Delivering zero carbon electricity

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Is the future electric?
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Significantly *(but not entirely)*
Is the Grid ready to invest?
Is the Grid ready to invest?

YES

*(but that’s not the right question)*
2050: where will our energy come from?

~50% from electricity at ~15g CO₂(e) / kWh
- Wind, nuclear & CCS dominant at ~25GW – 30GW each
- ~20GW other renewables
- ~15GW interconnection
- ~20GW embedded generation

~35% from gas at ~185g CO₂(e) / kWh
- LNG & continental imports
- Bio-methane

~15% from oil at ~245g CO₂(e) / kWh

Generation capacity mix

~115GW

- Gas CCGT
- Coal
- CCS
- Nuclear
- Wind
- Renewable
- Interconnector
- CHP
- Other
2020: where will our energy come from?

~20% energy from electricity at ~200g CO₂(e) / kWh
- Wind, gas dominant at ~30GW each
- ~11GW nuclear
- Some unabated coal
- ~10GW interconnection
- ~14GW embedded generation

~40% from gas at ~185g CO₂(e) / kWh
- LNG & continental imports increase
- UKCS & Norwegian gas decline

~40% from oil at ~245g CO₂(e) / kWh

~110GW

Generation capacity mix:
- Gas CCGT
- Coal
- CCS
- Nuclear
- Wind
- Renewable
- Interconnector
- CHP
- Other
Key policy debate: the balance between gas and electricity

Electricity demand
~1,000 GWh / day
(avg. November day)

Gas demand
~4,000 GWh / day
(avg. November day)

Energy use is ‘peaky’…

Full electrification of heat: what you have to believe…

~150 GW of heat electrified =

- Nuclear? ~45 sites at 3.3GW / site
- Renewables? ~30,000 wind turbines at 5MW / turbine
- CCS? ~75 sites at 2GW / site
- Solar PV? ~40m homes at 17m² / home
- Inter-connectors? ~150 BritNed’s at 1GW each

…even after significant energy efficiency
The transmission delivery challenge

Heat pumps in 2020
~1,200,000 in homes ~1–4GW peak demand
- Properties insulated for efficiency
- ‘Hot-spots’ of demand will emerge
- Evening peak impact mid-decade
- Time of use tariffs & smart metering enable peak management by 2020

Electric vehicles in 2020
~1,700,000 on the road ~1–5GW peak demand
- 13A plug-in home charge dominant
- ‘Hot-spots’ of demand will emerge
- Evening peak impact mid-decade
- Time of use tariffs & smart metering enable peak management by 2020

* Electric vehicle and heat pump at mid-range peak demand.
The transmission delivery challenge

- existing electricity network
- interconnectors
- potential wind farm sites
- potential nuclear sites

Map showing networks in France, Netherlands, Belgium, Norway, and Ireland.
The distribution delivery challenge

Peak electricity demand in the home increases significantly

- ~2.5kW peak appliance demand for an average house in 2010
- ~3kW charge for an electric car
- ~3.5kW demand for a heat pump
- ~9kW potential total demand

Distribution networks will need to double their capacity

<table>
<thead>
<tr>
<th></th>
<th>2010</th>
<th>2030</th>
<th>2050</th>
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</thead>
<tbody>
<tr>
<td>Household demand*</td>
<td>~2.5kW</td>
<td>~4.7kW</td>
<td>~7kW</td>
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<tr>
<td>Embedded generation</td>
<td>~8GW</td>
<td>~15GW</td>
<td>~20GW</td>
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<tr>
<td>Network loading (kW/km)</td>
<td>~75</td>
<td>~170</td>
<td>~300</td>
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<tr>
<td>Network scale</td>
<td>X2.3</td>
<td>X4.0</td>
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* After diversity average peak demand

Network scale vs 2010 levels
The real question is...
The real question is...

What do our customers want from grids?
RIIO: stakeholder engagement and value for money…

Revenue  =  Incentives  +  Innovation  +  Outputs

Our plan to 2020/21: £16.8bn totex*

Safety
(managing risks, preventing injuries)

Environment
(facilitating connection of low-carbon energy)

Customer connections
(meeting our obligations)

Customer satisfaction
(improving our service)

Reliability
(maintaining our current standards)

We will:
- Expand and renew the transmission network
- Find and develop enough people with the right skill sets
- Innovate the way we work and deliver outputs
- Upgrade critical IT systems
- Secure planning permission to deliver the required major infrastructure projects
- Manage commodity volatility
- Support the development of the regulatory and legal framework

* Capex + opex between 2013/14 and 2020/21, in 2009/10 prices