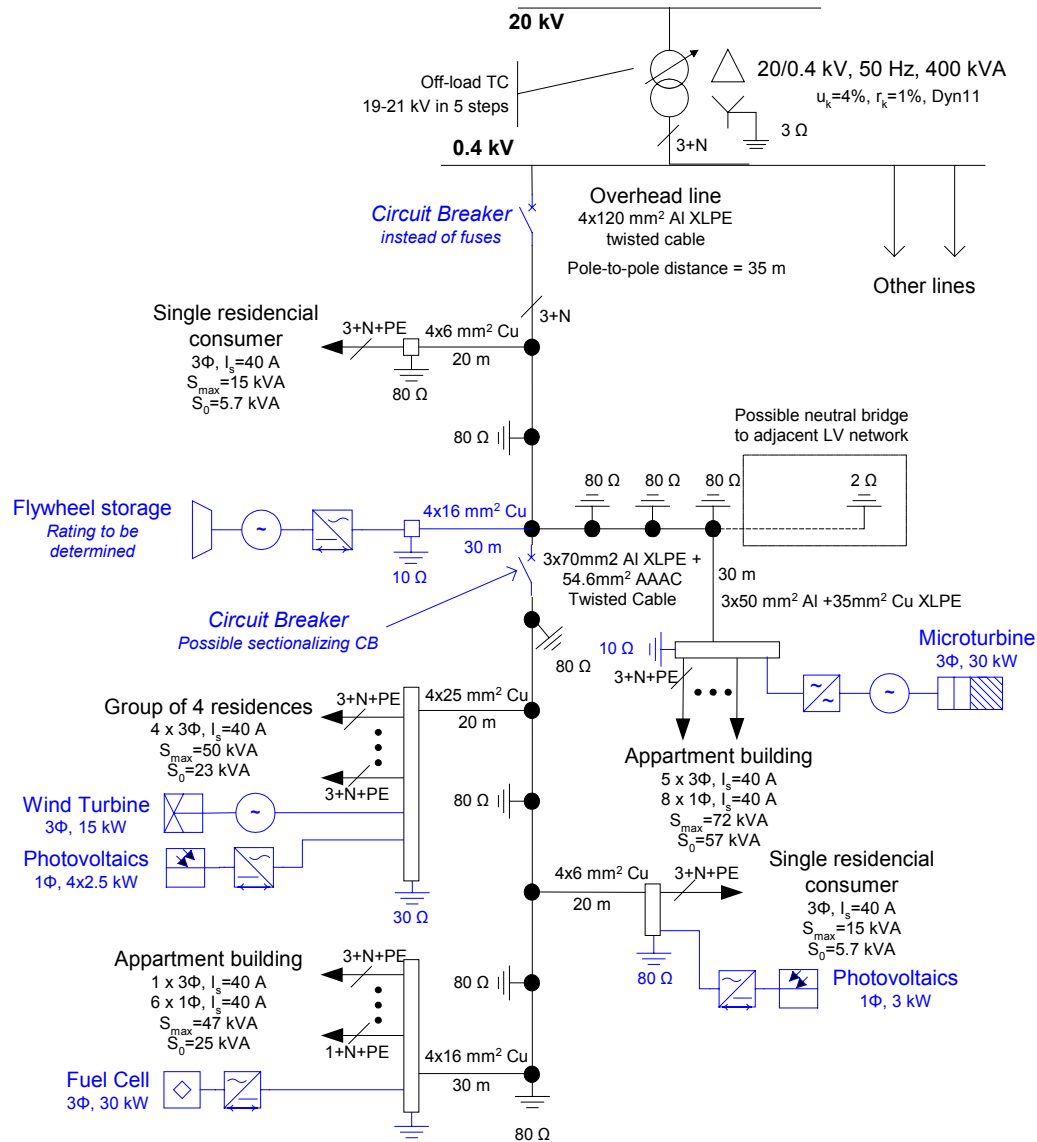
Research Needs - Future Development

- New tools and assessment techniques
- Micro Grids
- Use of storage
 - Dynamic response
 - Energy supply
- Demand Side Management
- De-carbonised power systems

