Green innovation and regulatory institutions: The case of smart electricity grids in Great Britain

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Green Innovation: Making it Work

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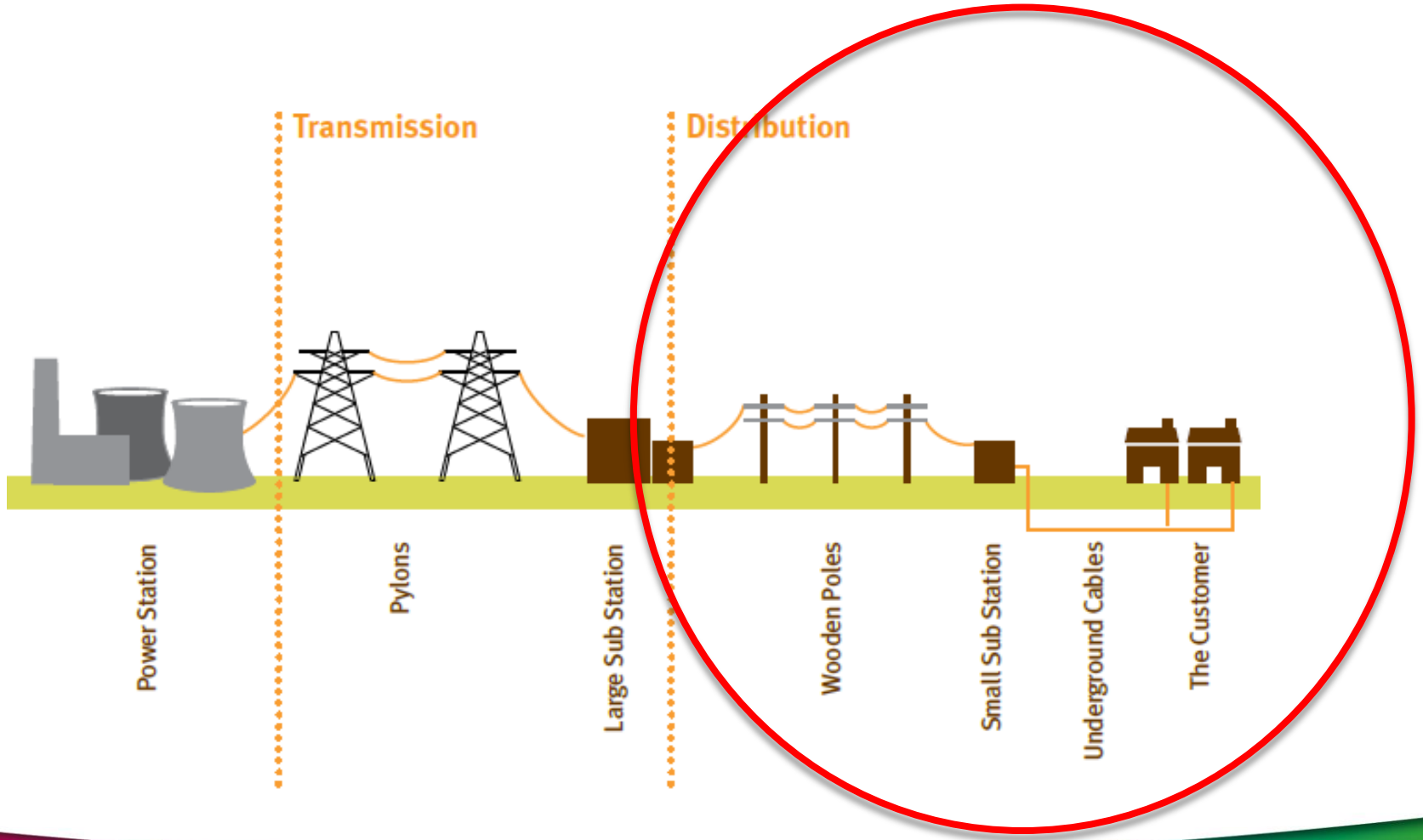
Outline

