Efficiency and heating in net-zero energy systems: A UK case study

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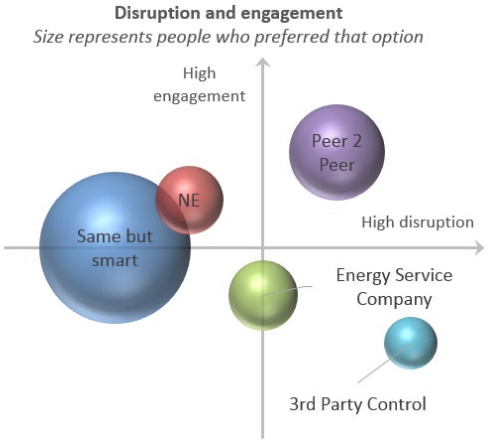
EnergyREV

About me and EnergyREV

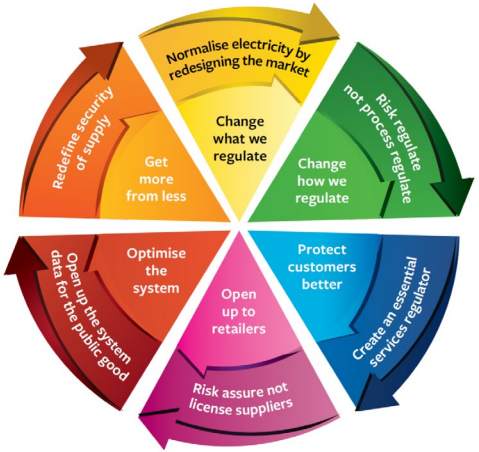
Current research interests

Future energy business models



Utility 2050

Energy policy and regulation



Redesigning Regulation

People and energy

Society led low-carbon transformation

Energy Revolution Research Consortium

EnergyREV

Prospering from the Energy Revolution

Research outputs
Consultations
Activity groups
Participants in research
Collaborative research

Collaborative outputs
Demonstrator working group
Joint workshops

CATAPULT Energy Systems

Energy Revolution Integration Service activities

EnergyREV

Synthesis of knowledge within and beyond PFER
Novel research and innovation (whole systems)
Academic evaluation of smart local energy concepts
Academic liaison and domain expertise

Comparing UK and New Zealand

Vital statistics - 2019

2019(ish)

- Population 5 million
- Energy per person = 0.034 GWh
- % electricity from renewables = 80%
- No vehicles per person = 0.81
- Electric heating in homes = 80%

- Population 66.4 million
- Energy per person = 0.025 GWh
- % electricity from renewables = 33%
- No vehicles per person = 0.58
- Electric heating in homes = 8% (86% gas)

Looking forwards to 2050

2050(ish)

- Population ~6 million
- Energy per person = ???GWh
- % electricity from renewables = up to 100%
- Vehicles per person = <0.81 (85-95% BEVs)
- Electric heating in homes = 75-95%

- Population ~ 77 million
- Energy per person = ???GWh
- % electricity from renewables = 80%
- Vehicles per person = 0.51 (96.5% BEVs)
- Electric heating in homes = 60%

Lots in common in the future

- High penetration of renewables (wind in common)
- Transformation of transport to BEVs
- Electric heating (60-95%)
- Quality of building stock
- Challenges with GHGs in agriculture

