DEPARTMENT OF ENERGY & CLIMATE CHANGE

Balancing electricity supply and demand

Smart Grids and Clean Power conference, Cambridge
www.cir-strategy.com/events

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DECC priorities

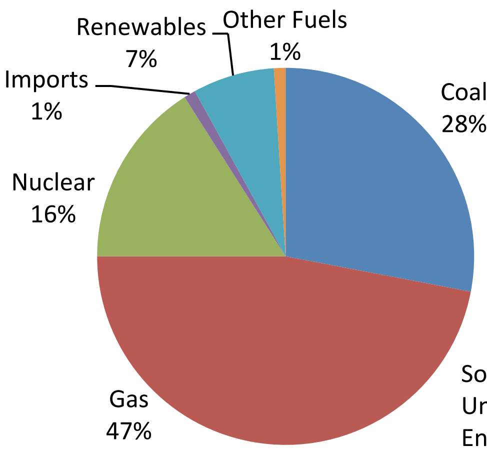
DECC has 4 key priorities, including:

"Deliver secure energy on the way to a low carbon future

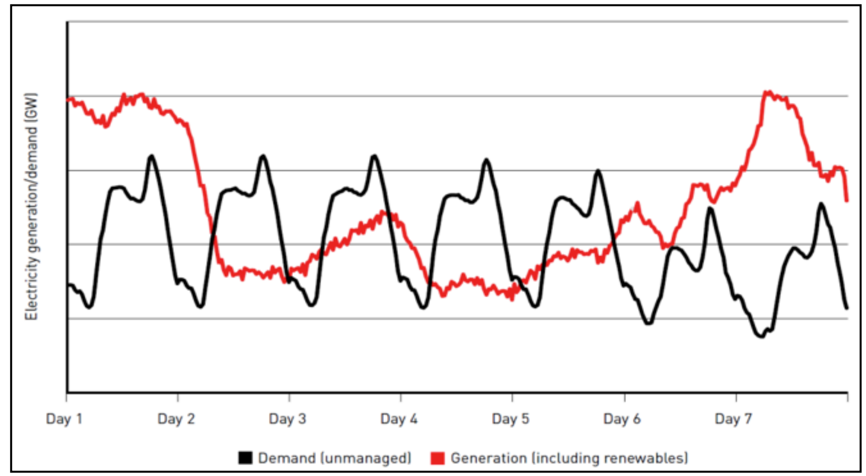
- Reform the energy market to ensure that the UK has a diverse, safe, secure, affordable energy system and incentivises low carbon innovation and deployment"

DECC's objectives will lead to changes in future generation and demand

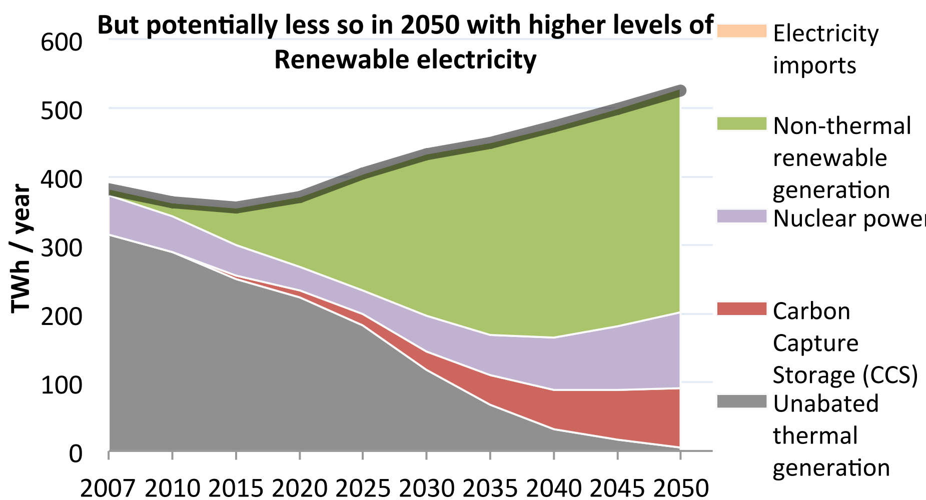
The UK generation mix in 2010 is primarily flexible



