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Innovation in the UK Grid and related sectors

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Institute for Energy and Environment

University of Strathclyde Engineering

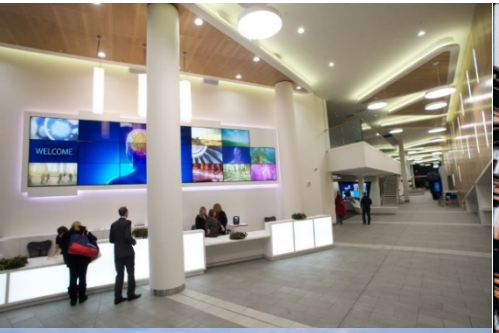
Institute Capacity

- 31 Academic Staff
- 75+ Research Staff
- 150+ Research Students
- 25 Tech/Admin Staff

INSTITUTE FOR ENERGY AND ENVIRONMENT

Institute Portfolio

- Research
  - EPSRC GoW: £21M+
  - Annual research spend £6M+
- Knowledge exchange
- Teaching & student support
- International engagement



AES

- Advanced Electrical Systems

HVT

- High Voltage Technology

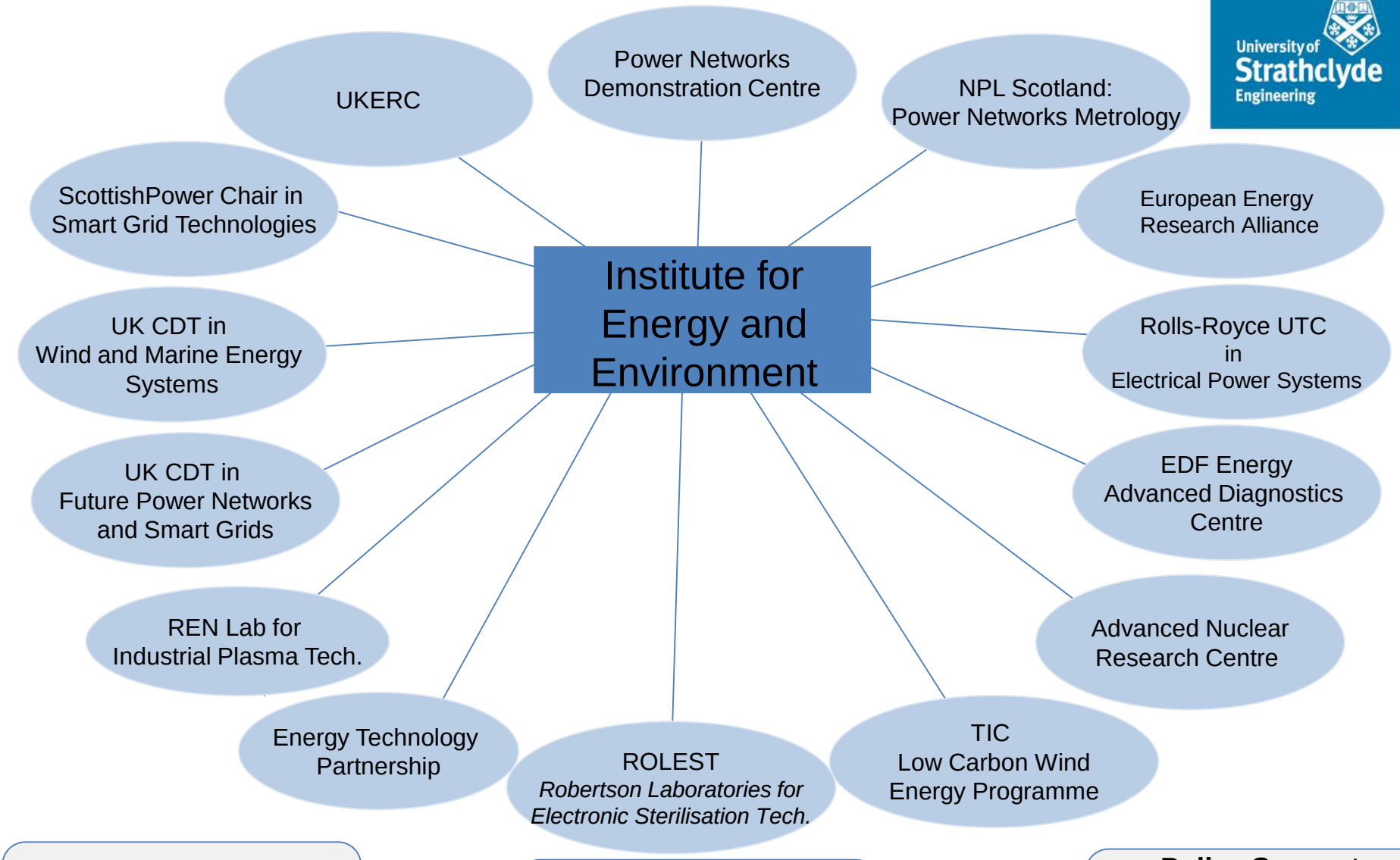
