

# Flexible Plug and Play

Enabling Faster & Cheaper Renewable Generation Connections

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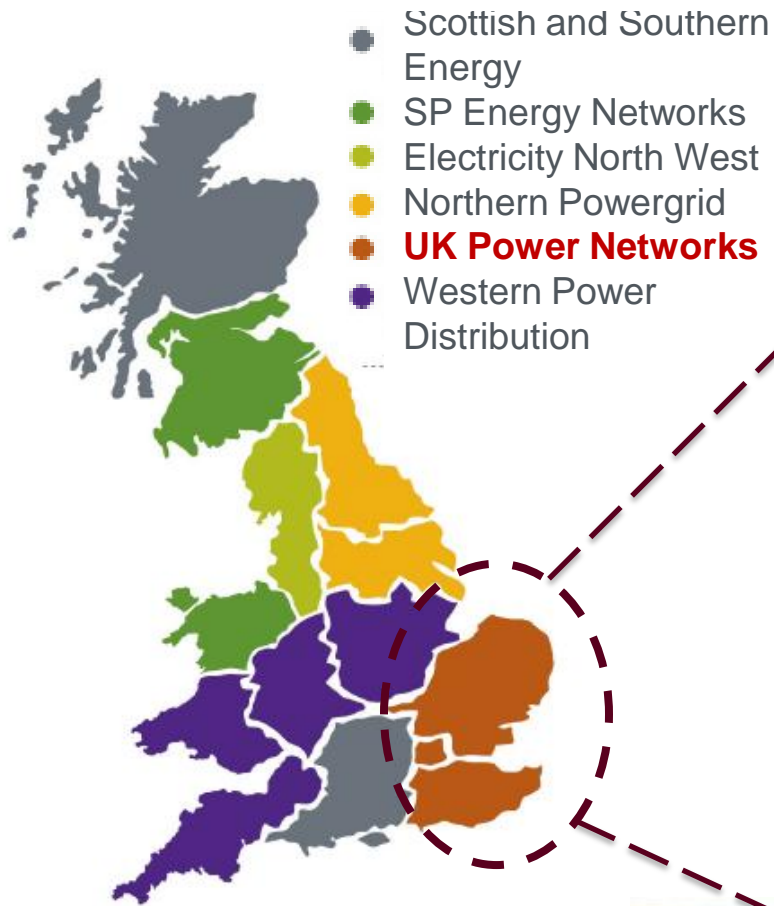
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THE YEAR**



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# UK Power Networks



	Total	% of industry
End customers (millions)	8	28 %
Service area (km <sup>2</sup> )	29,165	12 %
Underground network (km)	134,767	29 %
Overhead network (km)	47,391	15 %
Energy distributed (TWh)	89.4	28 %
New connections	130,768	35 %

# Flexible Plug and Play



**Objective:** Cheaper and faster connection of DG to constrained parts of the network by trialing smart grid technologies and smart commercial agreements

**Duration:** 3 years: January 2012 - December 2014

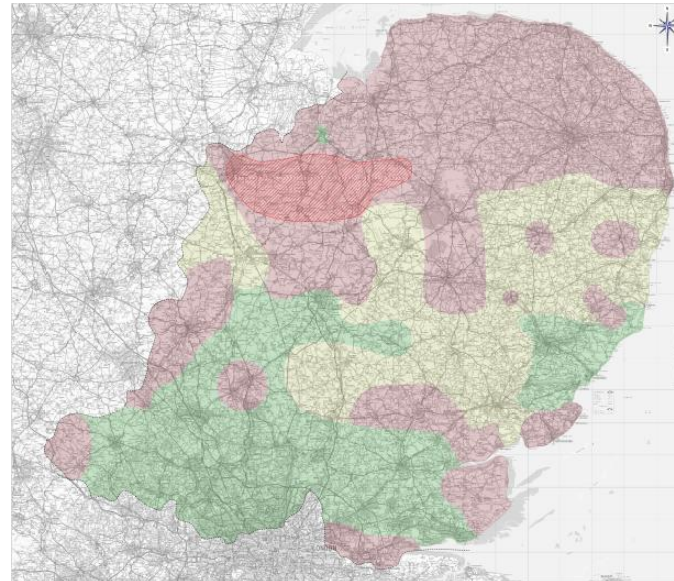
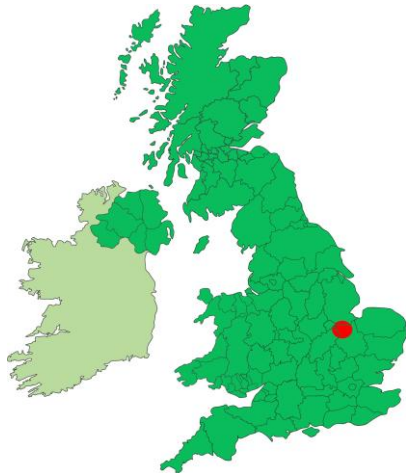
**Project Value:** £9.7 million (6.7m funding from LCNF Tier 2)