Source: Digest of United Kingdom Energy Statistics 2011



Source: based on the DECC pathway Alpha, 2050s Pathway Analysis 2010



Source: Higher renewables; more energy efficiency 2050 pathway, The Carbon Plan: Delivering our low carbon Future, 2011

Shorter term vs longer term issues

Pre – 2020 – focus on networks (being delivered)

- Timely network connection of new generation build
- Sufficient network capacity to deliver generation to demand
- Efficient coordination of network investment, especially offshore
- Development of smarter distribution network technology and approaches

Longer term issues

- Secure balancing of supply and demand
- Efficient use of generation and network assets
- Market framework to allow the development of a more integrated system
- Continuation of delivery against pre-2020 network challenges, in particular development of smarter distribution networks

Longer term issues broken down

Capacity of future system	Will the future projected generation mixes facilitate secure balancing of supply and demand and at what cost?
New demand loads	What will be the impact of new electricity loads such as electric vehicles and heat pumps, where will they be located and when will they come online?
Flexing core generation	What flexibility will we be able to derive from our future core generation fleet?
Opportunities for flexible technologies	How can these new challenges be addressed through non-generation flexible solutions such as DSR (utilising smart meters), storage and interconnection?
Roles in the system	How will the operators and mechanisms in the system change to manage the increased complexity?
New & smarter networks	What new network challenges are likely in the future (transmission and distribution) and how will the network need to respond?

Implications for the electricity system in summary

Up to 2020 - confident system is capable of meeting the challenges of a changing electricity market.

Challenge is beyond 2020:

- different types of generation in different places…

-… as well as increased demand and different load patterns

- This will pose significant challenges to networks and the balancing of the system

- Also the uncertainty in the system makes it difficult to prepare

- We need to take a whole system approach to mitigate the risks involved

Key Question for Government:
What action, if any, should Government take to ensure the electricity system can facilitate future low carbon generation and increasing electricity demand in the most secure and affordable way, with the most efficient use of assets?

Possible tools and technologies

Interconnection	Do we want more interconnection with other countries and if so how much and when?

Increased Interconnection

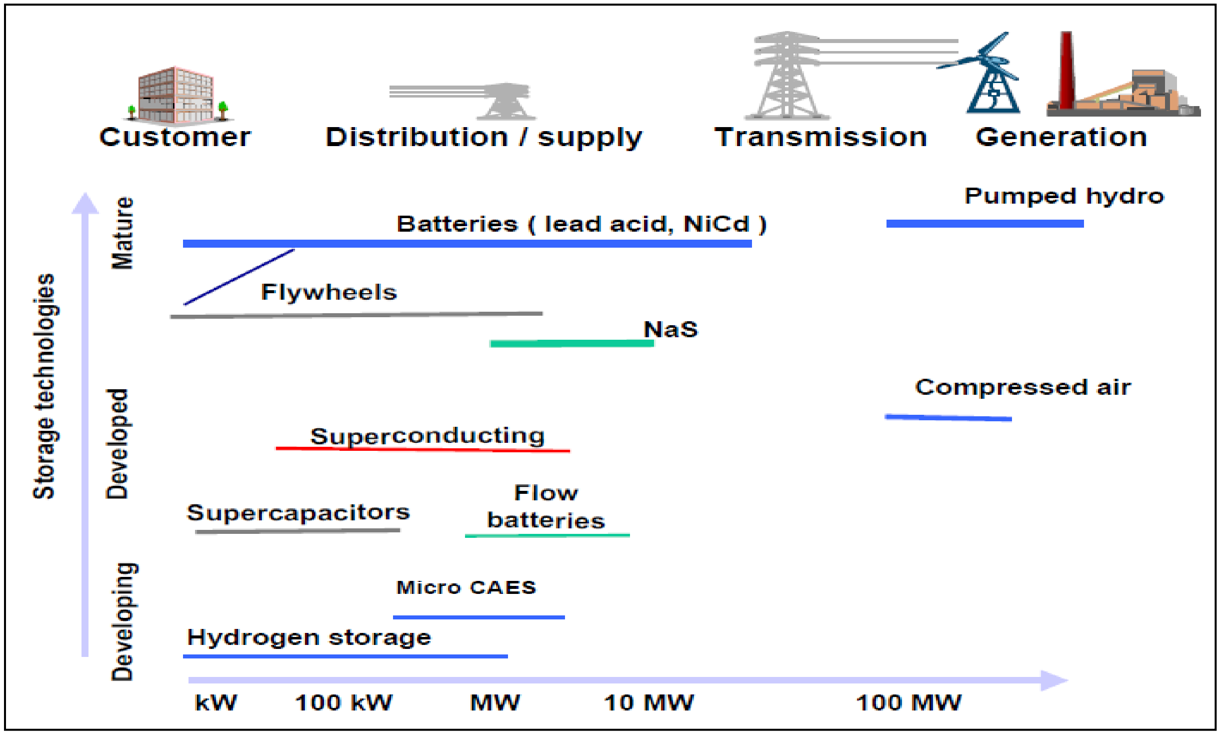
Illustration of potential for more EU interconnection