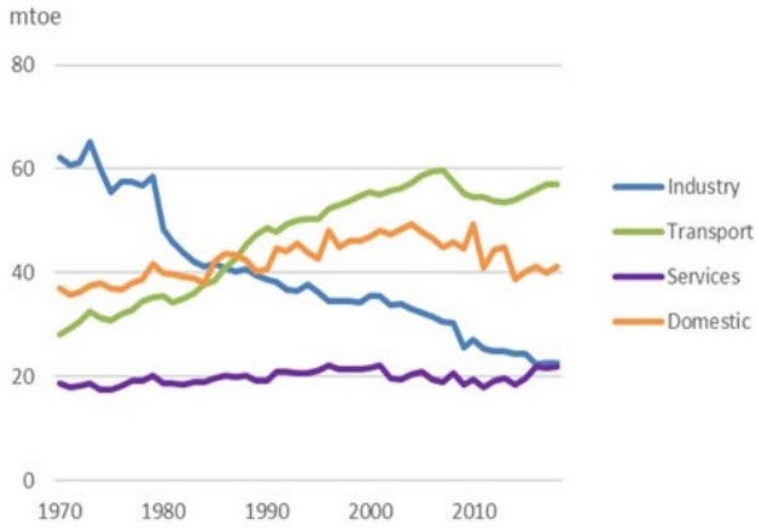
Issues

- Pace
- Governance
- Businesses
- Citizens and consumers

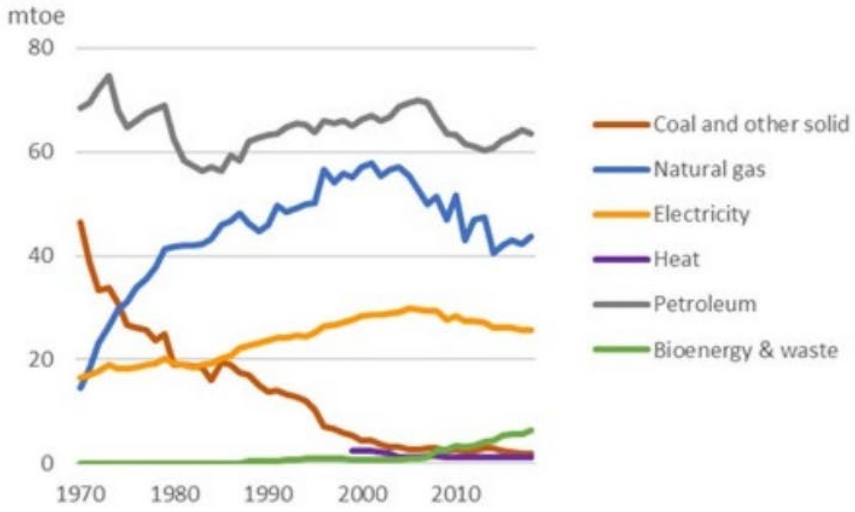
UK journey on energy efficiency and heat

UK change in energy consumption 1970 - 2018

By sector;



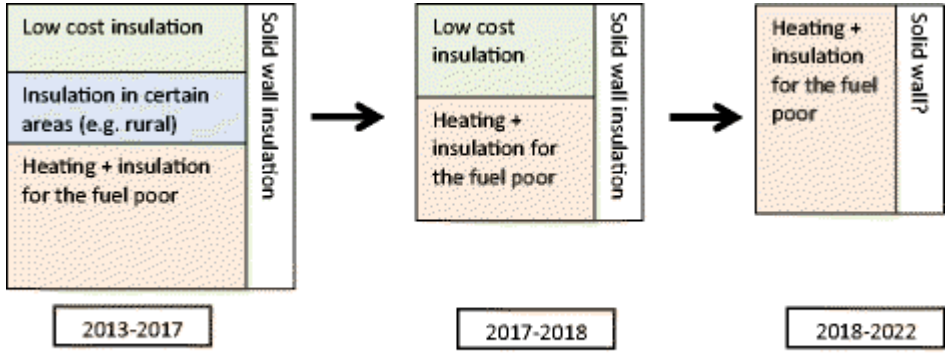
By fuel;



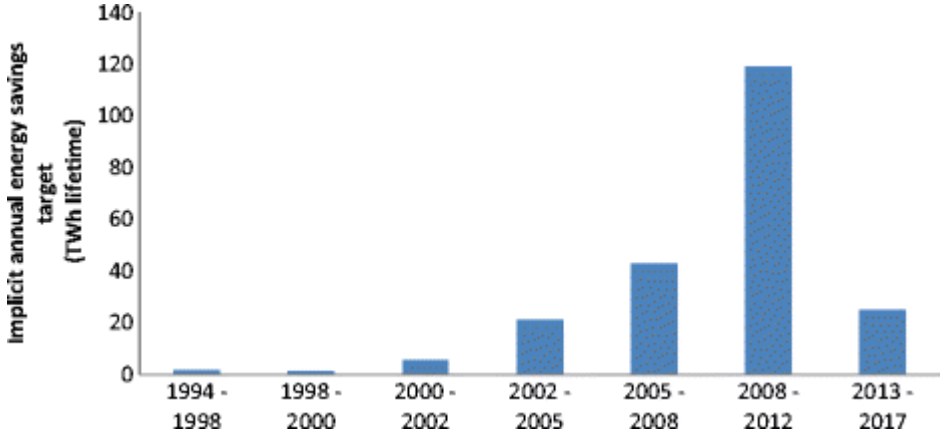
Source: https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/820843/Energy_Consumption_in_the_UK__ECUK__MASTER_COPY.pdf

Potted history: UK Energy efficiency obligation

- Energy Efficiency Obligation on energy suppliers (retailers) since 1994
- Redesigned several times:
  - 94 – 02: Energy Efficiency Standards of Performance (EESoP)
  - 02 – 08: Energy Efficiency Commitment (EEC)
  - 08 – 12: Carbon Emissions Reduction Target (CERT) & Community Energy Saving Programme (CESP)
  - 13 – now: Energy Company Obligation (ECO) (alongside Green Deal for able to pay consumers)



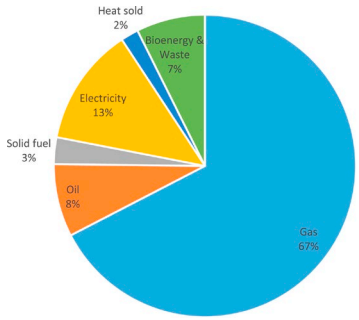
(not to scale). Adapted from DECC (2016)