PEDEC

- Power Electronics, Drives and Energy Conversion

WEC

- Wind Energy and Control

InstEE – centres & key relationships



Developing Countries:
MREAP → SOGERV

International:
Europe, Asia, Americas

Policy Support:
Ofgem; Republic of Ireland; Scottish Government; UKERC

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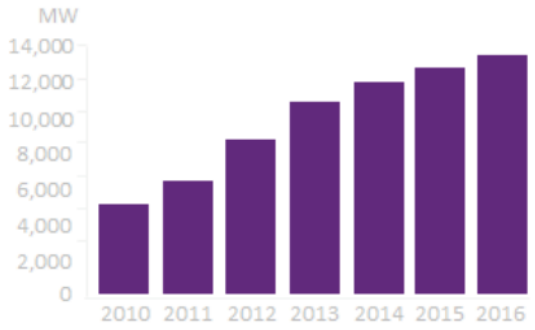
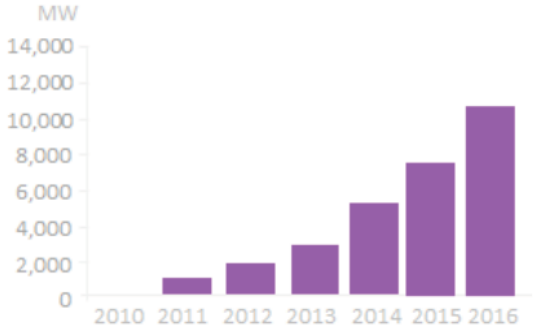
Changing GB Energy Landscape

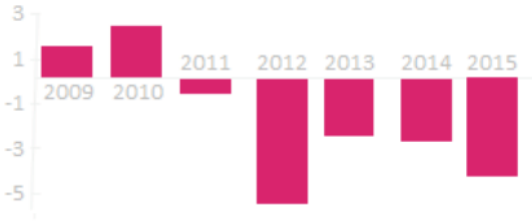
Wind
Installed Onshore & Offshore Capacity (MW)



Solar
Installed Capacity (MW)

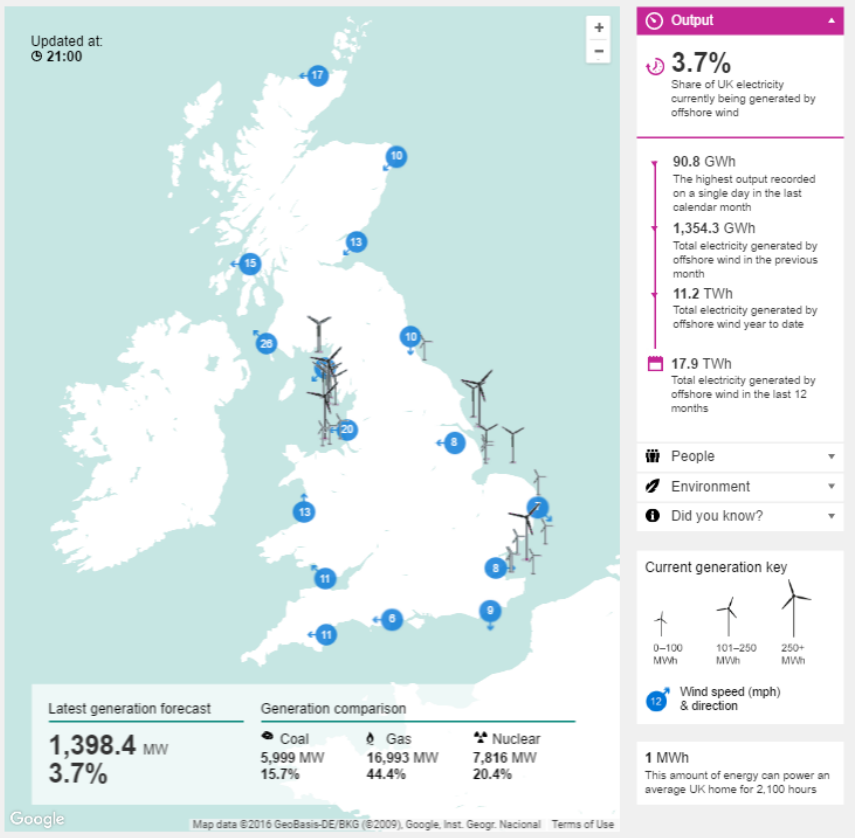


Thermal
Change in Generation Capacity (GW)