**Partners:**





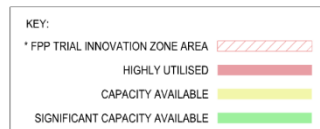
# Flexible Plug and Play: Trial location



## Constraints

(focus on 33 and 11kV)

- Reverse power flow limitations
- Thermal line limits



**Location:** Cambridgeshire

**Surface:** ~ 700km<sup>2</sup>

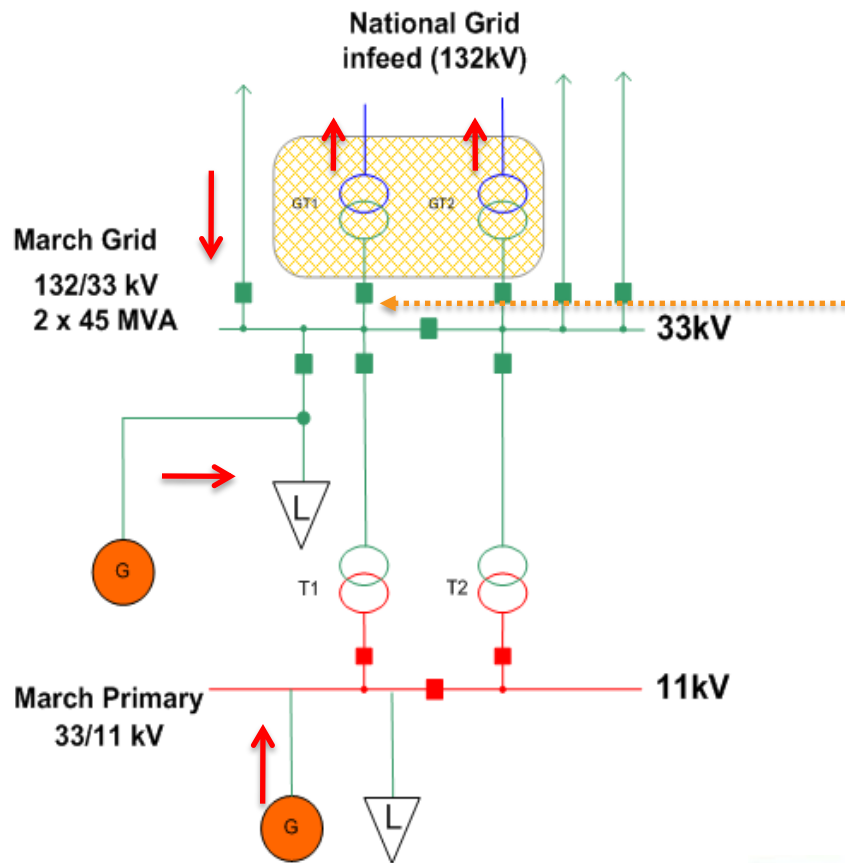
**Network:** 33kV and 11kV Network (2 Grid, 10 Primary substation sites)