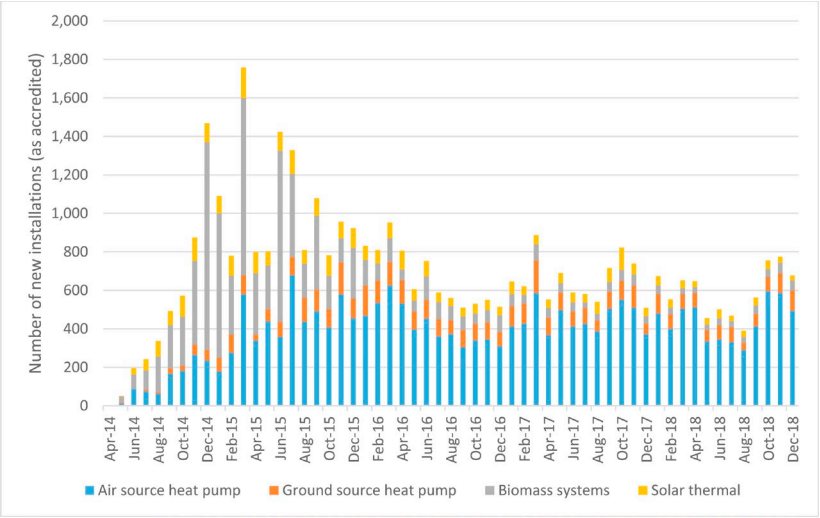


https://link.springer.com/article/10.1007/s12053-018-9657-1

Renewable Heat Incentive UK

- RHI first major intervention intervention since mandating condensing boilers in 2003
- RHI is a tariff-based incentive mechanism for renewable heat
  - Increase renewable heat
  - Reduce emissions
  - Grow supply chains
- Operational since 2011 with significant tinkering along way
- No certainty beyond March 2021
- Issues:
  - Take up low (22% expectations)
  - High carbon cost – around £142/tonne
  - Issues of fraud and non-compliance





https://www.sciencedirect.com/science/article/pii/S0301421519302903 & https://www.nao.org.uk/report/low-carbon-heating-of-homes-and-businesses-and-the-renewable-heat-incentive/

UK net-zero journey

UK Climate Change Act

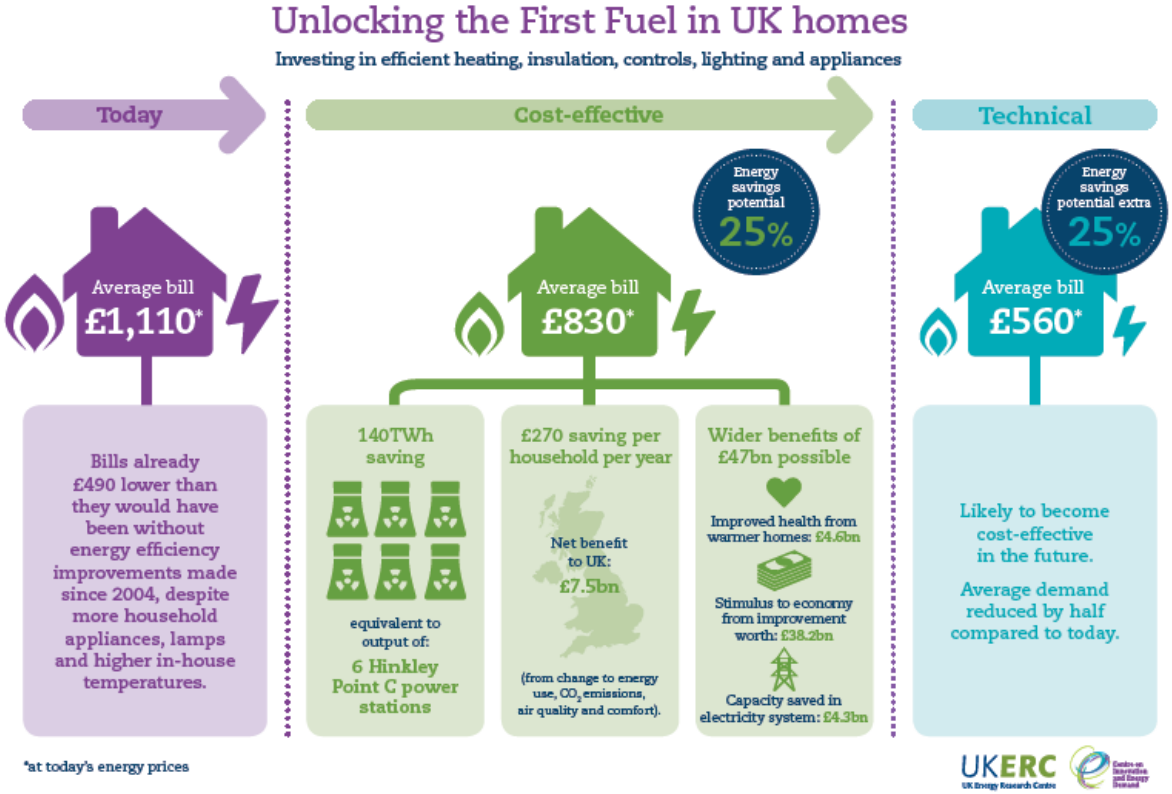
"It is the duty of the Secretary of State to ensure that the **net** UK carbon account for the year 2050 is **at least 100% lower** than the 1990 baseline."

Climate Change Act 2008

"Over ten years after the Climate Change Act was passed, there is still no serious plan for decarbonising UK heating systems and no large-scale trials have begun for either heat pumps or hydrogen."