Micro Grid Architecture



LV feeder with micro-sources





18th October 2004

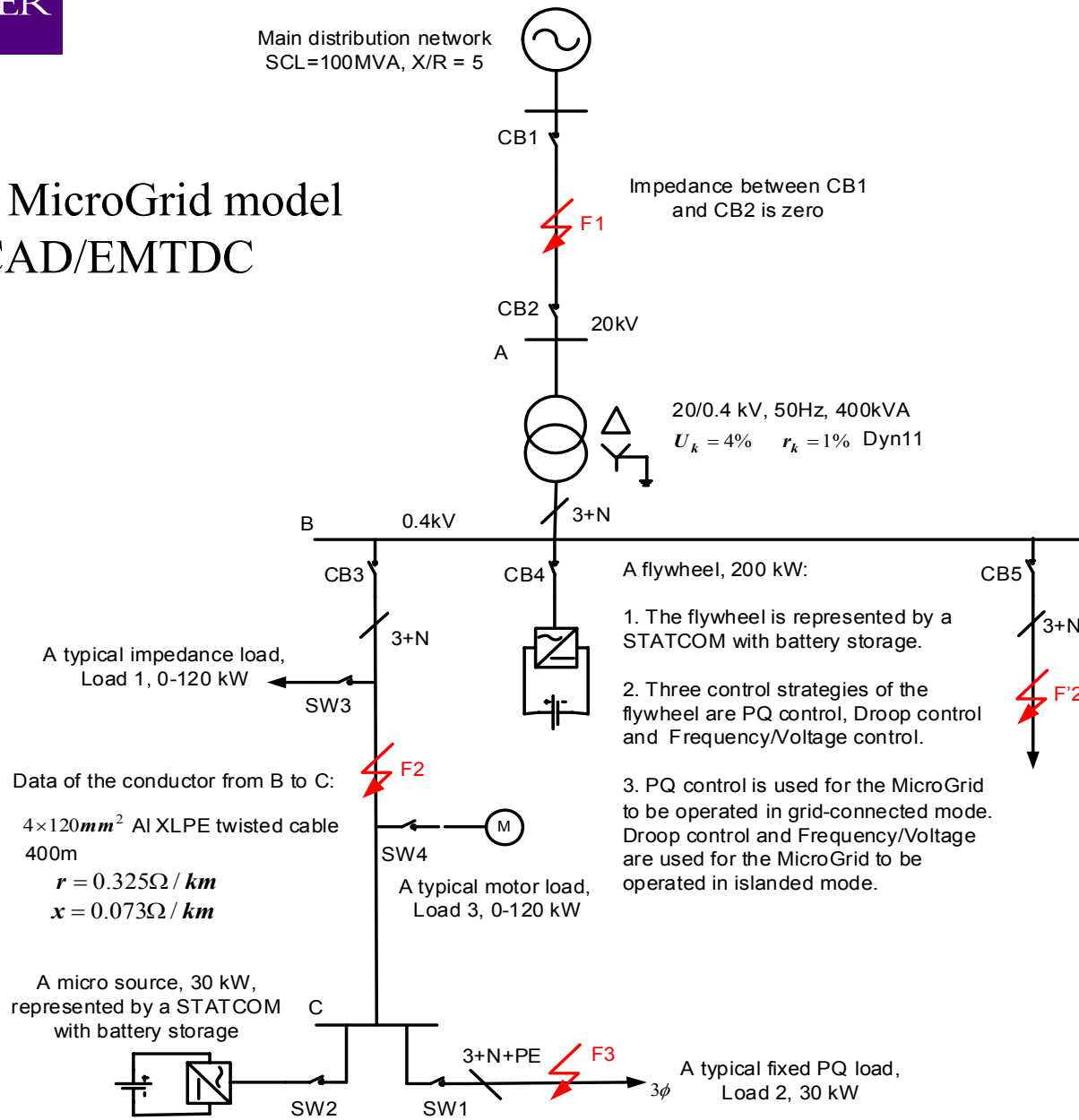
Ways forward for connecting renewable
and distributed generation

15

Permissible expenditure to enable islanding

Customer Sector:	Residential	Commercial
Annual benefit =	1.4 £/kW _{pk}	15 £/kW _{pk}
Net present value =	15 £/kW _{pk}	160 £/kW _{pk}
Peak demand =	2 kW	1000 kW
Perm. expenditure =	£30	£160,000
MicroGrid (2,000kW)	£30,000	£320,000