power responsive

nationalgrid



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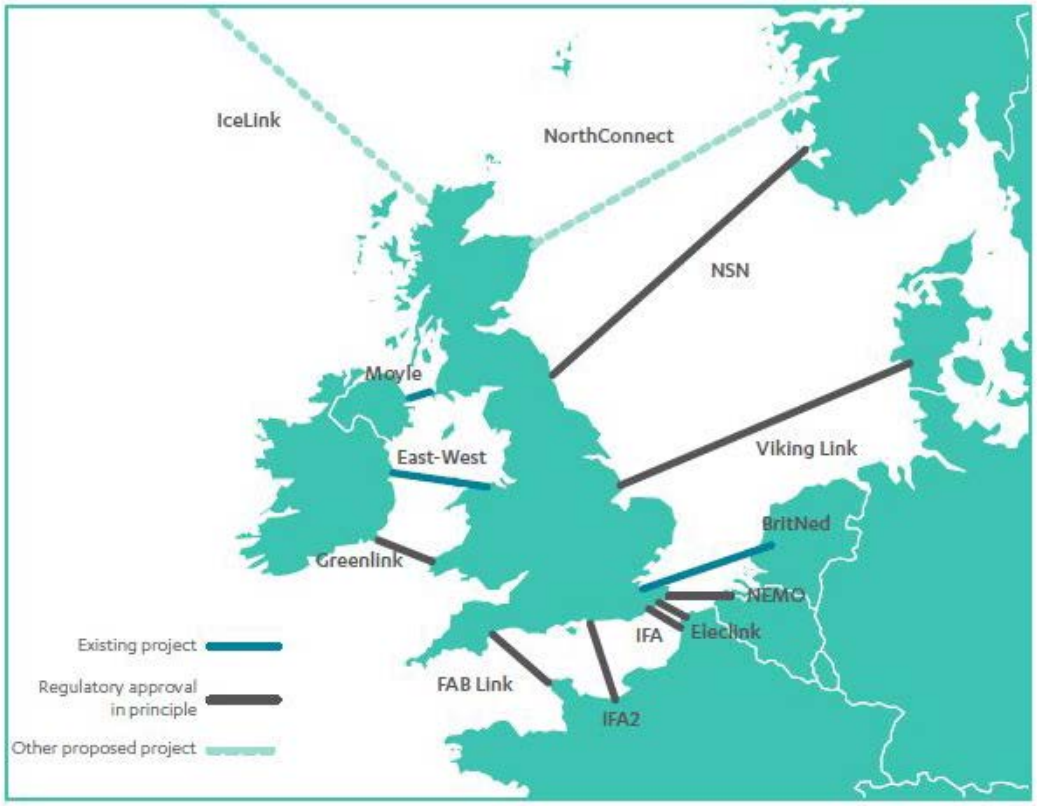
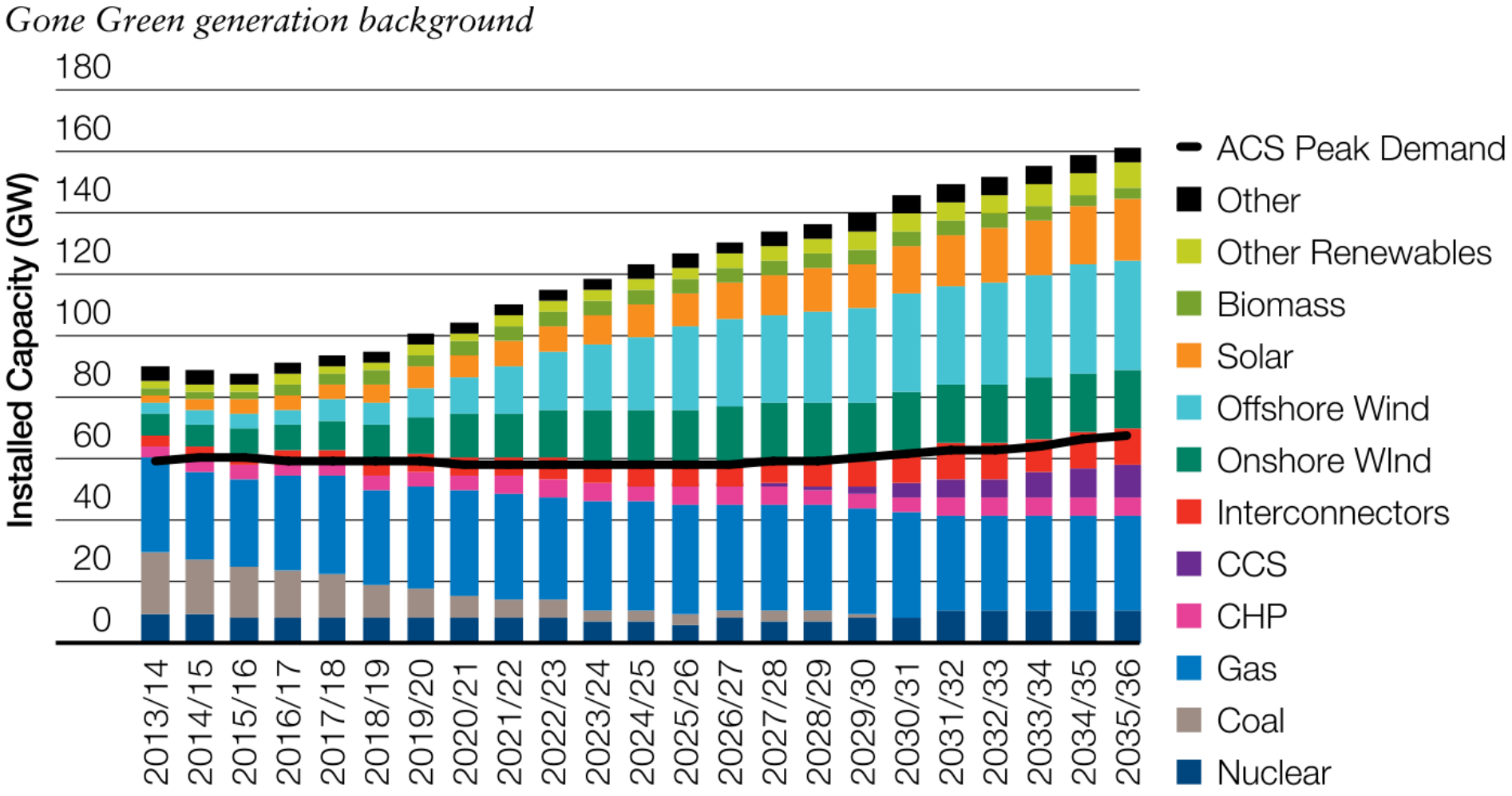