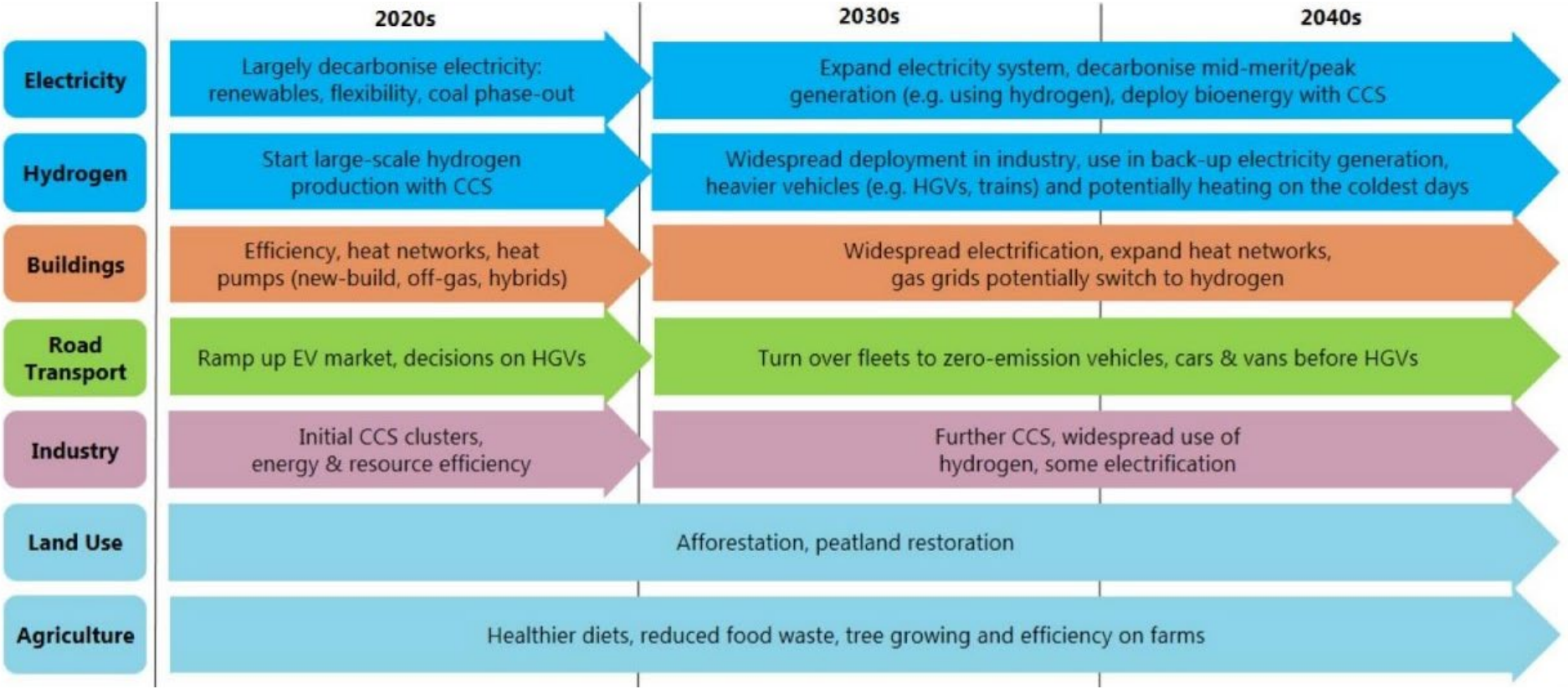
https://www.theccc.org.uk/publication/net-zero-the-uks-contribution-to-stopping-global-warming/#key-findings

Linking energy efficiency and heat



http://www.ukerc.ac.uk/publications/unlocking-britains-first-fuel-energy-savings-in-uk-housing.html

CCC advice on net-zero target

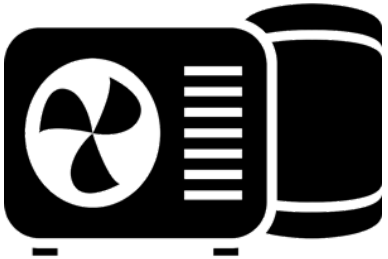


https://www.theccc.org.uk/wp-content/uploads/2019/05/Net-Zero-Chris-Stark-Presentation.pdf

Thirty years of action required to meet UK net zero target

~3.6 (6.1*) GW/year
(300 x 12MW turbines/year)
(current 4GW/year)

~1.2 million BEVs/year
(136 per hour)
(current 331 vehicles/hour)



~600k installations/year
(68 per hour)
(current 182 boilers/hour)