1. Smart grids as a green innovation goal
2. The central role of regulation and its failure to drive innovation
3. Two responses in British case
   - Opening up a space for RD&D
   - Amending the regulatory framework
4. From demonstration to diffusion?
5. Concluding observations

1. Smart grids as a green innovation goal

Electricity distribution networks

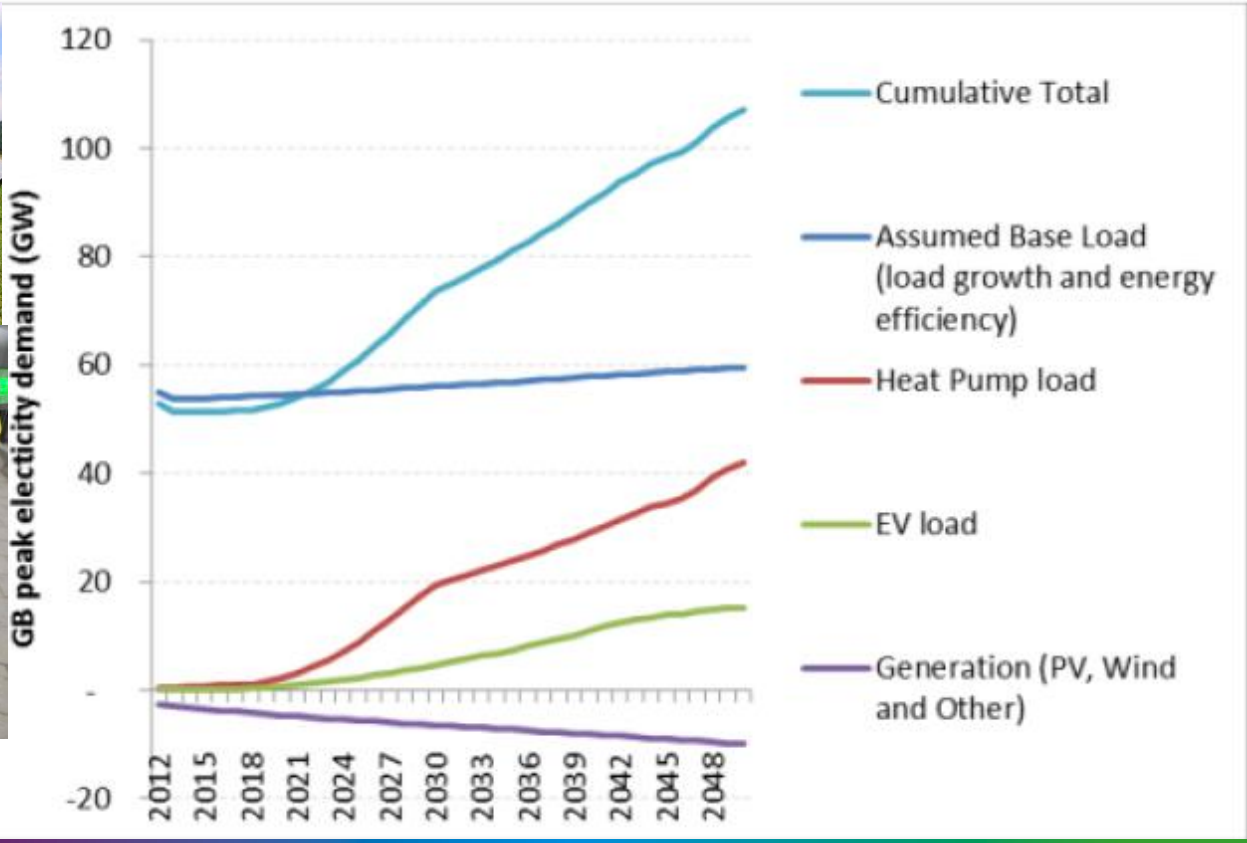
Diagram 1: the delivery of electricity
Image courtesy of the Energy Networks Association



Drivers of change

- Development of ICT for network management and control (‘Smart Grid 1.0’)
- Growth of ‘low-carbon technologies’ in generation (e.g. solar PV) and demand (e.g. electric vehicles) (‘Smart Grid 2.0’)