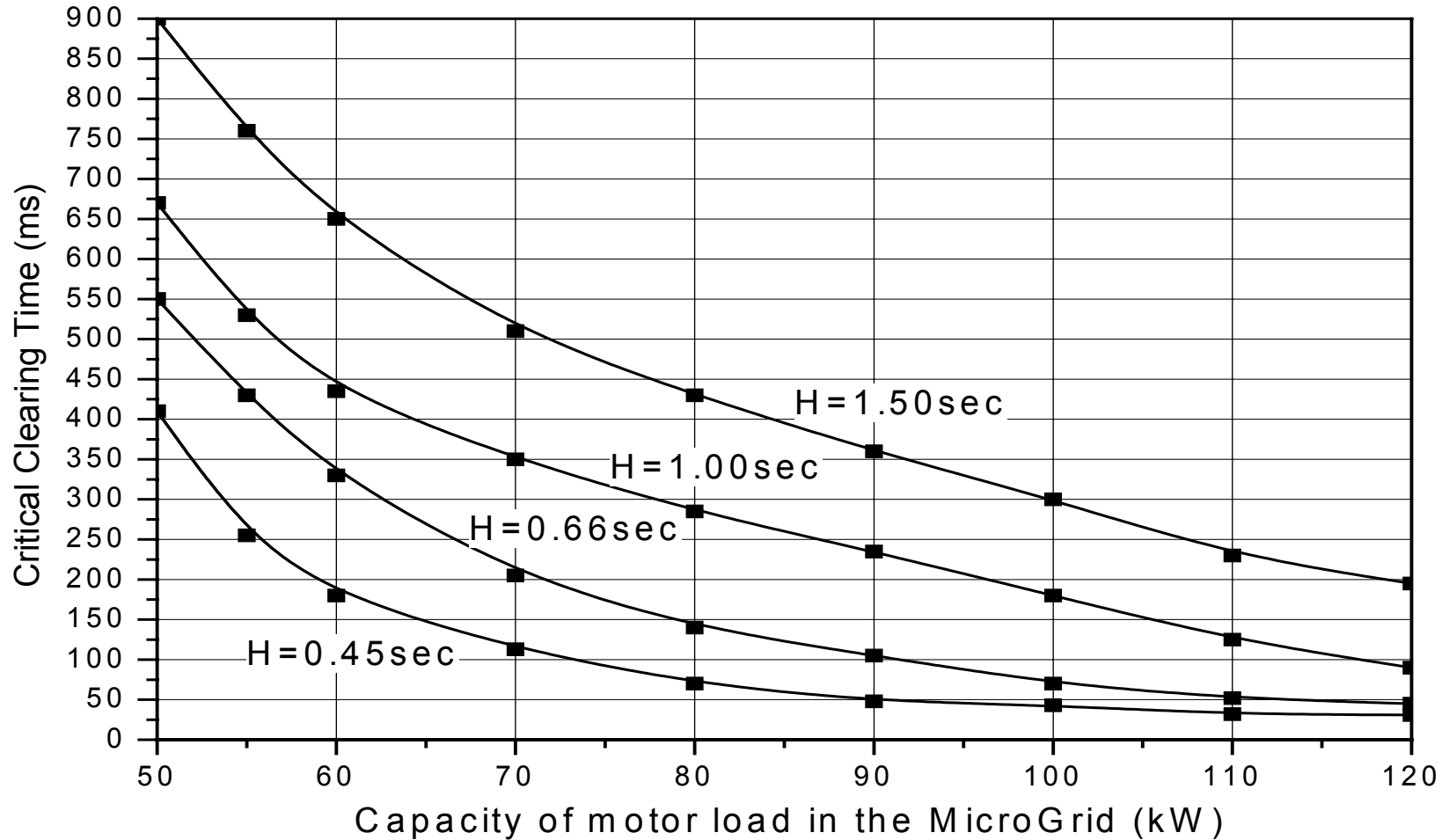
• A simple MicroGrid model in PSCAD/EMTDC