*including CCS and electricity storage

Need for more consumer centric business energy models

Implications for end-users…

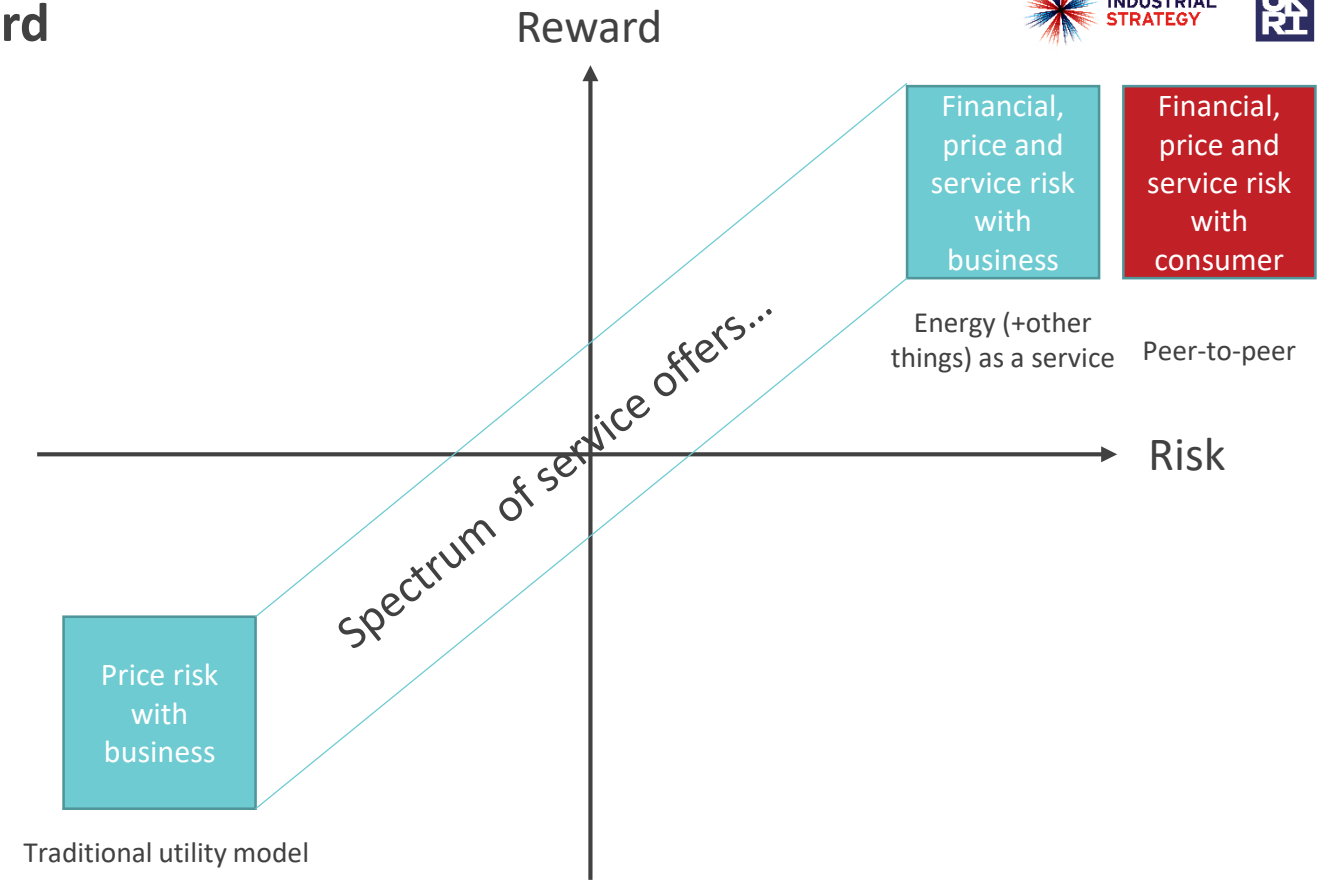
10:00 - 10:30	8.78 p/kWh
10:30 - 11:00	8.32 p/kWh
11:00 - 11:30	7.92 p/kWh
11:30 - 12:00	7.92 p/kWh
12:00 - 12:30	8.17 p/kWh
12:30 - 13:00	7.92 p/kWh
13:00 - 13:30	8.13 p/kWh
13:30 - 14:00	8.13 p/kWh
14:00 - 14:30	8.61 p/kWh
14:30 - 15:00	8.57 p/kWh
15:00 - 15:30	8.17 p/kWh
15:30 - 16:00	10.06 p/kWh
16:00 - 16:30	21.00 p/kWh
16:30 - 17:00	23.52 p/kWh
17:00 - 17:30	23.86 p/kWh
17:30 - 18:00	24.15 p/kWh
18:00 - 18:30	23.86 p/kWh
18:30 - 19:00	22.68 p/kWh
19:00 - 19:30	9.30 p/kWh

Time of use pricing

New kit

Upfront costs

Risk and reward

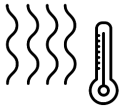


Business model innovation is needed to capture value

New electrifier

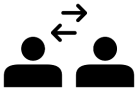
Traditional utility that is helping consumers switch to electric heat and mobility, including installing equipment and automating DSR

Energy as a Service



An ESCo delivers energy services to customers, such as comfort and illumination, rather than units of energy like a traditional supplier.

Peer-to-peer



P2P customers directly buy, sell or swap electricity with each other.

Lifestyle as a service

A third party, such as a price comparison website, takes decisions on consumers' behalf, like automatically switching energy supplier.