Future energy mix



http://www2.nationalgrid.com/WorkArea/DownloadAsset.aspx?id=34301

Future energy mix

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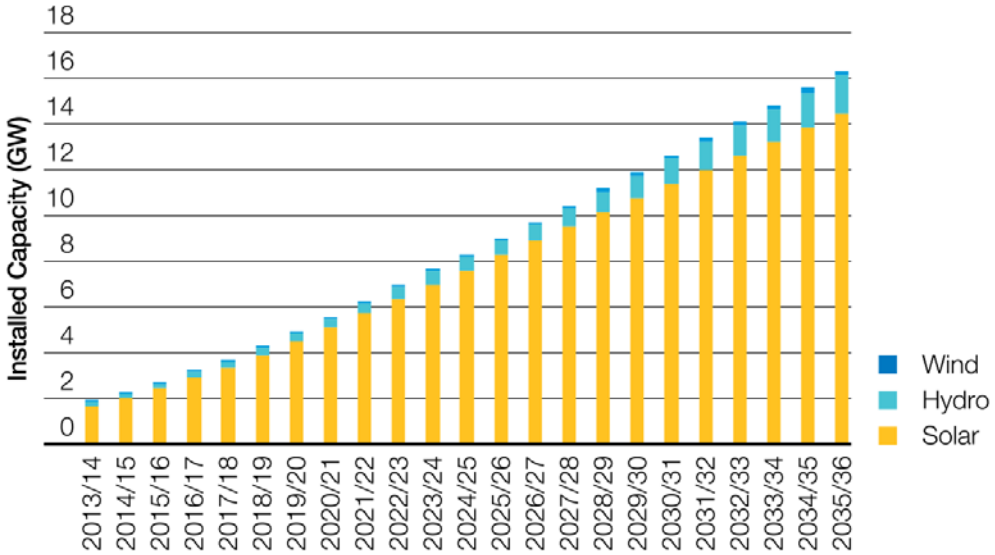
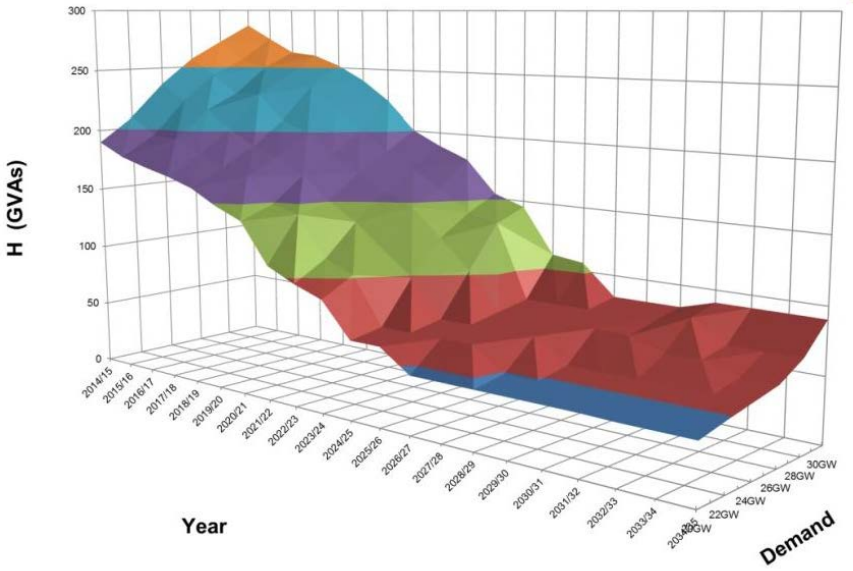
Gone Green	2013	2020	2035
Electricity			
Peak demand/GW	60.5	59.3	68.1
Annual demand/TWh	345	338	366
Total capacity/GW	91	106	163
Low carbon capacity/GW	28	50	109
Interconnector capacity/GW	4	6	11
Residential HPs/Millions	0.1	1.2	10
EVs number/Millions	0.01	0.6	5.4