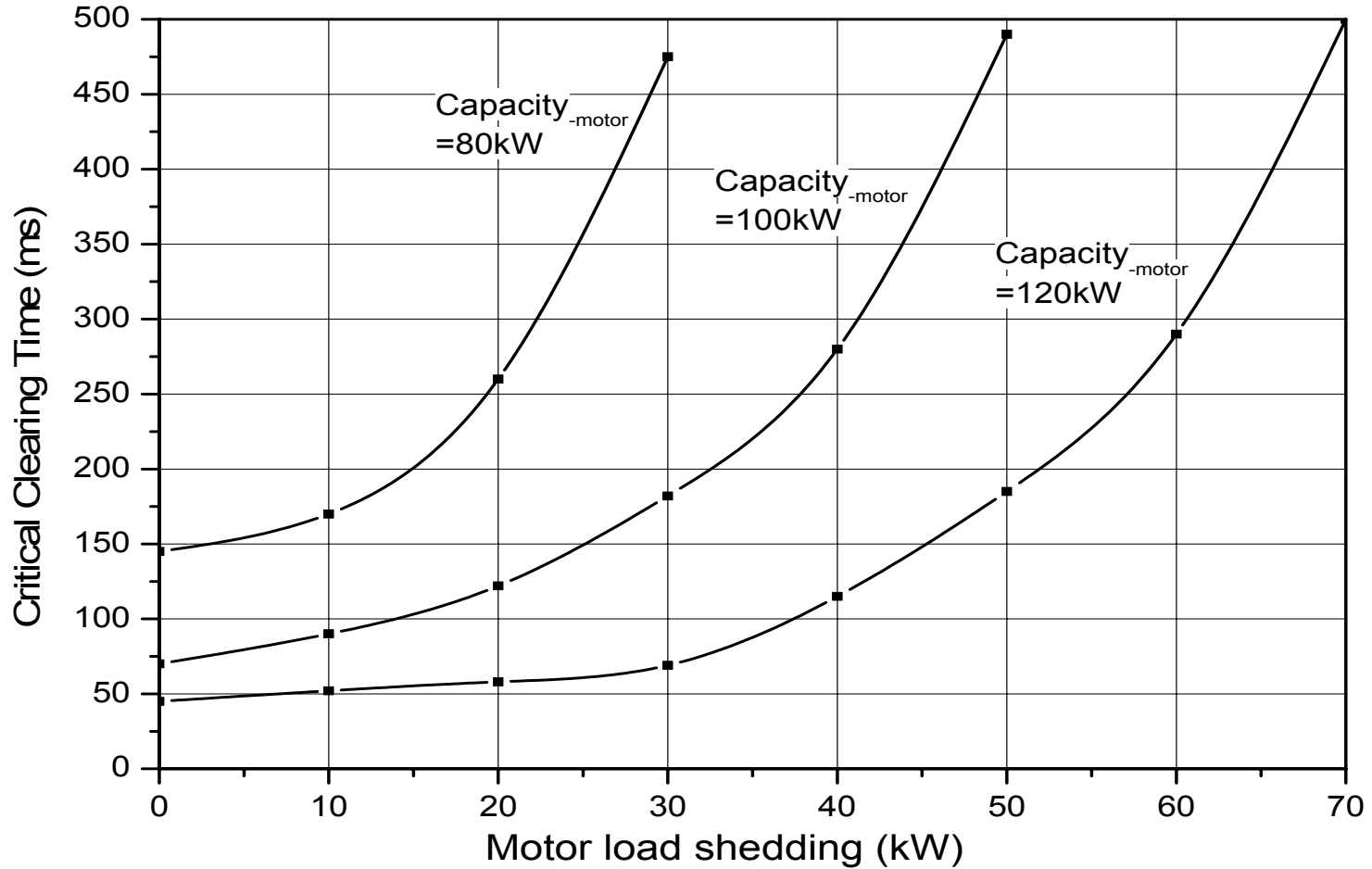
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The control scheme of the micro source is PQ control

Ways forward for connecting renewable and distributed generation

- Stability of the MicroGrid under different inertia constants of the motor



- Stability improvement of the MicroGrid using undervoltage load shedding method, $H_{\text{motor}} = 0.66$ sec.



UK Research Activity

- EPSRC
 - Responsive mode
 - Supergen 1, 3 & 5
 - UKERC
- DTI
 - New and Renewable Energy Programme
 - Centre of DG and Sustainable Electrical Energy
- Industrial R & D

CEU Projects

- ENIRDGnet
 - European network for connection of renewable and distributed generation
- DISPOWER
 - Network management
- SUSTELNET
 - Regulatory aspects
- CRISP
 - ICT network applications

CEU Projects

- MICROGRIDS
 - Investigation of Micro Grids
- EU-DEEP
 - Includes consideration of demand side issues
- IRED
 - Cluster project

Conclusions

- There is considerable R&D activity in the area.
 - A key output is trained people.
- The issues of “Connection” of individual generators are now well explored and are entering the commercial domain.
- The issues of “Integration” of significant penetrations of DG are only now starting to be addressed.

Conclusions

- The topical research domain includes future development of the power system:
 - Planning and Operating T & D networks for low carbon electrical systems
 - Is ICT going to make an impact on Distribution?
 - What is the role for Micro Generators and Micro Grids?
 - More general considerations of de-carbonised energy systems.