**Connected Wind Generation:** 120MW

**Planning & Delivery Stage:** approx 270MW

# Case Study 1: March Grid

## The challenge



### Constraints

Reverse power flow limitation (N-1)  
Occur at min Load max Gen situations

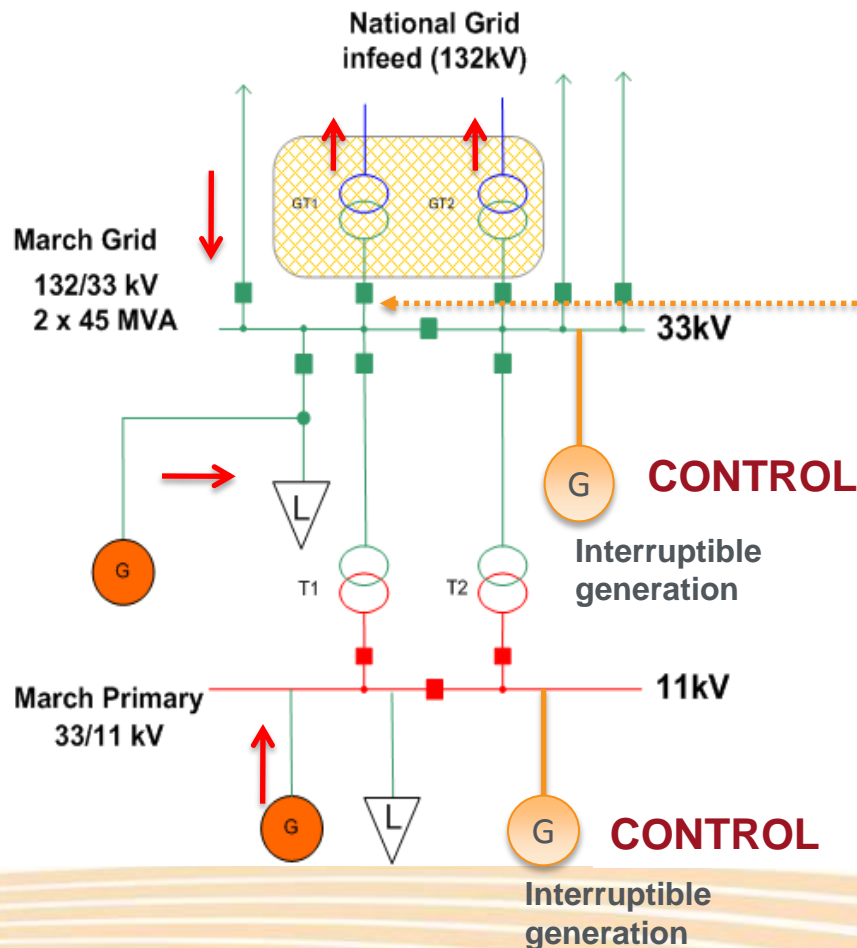
### Consequences

- Substation considered full
- Very expensive quotes for connections to projects in the vicinity (Distance or increased voltage level)



# Case Study 1: March Grid

## The solutions



### Constraints **MEASURE**

Reverse power flow limitation (N-1)

### Solutions:

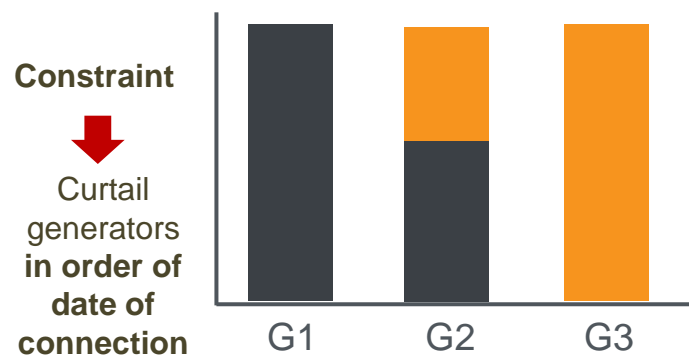
- ✓ Novel protection scheme
- ✓ **Active Network Management**
- ✓ IP Communications
- ✓ Suitable **commercial & contractual framework**



# Principles of Access

- Mechanism for allocating curtailment between generators.