Everyone has an opinion on the energy business model of the future…

SMART ENERGY GB | Smarter Britain

Imperial College London

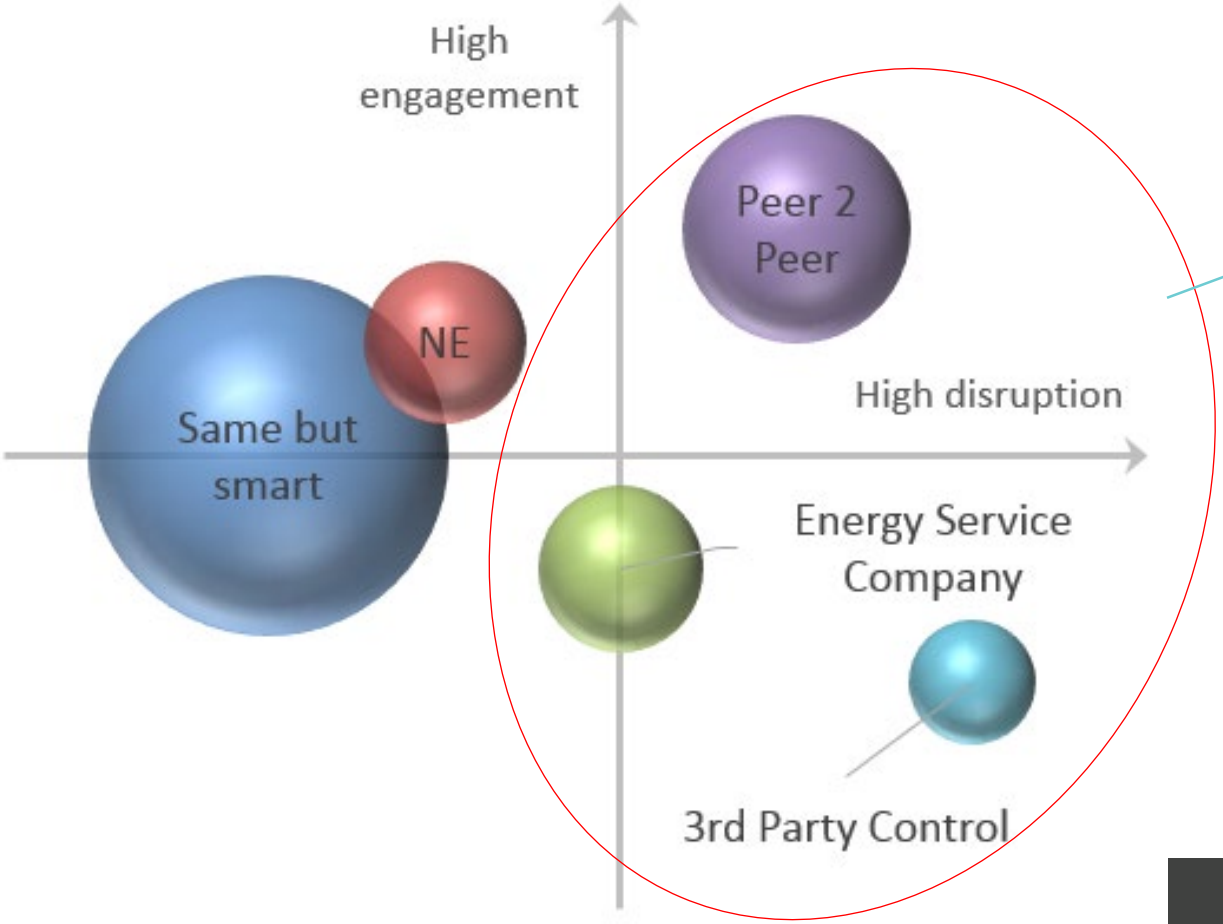
How could we buy energy in the smart future?

