Net zero levels of innovation: what is needed?

24 September 2019

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What is Energy Systems Catapult?

Mission: Unleash innovation and open new markets to capture the clean growth opportunity

170 Innovation experts

Hubs in Birmingham and Derby

We work with Innovate UK

Established and overseen by Innovate UK. Independent from Government. Not for profit

Bridge the gap between stakeholders in the sector

A place to develop and test new ideas

Supporting innovators

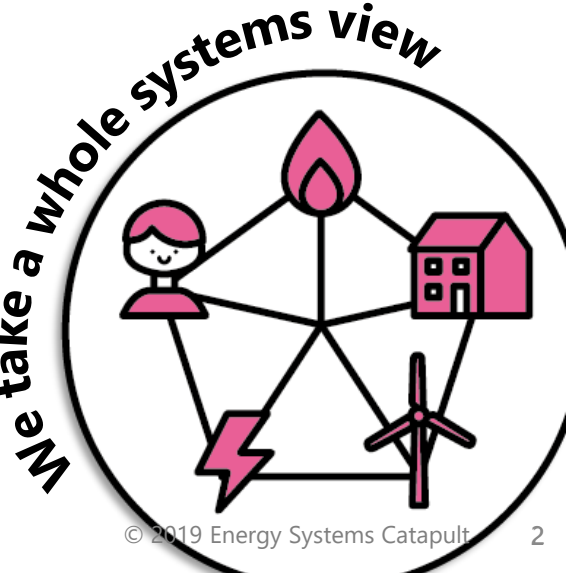
Research

Trials

Systems engineering

Digital

Modelling and simulation



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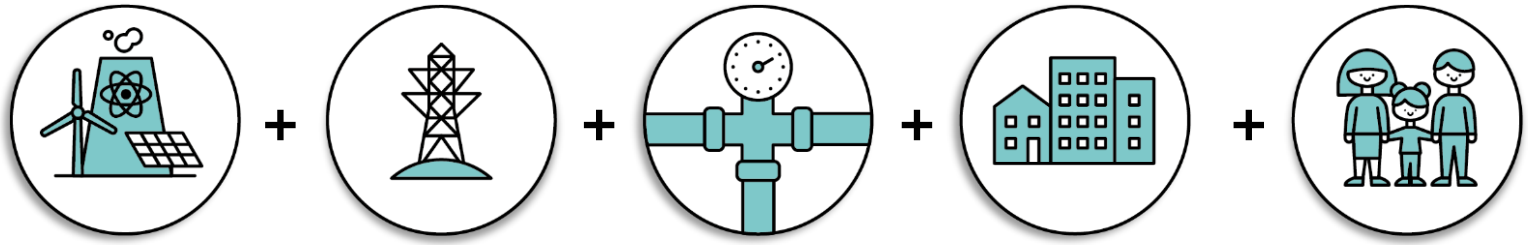
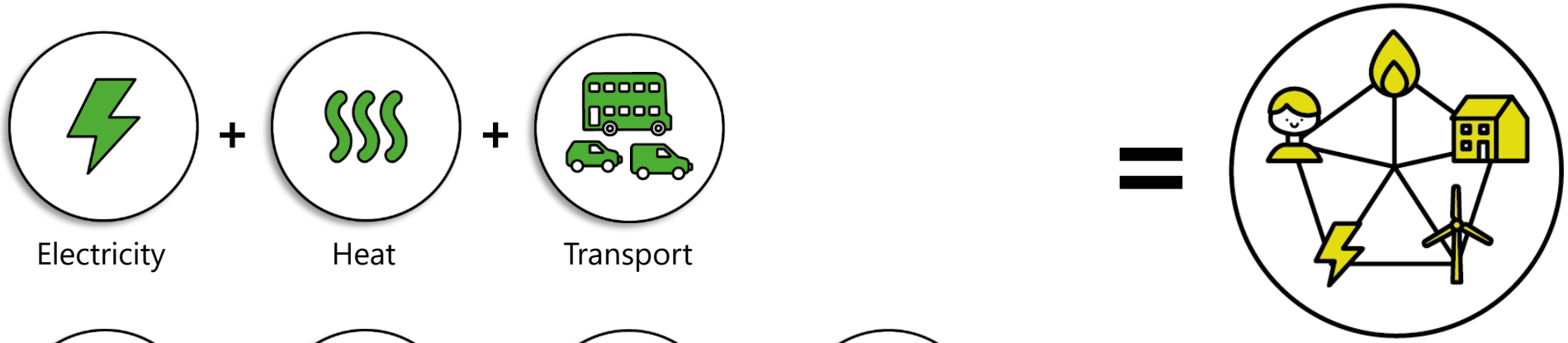
What is whole systems thinking?