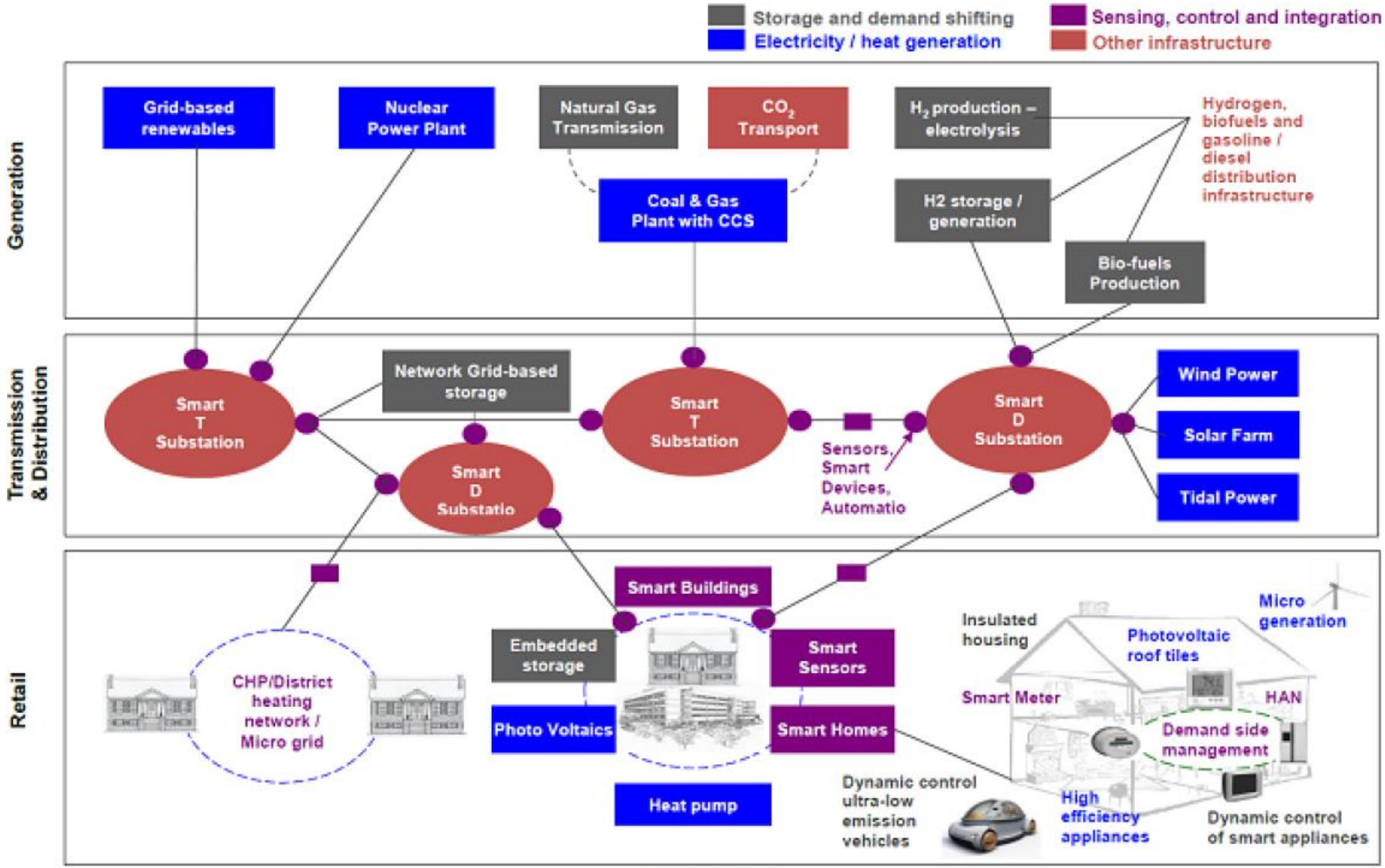
Source: Element Energy 2013



Smart grids concept

- Use of ICT to monitor and control generation and demand in near real-time
  - Dynamic line ratings
  - Active network management
  - Voltage management
  - Fault level monitoring and management
- Facilitates and uses local generation (e.g. solar PV), storage, demand-side response to balance the system and reduce peaks
- Anticipated benefits:
  - Reduced costs to consumers through savings on network costs (est. savings of £2.5bn - £12bn in avoided reinforcement costs by 2050 against BAU) (Smart Grid Forum 2014)
  - Increased energy security and integration of LCTs
  - Growth and jobs (est. £13bn GVA, £5bn potential exports, 9,000 jobs by 2030) (Smart Grid Forum 2014)