Dr Jeffrey Hardy, Imperial College London

March 2017

Disruption and engagement

Size represents people who preferred that option



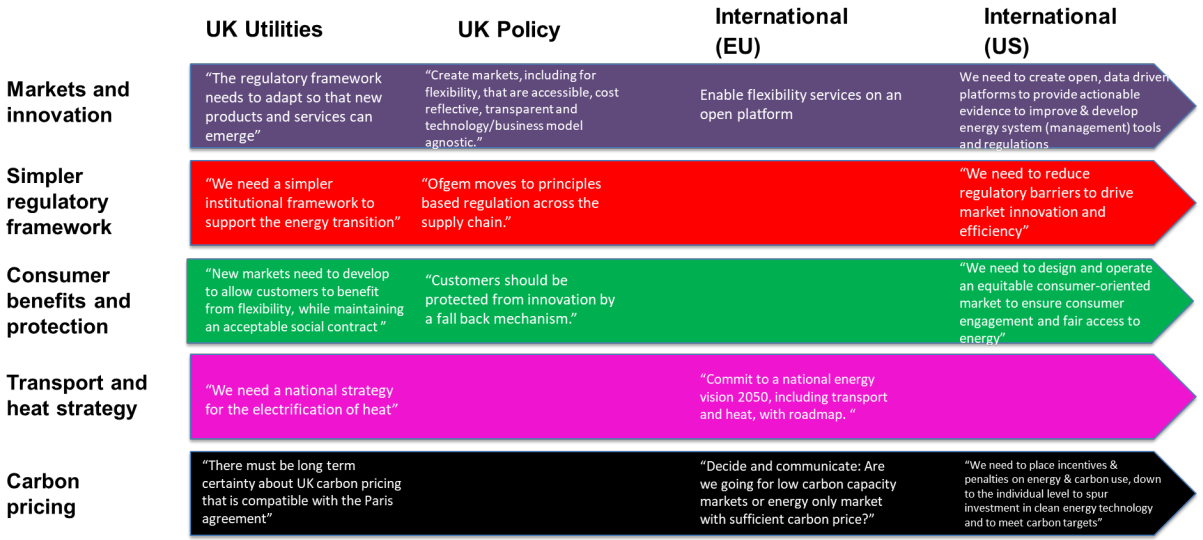
Around 50% of domestic consumers

In review: Nature Energy

Decisions, decisions, decisions…

Top 5 priorities

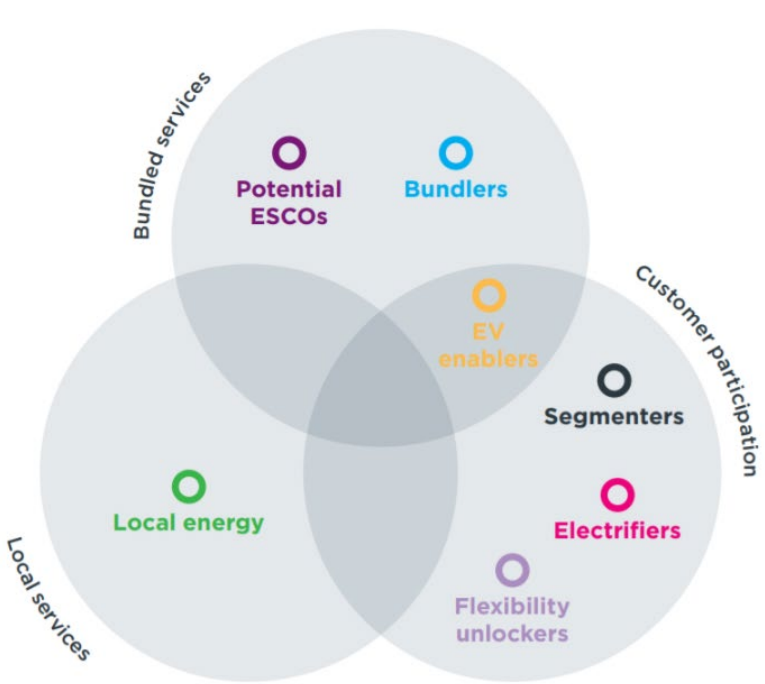
(1) A transparent commitment to carbon pricing.
(2) A clear strategy on transport *and* heat.
(3) Controlling consumer risk.
(4) A reformed regulatory framework across the supply chain.
(5) A framework and platform that allows new energy services to emerge.



https://doi.org/10.1016/j.erss.2019.101317

Redesigning regulation?

Innovation in UK energy suppliers



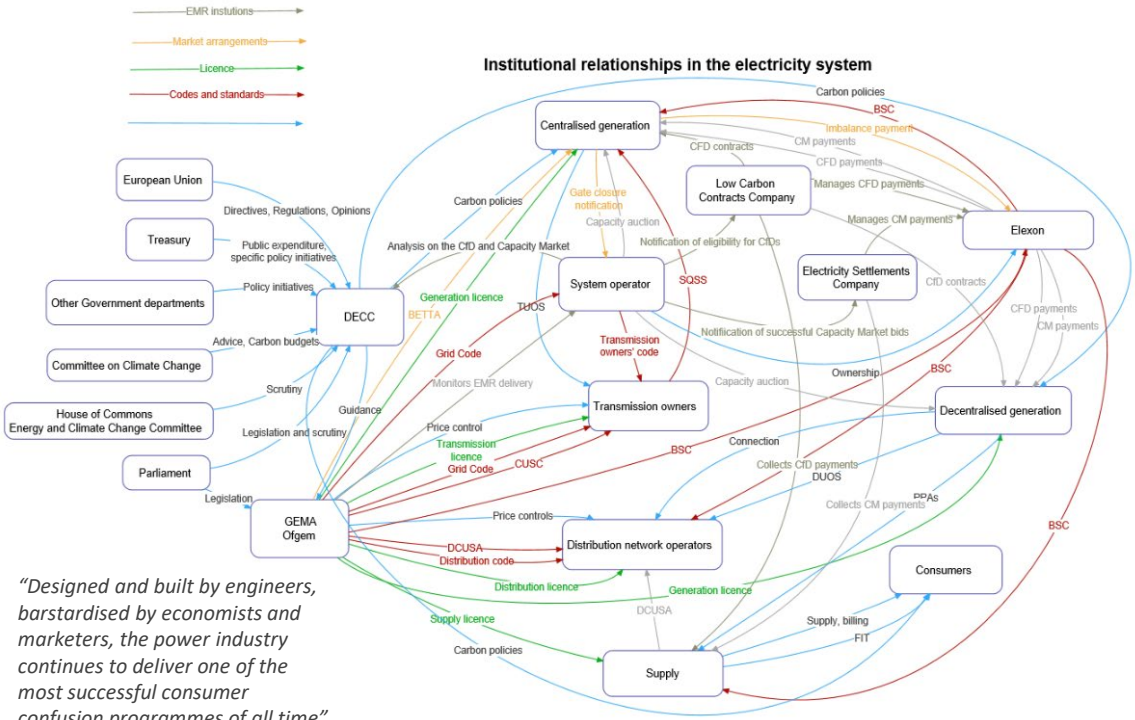
- Ovo
- Octopus
- Tonik
- Ecotricity
- HartlePower
- Co-operative Energy
- E.ON
- SSE
- Scotish Power
- The Renewable Energy Company Ltd (Ecotricity)
- Good Energy
- Bristol Energy
- So Energy
- Brits Energy
- Mongoose
- Bulb
- npower
- British Gas
- First Utility
- Local Electricity Supply Plus Ltd
- EDF
- Green Energy
- Our Power
- GnERGY
- Green Energy Network
- Utilita Energy
- Nabuh Energy