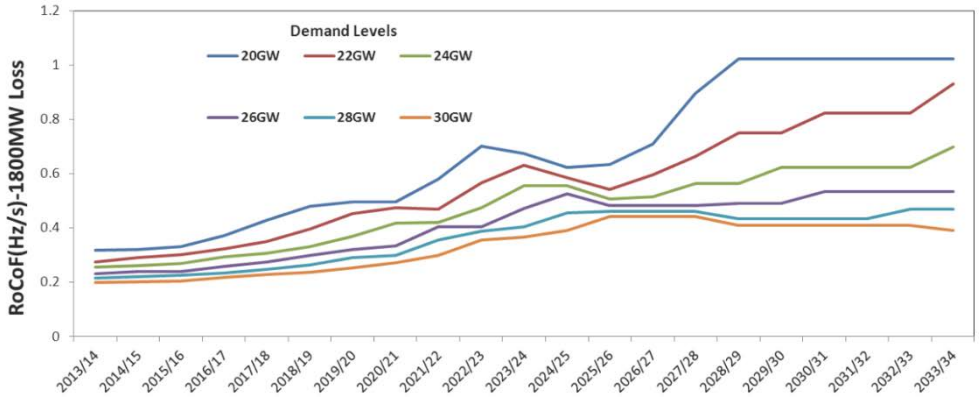
Future power system

Gone Green micro-generation installed capacity





Rate of Change of Frequency (RoCoF) for Gone Green following 1800MW infeed Loss



System Operability - Future

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Why do we need a System Operability Framework in GB?

nationalgrid

Islanded AC power system

Changes in the energy landscape

Generation	Demand side	Network
Increase in non-synchronous generation	Increase in Embedded non-synchronous generation	First Embedded HVDC Link (parallel to AC)
Closure of conventional plants	Change in Demand type (LED lights – Heat Pump)	Thyristor Controlled Series Compensation (TCSC)

http://www2.nationalgrid.com/UK/Industry-information/Future-of-Energy/System-Operability-Framework/

System Operability - Future

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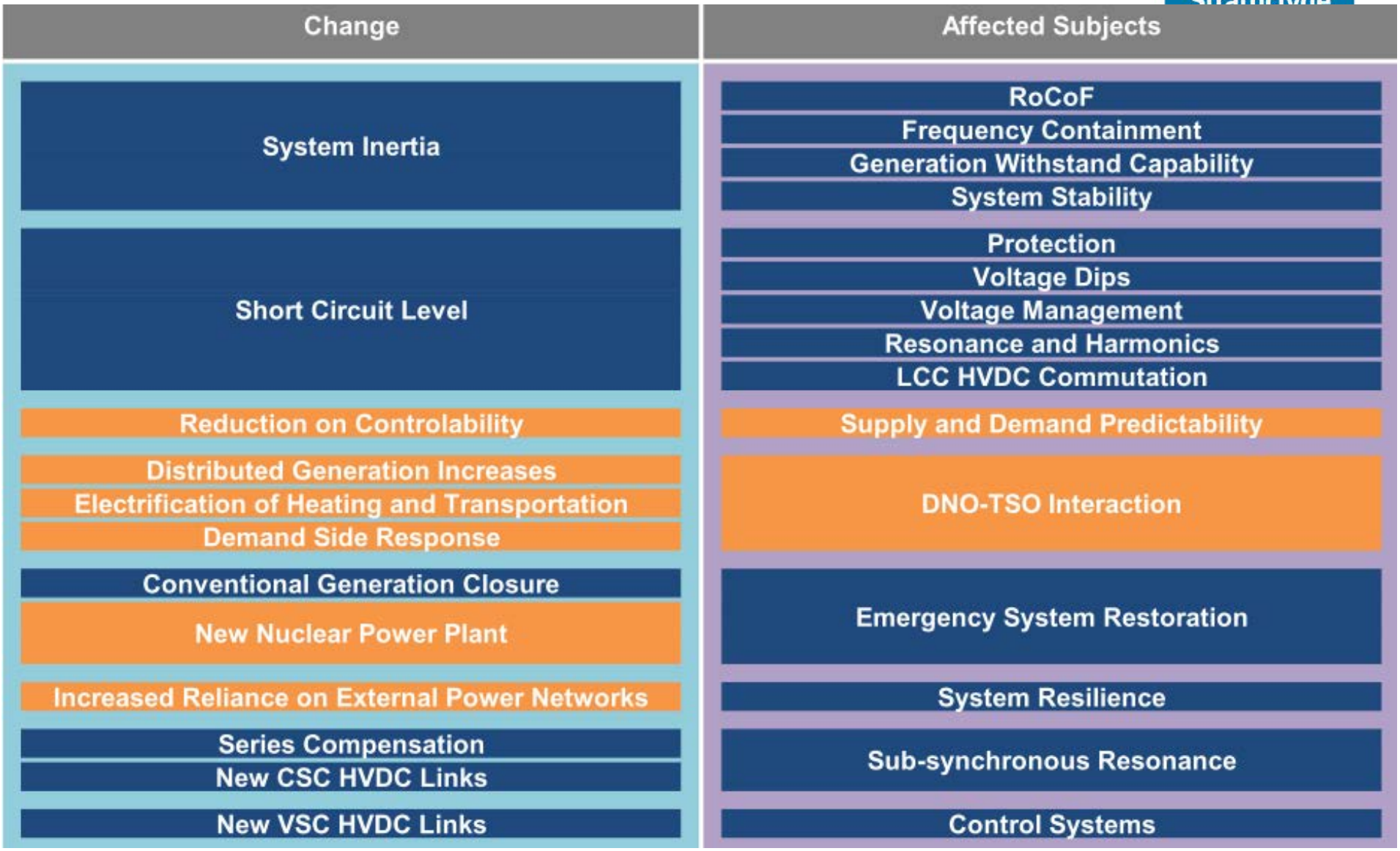
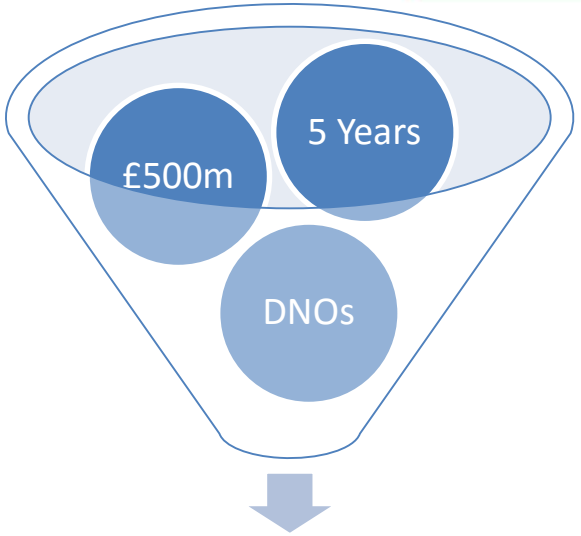