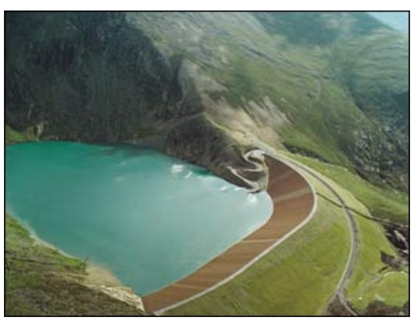
- GB currently has 3.7 GW of interconnection to France the Netherlands and Ireland.
- By 2020 approximately 6GW of interconnection is planned.
- Currently interconnectors are built and operated on a commercial basis.
- New GB interconnectors have to be approved by the European Commission, often with conditions.
- Ofgem is proposing a regulated approach (with minimum and maximum revenue limits) which should reduce some of the risk to investment (revenues depend on future differences in electricity prices between countries) and encourage more to come forward.
- There are questions over the extent to which interconnection could help balance the system when the wind isn't blowing here – conditions may be similar elsewhere in Europe.

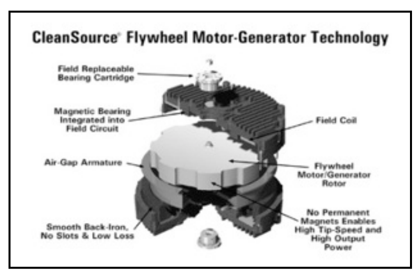
Possible tools and technologies

Interconnection	Do we want more interconnection with other countries and if so how much and when?
Electricity Storage	Do we need storage to help manage the intermittent generation?

Investment in new storage







- Storage can provide a low-carbon alternative to peaking plant as well as help manage various network issues.
- There is currently just under 3 GW of large-scale storage in GB, all of which is pumped hydro and run on a commercial basis.
- Dinorwig power station provides over 60% of storage capacity.
- Dinorwig can deliver 1.8 GW for up to 6hrs at 75 seconds notice.
- It would cost billions to build today.

Possible tools and technologies

Interconnection	Do we want more interconnection with other countries and if so how much and when?
Electricity Storage	Do we need storage to help manage the intermittent generation?
Demand Side Response	What is the role of DSR in ensuring a future smart system

Demand-side response

- Demand-side response is currently very small (about 0.5 GW) and mostly call-off contracts with industrial users.
- In the future, electric vehicles and heat would potentially provide greater opportunity for demand-side response.
- This is potentially the most cost-effective and carbon efficient way to balance the system, but may require strong price signals and/or an element of compulsion to get full benefit.
- A study in the US suggests that participation of demand-side response in a New England auction could have saved customers up to $280m by lowering the price paid to all capacity resources in the market.
- We estimate considerable savings in GB in 2050 from using DSR to shift demand to meet peak wind generation (by maximising use of wind, reduces wholesale price).

Possible tools and technologie

Interconnection	Do we want more interconnection with other countries and if so how much and when?
Electricity Storage	Do we need storage to help manage the intermittent generation?
Demand Side Response	What is the role of DSR in ensuring a future smart system
Thermal peaking plant	What role will thermal peaking plant play in balancing supply and demand in future?