Figure 8: Emerging domestic electricity supplier value propositions compared to broad NTBM themes

- **Lot's going on, particularly on local energy, electric vehicles, 'smart' electric homes and bundling products**
- **However, little innovation in the core traditional utility business model (selling units of electricity and gas)**

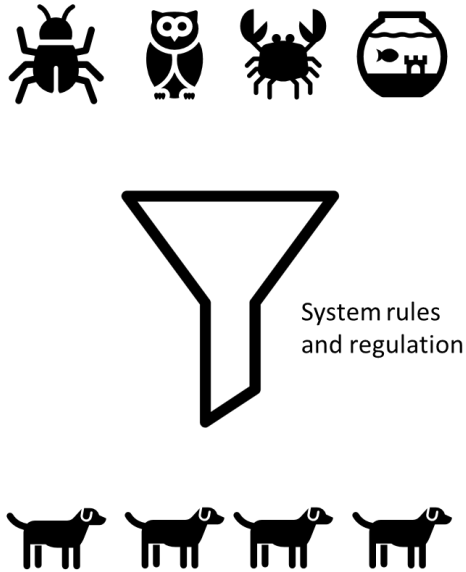
Credit: IGov - http://projects.exeter.ac.uk/igov/wp-content/uploads/2019/01/IGov-BM-Analysis-report.pdf

Energy policy & regulation

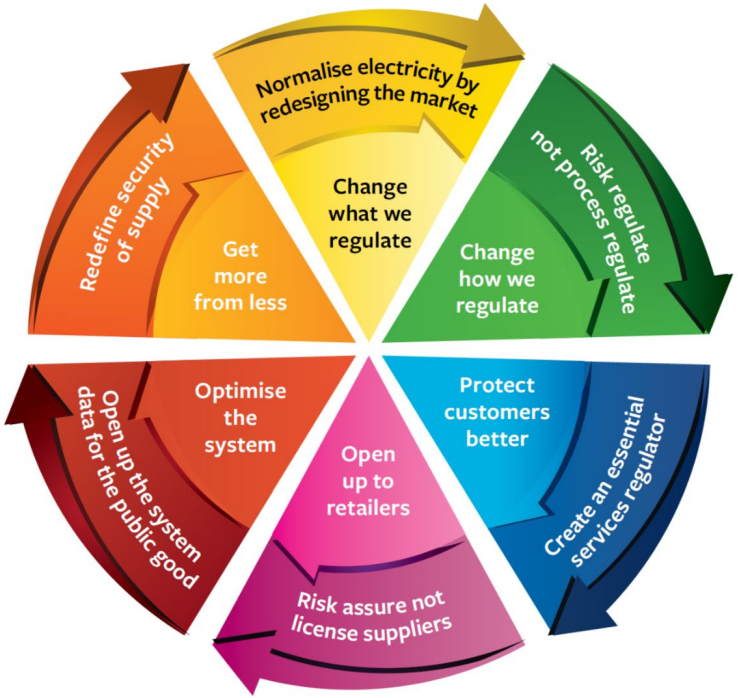


"Designed and built by engineers, barstardised by economists and marketers, the power industry continues to deliver one of the most successful consumer confusion programmes of all time"
Ari Sargent

Credit: Exeter Energy Policy Group - https://blogs.exeter.ac.uk/energy/2014/11/12/mapping-the-power-in-the-electricity-system/



Redesigning regulation



- **Change what we regulate:** normalise electricity through redesigning the market
- **Change how we regulate:** change from regulating process to regulating for risk
- **Protect and serve consumers better:** create one essential service consumer regulator
- **Open up to retailers:** risk assure retailers rather than license suppliers
- **Optimise the system:** opening up system data for the public good
- **Get more from less:** redefine and recalibrate security of supply

Redesigning regulation – December 2018
https://www.imperial.ac.uk/grantham/publications/redesigning-regulation-powering-from-the-future.php