http://www2.nationalgrid.com/UK/Industry-information/Future-of-Energy/System-Operability-Framework/

The Low Carbon Networks Fund

Ofgem



Innovation

Electricity Networks should facilitate the take up of low carbon technologies

help DNOs understand how they provide security of supply at value for money and facilitate transition to the low carbon economy

Tier 1 (TRL 5-8)

- Small scale, allowance given to each DNO
- Total £80m allocation; use it or lose it

Tier 2 (TRL? “Not R&D”)

- £64m per year, competitively allocated
- Small number of ‘flagship’ projects
- £100m ‘successful delivery’ bonus pot

LCNI Low Carbon Networks & Innovation Conference

Outcomes from LCNF Projects

- ‘Active’ management of distributed generation and flexible industrial and commercial demand should both be viable ‘business as usual’ options.
- Strongly performing voltage control equipment could be used more often and can release network capacity more cheaply than historical ‘fit & forget’ solutions.
- Battery storage is not yet cost-effective; flexible domestic demand not yet effective in avoiding network reinforcement. Implementation & commercial innovation still required.

Strong Evidence Against		Indications Against		Inconclusive	Indications For		Strong Evidence For	
-4	-3	-2	-1	0	1	2	3	4

Outcomes from LCNF Projects

- DNOs reach mixed and sometimes contradictory conclusions on real-time thermal ratings of network branches and network reconfiguration for power flow management.
- More needs done on system level methodologies and business processes such as optimal operation, support for investment decision making, and commercial and regulatory frameworks.

Strong Evidence Against		Indications Against		Inconclusive	Indications For		Strong Evidence For	
-4	-3	-2	-1	0	1	2	3	4

http://www.hubnet.org.uk

Voltage Control

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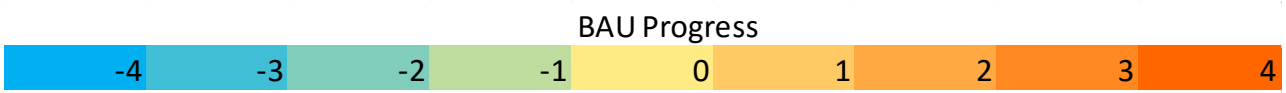
Primary Substations

- Voltage reduction effective for increasing headroom – has good BAU potential
- Enhanced AVC via relay upgrade, additional control capability and enabling remote configuration, allows improved autonomous control and is a key enabler for area coordinated voltage control

Secondary substation OLTC has been shown to release significant legroom – but CBA vs LV reinforcement is uncertain



Innovation	DNO
Voltage Reduction	ENW
	SPEN
Primacy AVC coordinated control	UKPN
	NPG
	WPD
Secondary substation OLTC	NPG
	ENW
FACTS	WPD
HV/LV Regulators	NPG
	SPEN
Switched Capacitors	NPG

Network Innovation Challenge

The NICs are designed to stimulate innovation by network operators. Network companies submit and deliver projects in partnership with the wider energy industry. Funding of up to £81M every year.

Transmission

- OSEAIT 2015
- EFCC 2014

- FITNESS 2015
- VISOR 2014

- NeSTS 2015
- MASC 2014
- MTTE 2013

- TC Ormonde OFTO 2014

Distribution

- Celsius

- Angle DC

National Innovation Allowance Distribution

The NIA is a smaller allowance each RIIO network licensee receives to fund smaller scale innovative projects which have the potential to deliver benefits to network customers.