Smart grids concept



Source: Smart Grid Forum 2014

2. The role of regulation

Role of network regulation

- ‘Market’ for network services created through regulation of distribution network operators (DNOs) as natural monopolies
- Price-cap regulation (RPI-X) from late 1980s incentivised efficiency through short-term cost reductions (< 3-5 years), and focus on reliability (Shaw et al 2010)
- R&D disincentivised as activity with uncertain longer-term returns
- Weak incentive as rent from innovation would be lost at end of price control period
- Collapse in network RD&D following privatisation (<0.1% of revenue by early 2000s) (Pollitt and Bialek 2008)
- Culture of solving problems by physical capacity (‘fit-and-forget’)
- “It would be a crude but not an unrealistic simplification to say that the way energy networks are designed, built and operated has not changed significantly since they were built in the post war period.” (Smith 2010: 9)

3. Two responses

Opening up a space for R&D

- Creation of 2 funding mechanisms (IFI, RPZs) in 2004 for R&D by DNOs
- Endogenous institutional change in regulator (Lockwood 2016)
  - Central role of Chief Engineer
  - Contestation over view of innovation process – ‘purists’ vs ‘pragmatists’
  - Decision elevated to GEMA
- IFI spending rose quickly (£2 million in 2003/04 to £12 million in 2008)

Expanding the space for RD&D

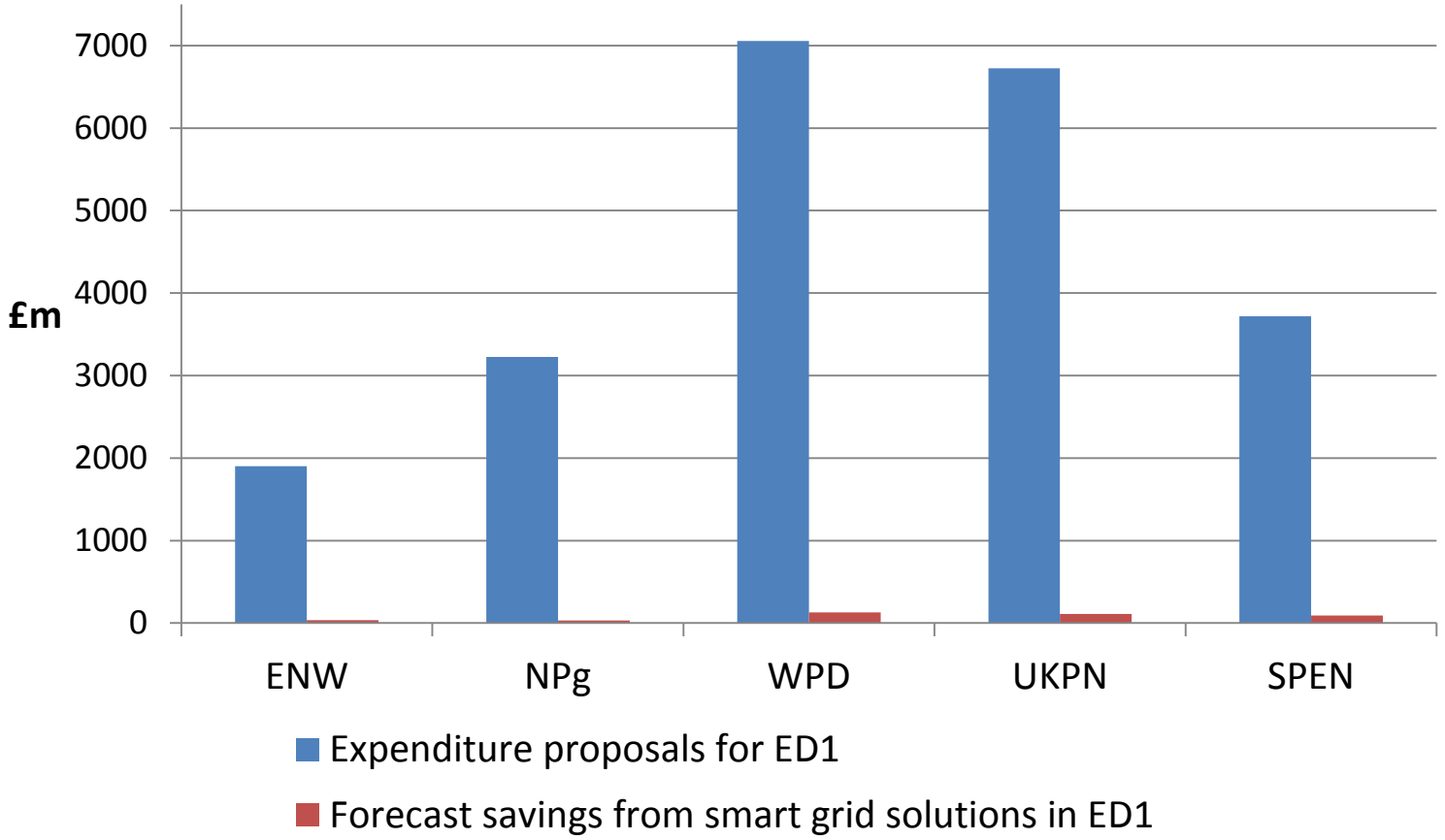
- Need for much larger bolder scheme (“a vehicle for risk-free learning and bringing it into BAU”)
- Involve other organisations
- Extension into demonstration projects
- “Super-charged” scale to get attention to DNO CEOs
- Recognition that would involve some failures
- Low Carbon Networks Fund, 2010 to 2015, up to £500m over 5 years (~2.3% of allowed revenue) (£250m has actually been spent)
- Network Innovation Allowance/Competition, 2015 to 2023, similar order of magnitude