## □ LAST IN FIRST OUT



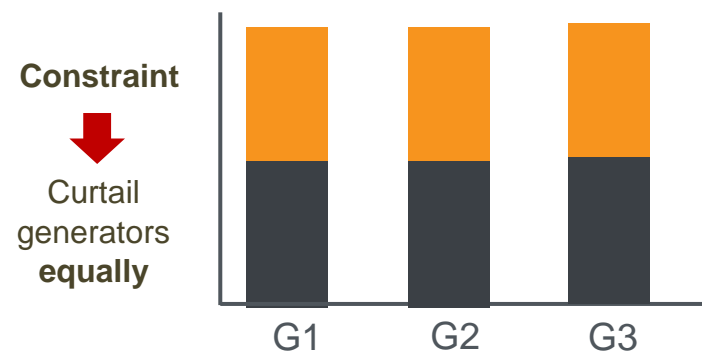
Connected

1st

2nd

3rd

## □ PRO – RATA



Connected

1st

2nd

3rd



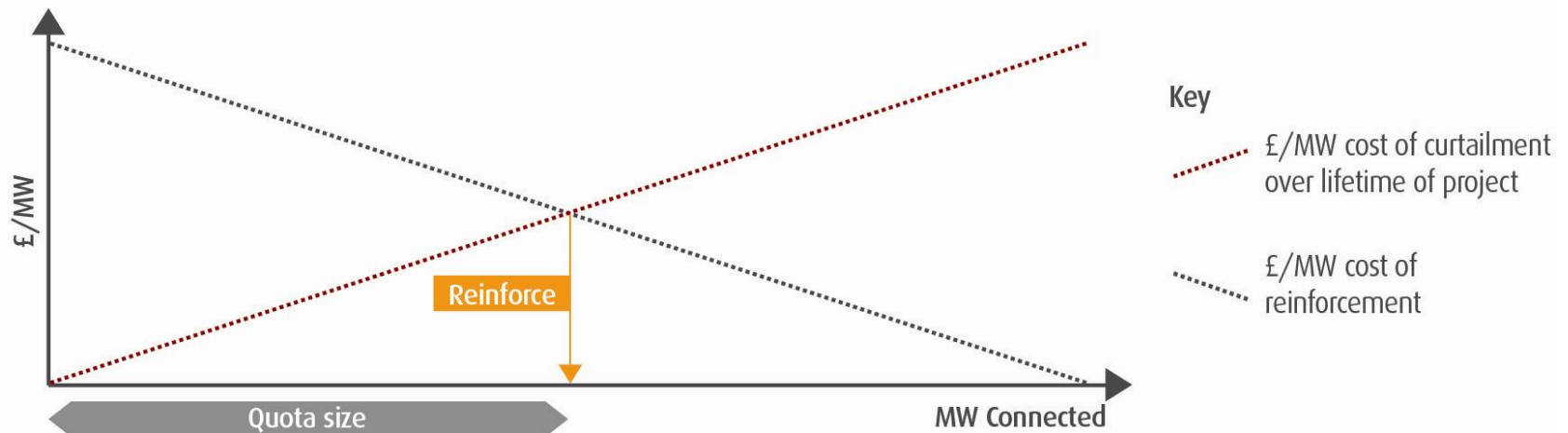
# Commercial Packages



- Time Vintaging
- Capacity Auction
- Capacity Quota:
  - Based on defining a specific level of curtailment
  - Based on comparing the cost of curtailment to the cost of reinforcement

# Capacity Quota

- Curtailment levels (MWh/yr) will increase as more capacity connects, increasing generators' lost revenues
- We plan to set the quota at the level where the **cost of curtailment is equal or exceeds the cost of reinforcement**



# Framework for a Capacity Quota Rules to connect under FPP



1. Grandfathering existing customers
2. FPP customers connect to ANM
3. Principles of Access: Pro-rata curtailment to ANM generators
4. Capacity Quota: UK Power Networks will limit the total capacity of generation connected within the constrained area to a pre-agreed cap
5. Managing the Quota
6. LIFO after Quota

# Customer recruitment

- ✓ Customers **seeking connection** in the trial area
- ✓ Be proactive through **stakeholder engagement**
- ✓ Recruiting within the **existing connections process**
- ✓ Demonstrating a clear business case and **benefits to customers**

Wind Farm	33 kV	11 kV	Business as Usual offer*	Point of Connection	FPP offer
A		0.5	£1.9 m	11kV feeder - 10.5km	£ 235 k
B		2.5	£1.9 m	11kV feeder - 12.75km	£157 k
C		1	£2.0 m	11kV feeder - 9.5km	£ 385 k
D	10		£4.8 m	132/33kV site	£ 590 k
E		5	£1.2 m	132/33kV site	£ 650 k

\*based on traditional reinforcement

# Connection agreement template



First connection arrangement to include the following concepts:

- ✓ **Curtailment:** the action of limiting generation output
- ✓ **Constraint:** defines the specific location in the network that will have to be subject to curtailment
- ✓ **Maximum Interruptible Capacity:** declares MW connected under interruptible conditions by Active Network Management
- ✓ **Capacity Limit:** MW of installed capacity that will connect and get curtailed as a quota



# Conclusions and Next Steps



- ✓ Each project represents **more than 80% savings** in connection cost
- ✓ **33.5MW quota** behind March Grid constraint
- ✓ **30MW** currently **in the pipeline**
- ✓ Estimated **5.3% curtailment** (reduction in annual output)
- ✓ Make interruptible connections a **Business as Usual** alternative
- ✓ Work with our customers to understand **financing challenges**
- ✓ Understand optimal **cost allocation**



Thank you



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**LCN Fund**  
Low Carbon Networks

