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

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About me and EnergyREV
Current research interests

**Future energy business models**

- **Disruption and engagement**
  - Size represents people who preferred that option
  - High engagement
  - High disruption
  - Same but smart
  - Peer 2 Peer
  - 3rd Party Control

- **Energy Service Company**

**Utility 2050**

**Energy Revolution Research Consortium**

**Energy policy and regulation**

- Redefine security of supply
- Get more from less
- Change what we regulate
- Change how we regulate
- Open up to retailers
- Protect customers better
- Create a complex service regulator

**People and energy**

- Society led low-carbon transformation
- Some issues need to be addressed to enable these businesses to succeed
  - Transnational data protection
  - Multi-fuel regulation
  - Data and energy interoperability
  - Effective carbon regulation
  - Impact on national grid
  - Models for rental sectors
  - Efficiency for all customers
  - Flex to local balancing
  - Pull back options

**Redesigning Regulation**

**Key take homes**

- Space to enable business model innovation
- Smart devices and data must be interoperable and secure
- Service standards must be better
- Solutions for all consumer situations required
- Targeted carbon regulations needed

**EnergyREV**
Prospering from the Energy Revolution

Future energy model proving

Practical demonstrators £40m

Future designs £30m

Collaborative outputs
Demonstrator working group
Joint workshops

Research outputs
Consultations
Activity groups
Participants in research
Collaborative research

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

Energy Revolution Integration Service activities
Comparing UK and New Zealand
Vital statistics - 2019

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

2019(ish)

• 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

- 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;

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)

Renewable Heat Incentive UK

- RHI first major 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

UK net-zero journey
“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.”

“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

Unlocking the First Fuel in UK homes
Investing in efficient heating, insulation, controls, lighting and appliances

Today

Average bill £1,110*

Bills already £490 lower than they would have been without energy efficiency improvements made since 2004, despite more household appliances, lamps and higher in-house temperatures.

Cost-effective

Average bill £830*

140TWh saving

140TWh saving equivalent to output of:
6 Hinkley Point C power stations

£270 saving per household per year

Wider benefits of £47bn possible

Net benefit to UK: £7.5bn

('from change to energy use, CO2 emissions, air quality and comfort')

Technical

Average bill £560*

Energy savings potential 25% Energy savings potential extra 25%

Likely to become cost-effective in the future

Average demand reduced by half compared to today

*at today’s energy prices

CCC advice on net-zero target

**2020s**
- **Electricity**: Largely decarbonise electricity: renewables, flexibility, coal phase-out
- **Hydrogen**: Start large-scale hydrogen production with CCS
- **Buildings**: Efficiency, heat networks, heat pumps (new-build, off-gas, hybrids)
- **Road Transport**: Ramp up EV market, decisions on HGVs
- **Industry**: Initial CCS clusters, energy & resource efficiency
- **Land Use**: Afforestation, peatland restoration
- **Agriculture**: Healthier diets, reduced food waste, tree growing and efficiency on farms

**2030s**
- **Electricity**: Expand electricity system, decarbonise mid-merit/peak generation (e.g. using hydrogen), deploy bioenergy with CCS
- **Hydrogen**: Widespread deployment in industry, use in back-up electricity generation, heavier vehicles (e.g. HGVs, trains) and potentially heating on the coldest days
- **Buildings**: Widespread electrification, expand heat networks, gas grids potentially switch to hydrogen
- **Road Transport**: Turn over fleets to zero-emission vehicles, cars & vans before HGVs
- **Industry**: Further CCS, widespread use of hydrogen, some electrification

**2040s**
- **Electricity**:
- **Hydrogen**:
- **Buildings**:
- **Road Transport**:
- **Industry**:
- **Land Use**:
- **Agriculture**:

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...

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<th>Upfront costs</th>
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Risk and reward

Risk

Price risk with business

Traditional utility model

Reward

Financial, price and service risk with business

Energy (+other things) as a service

Peer-to-peer

Spectrum of service offers...
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...

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.

UK Utilities

UK Policy

International (EU)

International (US)

Markets and innovation

“The regulatory framework needs to adapt so that new products and services can emerge”

“Create markets, including for flexibility, that are accessible, cost reflective, transparent and technology-business model agnostic.”

Enable flexibility services on an open platform

Simpler regulatory framework

“We need a simpler institutional framework to support the energy transition”

“Ofgem moves to principles based regulation across the supply chain.”

“We need to reduce regulatory barriers to drive market innovation and efficiency”

Consumer benefits and protection

“New markets need to develop to allow customers to benefit from flexibility, while maintaining an acceptable social contract.”

“Customers should be protected from innovation by a fall back mechanism.”

“We need to design and operate an equitable consumer-oriented market to ensure consumer engagement and fair access to energy”

Transport and heat strategy

“We need a national strategy for the electrification of heat”

“Commit to a national energy vision 2050, including transport and heat, with roadmap.”

“International (US)”

Carbon pricing

“There must be long term certainty about UK carbon pricing that is compatible with the Paris agreement”

“Decide and communicate: Are we going for low carbon capacity markets or energy only market with sufficient carbon price?”

“We need to phase incentives & penalties on energy & carbon use, down to the individual level to spur investment in clean energy technology and to meet carbon targets”

https://doi.org/10.1016/j.erss.2019.101317
Redesigning regulation?
Innovation in UK energy suppliers

- 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)

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

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