Key challenge is developing analytical base

Analysis commissioned to :

1. Quantify the balancing impacts from increasing inflexible generation and changing customer demand profiles (electrification of heat and transport)

2. Estimate the costs and benefits of possible balancing solutions (storage, DSR, interconnection and flexible generation) and their characteristics, network costs and trade-offs, ideally including where the costs and benefits fall

3. Estimate network upgrades costs and possible savings from different balancing mixes

4. Consider the most cost-effective balancing mix under different demand and supply scenarios based on 2050 pathways and the 4th Carbon Budget

5. Possibly identify 'no regret's' policy actions

Analytical framework

- Based on **snapshots** of 2050, 2040, 2030 and 2020
- Makes an assessment of **the "balancing challenge"**, then considers **system benefits** for different technologies
- Based on the DECC 2050 Carbon Budget 2050 pathways, the analysis looks at **four future potential pathways in 2040 and 2050**, and a **2020 and 2030 central scenario**:

Pathway A: High renewables	Pathway B: High Nuclear	Pathway C: High CCS	Pathway D: Markal - varied Generation Mix	2020 and 2030 Central Scenario
A world where generation is **intermittent**. **Demand is high** due to high electrification of heat and transport combines with high energy efficiency	A world where generation is **relatively inflexible**. **Demand is very high** due to medium electrification of heat and transport but only modest energy efficiency	A world where generation has **similar flexibility to today**. **Demand is moderate** due to low electrification of heat and transport and moderate energy efficiency	A world where generation is **relatively inflexible & intermittent**. **Demand is lower** due to lower electrification of heat and transport and ambitious energy efficiency	A varied generation mix with an initiation increase in electrification of heat and transport. **A sensitivity is considered by modelling Pathway A in 2020 and 2030.**

- The model assumed the **UK is energy neutral and self-secure**
- The model optimises at the **European system Level** and assumes **perfect market conditions**
- Includes a **3-day wind lull in an extreme winter** (a 1 in 10 winter)
- Carbon emissions were capped in the modelling so **all results meet the Government's carbon targets**

The analysis came to a number of high level conclusions

- There is value of non-generation balancing technologies in all pathways
- 'Value' of the balancing technologies means a reduction in overall system costs
- The value of balancing options increases significantly beyond 2030, but is more marginal before 2030
- The generation mix and increase in demand (and variation in demand) are crucial for the value of balancing technologies.
- A number of key sensitivities impact on the results:
    - Level of electrification of heat and transport
    - Amount of DSR (flexibility) in Europe
    - The European generation mix
    - Relaxation of the self security assumption
- DSR and Storage tend to compete for similar markets although the challenges of the implementation of each technology are very different
- IC is particularly sensitive to the self-security assumption and DSR in Europe.
- Gas plant is still used as peaking plant in all pathways (most with high renewables, high electrification pathway, and least when CCS is able to provide flexibility)

Emerging conclusions on Demand Side Response

Key conclusions of the analysis for Demand Side Response are:

- DSR creates value for the system in all pathways, but mainly after 2030
- However, DSR is modelled at zero cost; the input in the model is the percentage of the maximum technical potential DSR that may be available
- The benefits are more equally split across system operation savings, generation capex savings and distribution capex savings (which, like storage, are dependent on other smart grid solutions)
- There is an interaction with the value of interconnection: if DSR (or other flexible solutions) is used at scale in Europe then the value of DSR in GB is lower as there is less value from exporting balancing facilities
- The main issue for DSR is the take-up of tariffs. Nevertheless, even with low (10%) penetration there are considerable benefits for the system across all Pathways, suggesting that DSR should be pursued whatever the scenario

Will publish findings in summer paper

Future Challenges	An assessment of future challenges facing the electricity system
System Impacts of potential future scenarios	Challenges to the future system in balancing supply and demand, when they are likely to arise, their scale, whether there might be more cost effective ways of meeting them
Current and Future GB Market Framework	An assessment of how the planned changes to the electricity market will change the signals to invest in and operate generation flexibly
Network Infrastructure	An assessment of the current and future GB network Infrastructure requirements and steps being taken to ensure they are met
Balancing Tools and Technologies	Different generation and non-generation technologies that might provide flexibility in future – setting out their potential, current support and barriers – including storage, DSR, interconnection and flexible generation
Conclusions & next steps	High level conclusions about the future challenges and the potential role for Government

Conclusions

- Changing generation and demand profiles will impact on the effective functioning of the electricity system
- Implications likely to become more significant towards end of 2020s
- A number of tools and technologies will be required to ensure the cost effective and efficient balancing of the system, including DSR
- Smart meters are integral to achieving the full potential of DSR
- Government will publish high level conclusions on consideration of system balancing issues in the Electricity Systems paper