



# Adaptive Control of Active Distribution Networks

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**Thinking Networks**



# Contents



- Introduction to myself
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# Myself



- BEng electrical and MSc sustainable
- Areas of
  - Power
  - Renew
  - Distribu
- PhD student in Smart Flexible Controls work package





# Background



- Renewable energy targets and incentives are promoting development of distributed generation (DG)
  - most connection of DG at distribution level
- Distribution networks were historically passive networks
- Connection of DG affects operation of distribution networks
  - Voltage levels / reverse flows / fault levels / thermal limits
  - Implications for DNOs and Developers
- Smart control methodologies are one way to mitigate potential problems and raise penetration



# Background



- Voltage regulation in distribution network are generally performed by OLTCS
  - DG in power factor control
- **Lots** of research on active management
  - Ranging from classical approaches to AI
- Some recent examples:
  - AURA-NMS: Autonomous Regional Active Network Management System (Imperial et al)
  - Orkney Distribution Management System (SSE and Strathclyde)
  - Centre for Sustainable Electricity and Distributed Generation (SEDG) (Imperial, Strathclyde, Cardiff)



# Existing Work at Edinburgh University



- Intelligent decentralised DG voltage control
  - automatic voltage/power factor controller
- Strategies for OLTC tap setting
  - Agent-based simulations in PSSE and Python
- Comparison of decentralised and centralised voltage control for maximum DG penetration
  - embedded voltage control strategy within OPF



# PhD Project Aims



- Based on premise that (artificial) intelligence can handle uncertainties arising from limited information and variable topology
- Extend existing UoE intelligent DG control and agent-based coordination methods to network components
  - OLTCs, switches, dispatchable loads, etc.
- Develop discrete, adaptive control and coordination of switching and dispatch of DGs under a range of information scenarios
- Compare decentralised and centralised active control methods to quantify their benefits and risks



# Active Management Spectrum



*Decentralised*

*Centralised*

DG voltage  
control

OLTC/DG  
coordination

Distribution  
Management  
System

Local measurement  
No coordination  
Limited optimisation  
Local control

Wide measurement  
Full coordination  
Optimisation  
Extensive control

Comparison:  
Performance, economics, penetration

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# Outcomes



- Methodologies to embed control approaches and dispatch tools within network planning/operation models under a range of coordination scenarios
- Comparison, on an equitable basis, of decentralised and centralised active management in terms of:
  - Performance
  - Economics
  - DG penetration
- Effective coordination of the project within the SFC work package



# Work Plan



Tasks	2007		2008										
	Dec 1	January 2	February 3	March 4	April 5	May 6	June 7	July 8	Aug 9	Sep 10	Oct 11	Nov 12	Dec 13
<p><b>Task A:</b> Familiarisation with the task, literature survey and survey of current network planning and control approaches.</p>	Yellow bar												
<p><b>Task B:</b> Familiarisation and initial implementation of UoE's existing 'intelligent' decentralised DG control and coordination approaches.</p>	Green bar												
<p><b>Task C:</b> Extension of intelligent control to additional network components such as OLTC, dispatchable loads, switches, etc.</p> <p>Simulation of a range of information and coordination situations.</p>						Pink bar							
	2009												
	January 14	February 15	March 16	April 17	May 18	June 19	July 20	Aug 21	Sep 22	Oct 23	Nov 24	Dec 25	
	Pink bar												
<p><b>Task D:</b> Comparison of decentralised approach with centralised active management in terms of network performance, economics and DG penetration.</p> <p>Embedding of control algorithms within OPF-based network planning and dispatch tools.</p>						Cyan bar							
	2010												
	January 26	February 27	March 28	April 29	May 30	June 31	July 32	Aug 33	Sep 34	Oct 35	Nov 36	Dec	
	Cyan bar												
PhD write-up		Purple bar											

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