Amending the regulatory framework

- Major review of network regulation in 2008-10 ('RPI-X@20'); acknowledged that RPI-X had suppressed innovation and would not work for major changes ahead
- 'RIIO' = Revenue = Incentives + Innovation + Outputs, from 2010
- Aim is to produce "unprecedented" levels of innovation by network companies
  - Removes bias towards capital spending
  - Longer price control periods (from 5 to 8 years)
  - Allows 'anticipatory investment' on basis on projected LCT growth
  - Requirement for smart grid plan
- But still price cap regulation at core
- First RIIO price control for electricity distribution networks = RIIO ED1, running from April 2015 to 2023

4. From demonstration to diffusion?

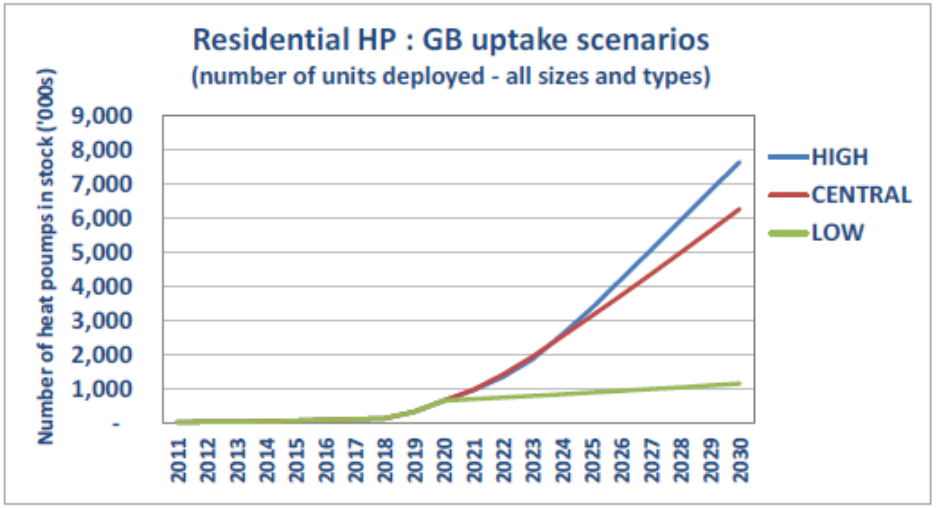
From RD&D to BAU investment in ED1?