27 Projects

10 Projects

2 Projects

8 Projects

4 Projects

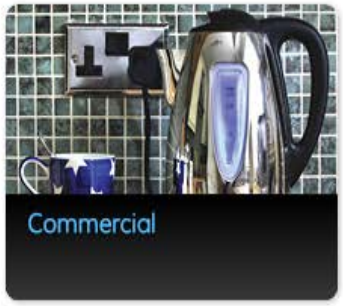
14 Projects

8 Projects

15 Projects

Images from http://www.smarternetworks.org/

National Innovation Allowance Transmission

13 Projects	41 Projects	28 Projects	5 Projects
			
			
1 Project	22 Projects	75 Projects	9 Projects

Images from http://www.smarternetworks.org/

ATI Technology Strategy & Portfolio Update 2016

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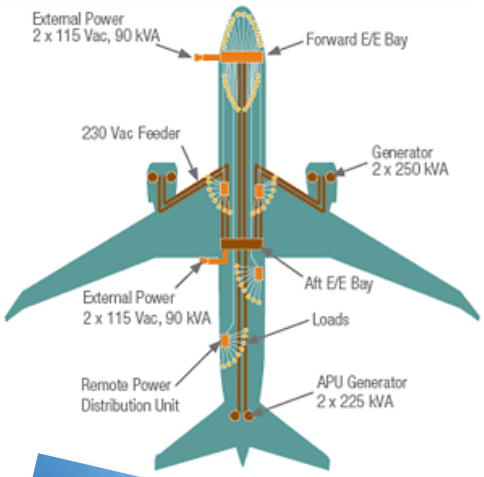
AIRCRAFT OF THE FUTURE

SMART, CONNECTED AND MORE ELECTRIC AIRCRAFT

- Enabling introduction of more electric systems
- Developing secure digital systems and communications
- Securing capabilities in fuel, landing gear and energy management systems

AEROSTRUCTURES OF THE FUTURE

PROPULSION OF THE FUTURE



Marine Power Systems

- Increasing popularity of all-electric designs
  - Fuel efficiency and emissions reduction
  - Flexibility and reliability
  - High capacity, low impedance
  - Novel architectures/loads

http://www.globalsecurity.org/military/systems/ship/images/tanker-lng-image101.jpg

http://www.naval-technology.com/projects/horizon/images/Type45_2.jpg

http://www.ship-technology.com/projects/queen_mary/images/image_1.jpg

Critical Infrastructure & Skills

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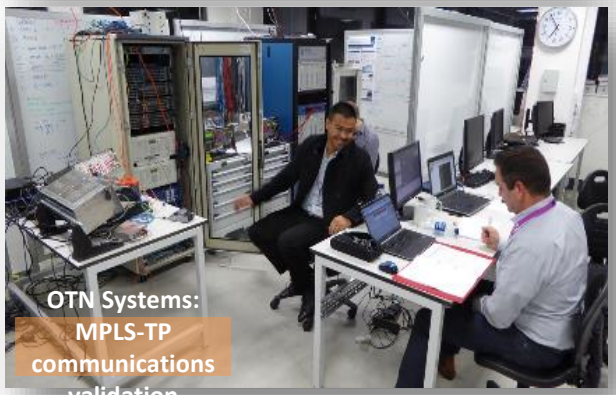
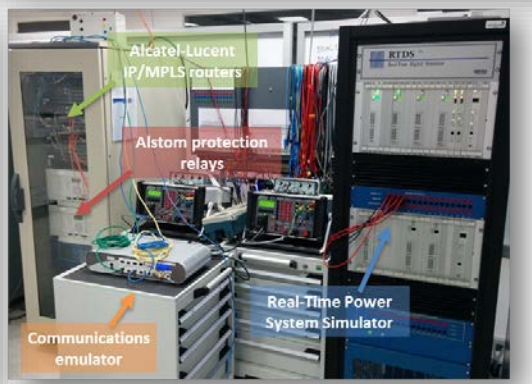
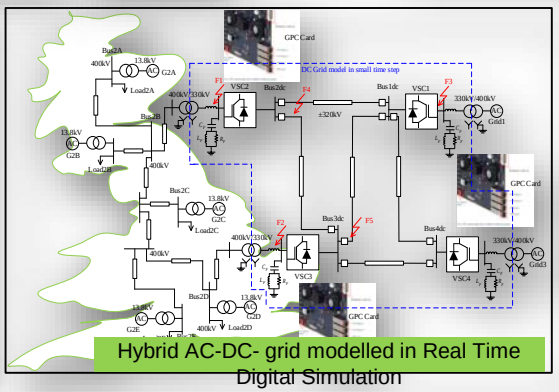
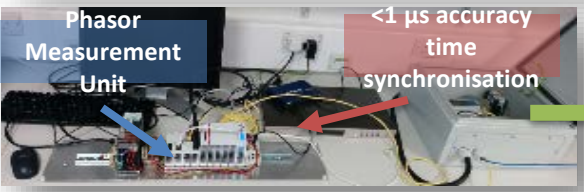
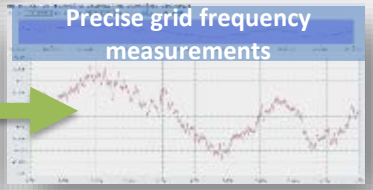