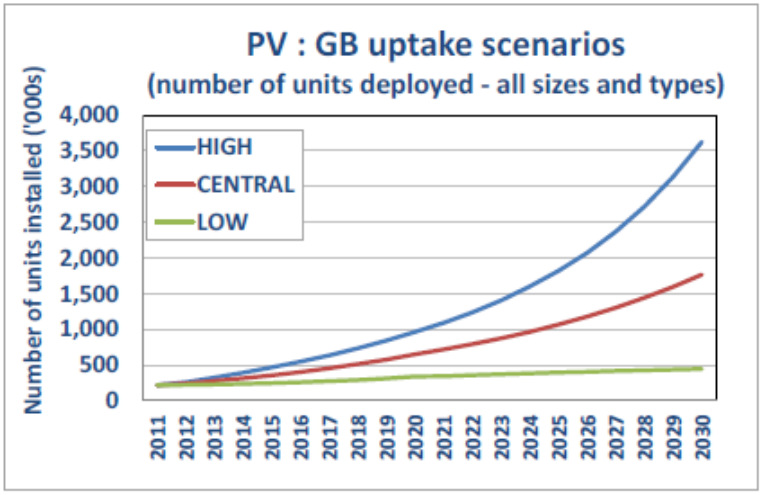


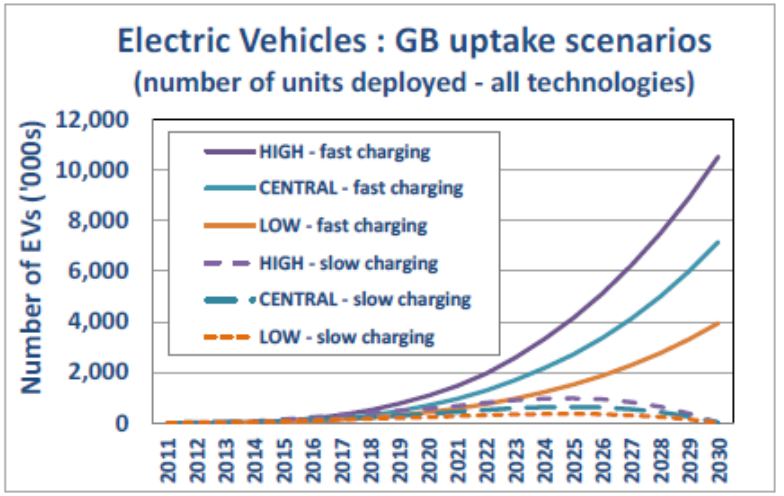
Source: Lockwood 2014

Expected savings from smart grid solutions for ED1 period (2015-2023)

Take-up of LCTs expected to be slow before 2020

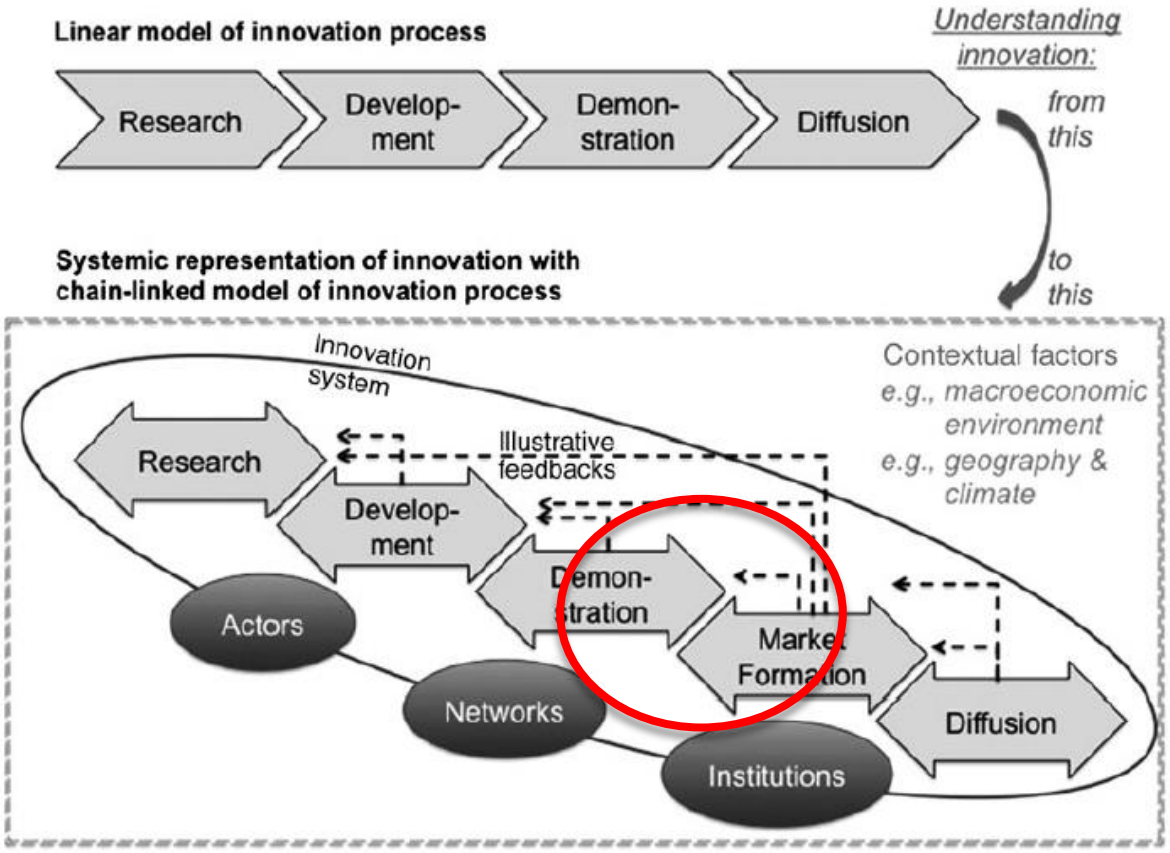






From RD&D to BAU investment in ED1?

- Moving from demonstration (LCNF) to diffusion ?
- Assumption that cost efficient incentives will be sufficient to get across regulatory equivalent of 'valley of death'
- But if risks remain, then other incentives in regime (outputs, especially relating to reliability) may be a barrier to deployment



Source: Gallagher et al 2012

Most LCNF outputs not immediately deployable

	-4	-3	-2	-1	0	1	2	3	4
Battery storage	0	0	2	1	3	0	0	0	0
Flexible demand	0	1	0	3	3	2	1	4	0
Connection of DG	0	0	0	0	0	0	1	0	2
Voltage control	0	0	0	1	3	3	2	2	0
Power flow	1	0	1	0	2	0	0	0	1
Network visibility	0	0	0	0	2	6	4	1	8
Total	**1**	**1**	**3**	**5**	**13**	**11**	**8**	**7**	**11**

Source: Frame et al 2016

78% of outputs lie between ‘failure’ and immediately commercially deployable

Wider issues

- Changing DNO ‘culture’ – are incentives strong enough?
- Need for change in investor class?
- From DNOs to Distribution System Operators or Distribution Service Providers – entirely new incentive framework needed?

5. Concluding observations

Concluding observations

- Green innovation in regulated monopolies, including network infrastructure, will be increasingly important, and is significant – €600 billion needed for European electricity networks by 2020 (Eurelectric 2014)
- Innovation in regulated monopolies depends very much on regulation, which historically, has been aimed at improving efficiency through squeezing costs, not innovation
- Regulators can respond to challenge, but *how* they do so will be influenced by their models of the innovation process
- Approach in Britain still largely incremental; not yet clear whether or when a more transformational approach will be needed

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