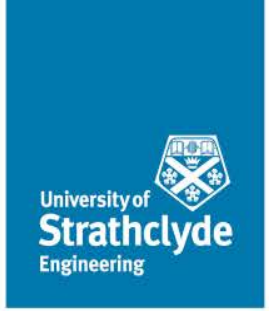








Technology testing…
>> systems testing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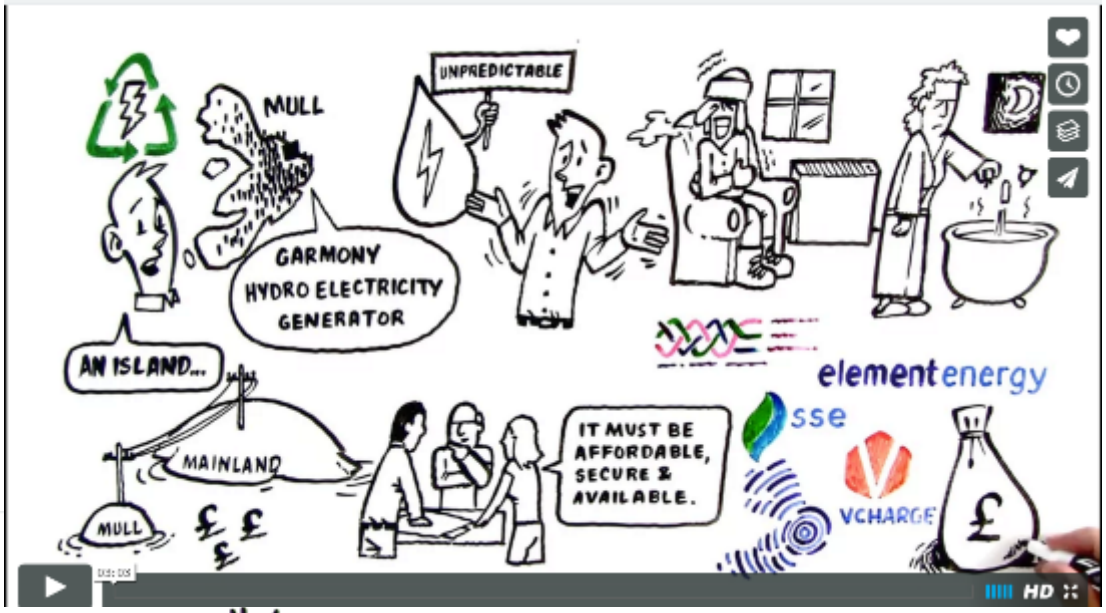
POWER NETWORKS
DEMONSTRATION CENTRE

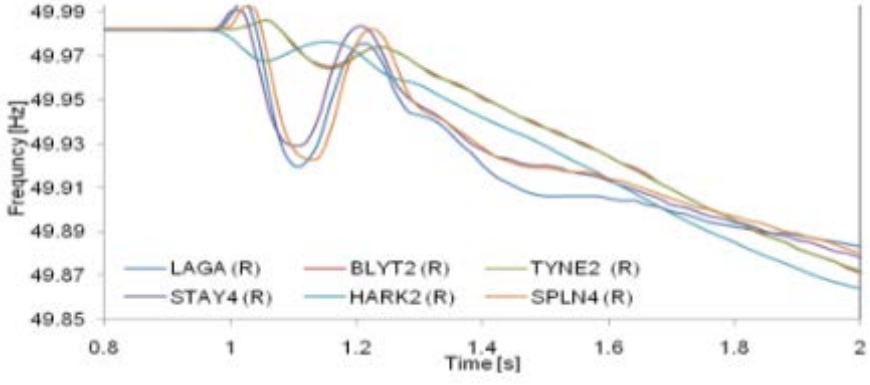
Example: supporting community renewables

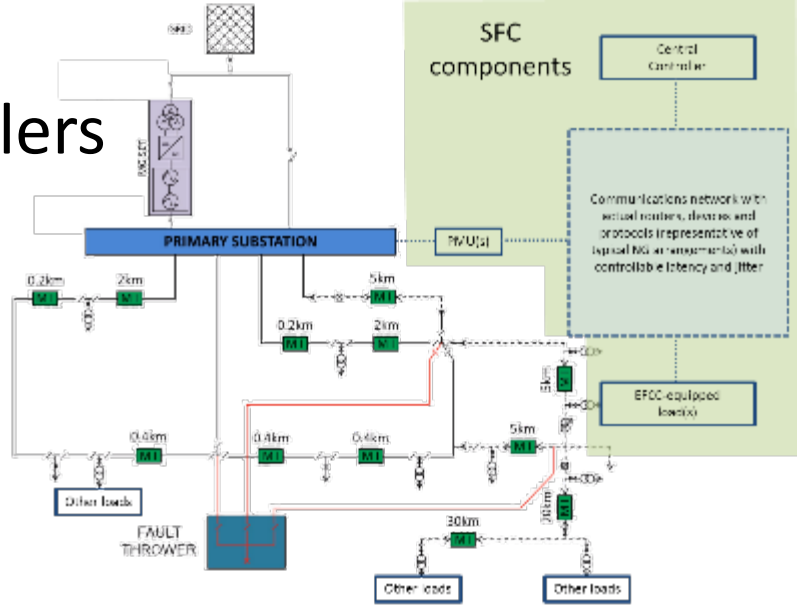
- Systems testing and proving prior to deployment
  - Communications
  - Interfaces
  - Storage technologies
  - …



Example: Smart Frequency Control Project

- £9m+ project led by National Grid
- Investigation of fast regional RoCoF-triggered response using PMUs– loads, storage, generation
- Save £100M's in future
- PMUs and distributed controllers
- Testing at PNDC





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POWER NETWORKS DEMONSTRATION CENTRE

nationalgrid
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centrica
BELECTRIC
MANCHESTER 1824
The University of Manchester
flexitricity
University of Strathclyde Glasgow