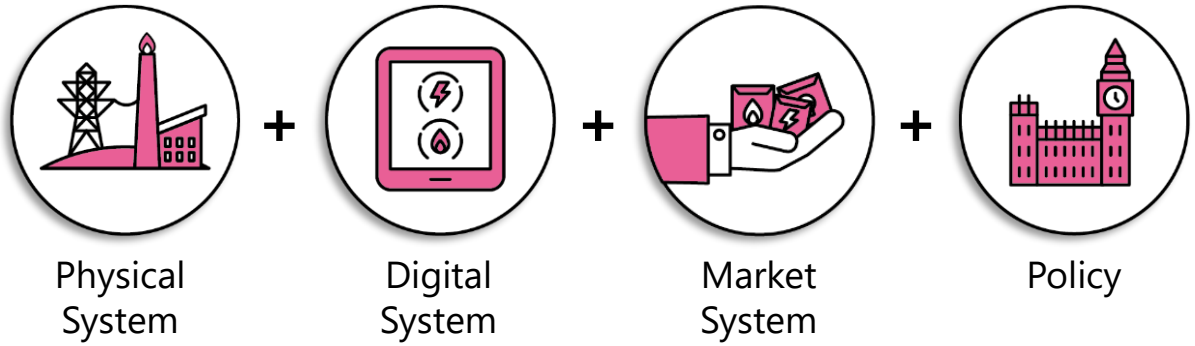
Joining up the system from sources of energy to the consumer



Breaking down silos between energy vectors



Joining up physical requirements of the system, with policy, market and digital arrangements



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Key messages

- 80% target was hard. Net Zero is **very hard**
- Modelling can get only you so far. Significant unknown is **how consumers will respond** to necessary changes
  - Heating, Transport
- **Broad consensus on key technology options needed.** Inc. CCS, biomass, nuclear, offshore wind, low-carbon heating (electrification, district heating, hydrogen), EVs. But **inherent uncertainty** about 'right' mix
- Net Zero very unlikely to happen without **robust policy.** An **ecosystem** of low carbon regulation, planning/co-ordination, markets, pricing, innovation required
  - Inc. need for more granular price signals (Rethinking Electricity Market Design)
- Understanding the opportunities *and* risks of **digitalisation** is essential

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Context: Decarbonising heat is going to require significant changes to our economy

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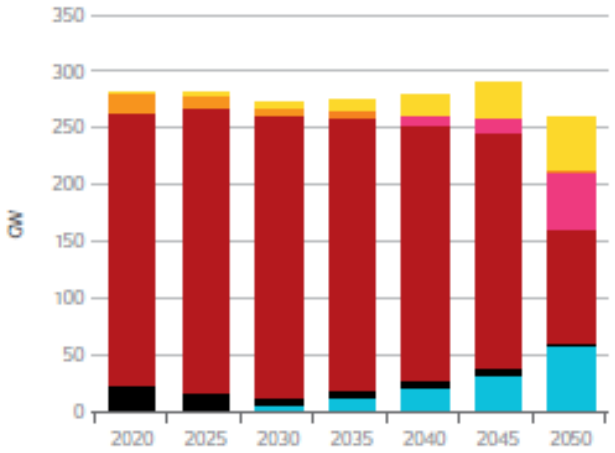
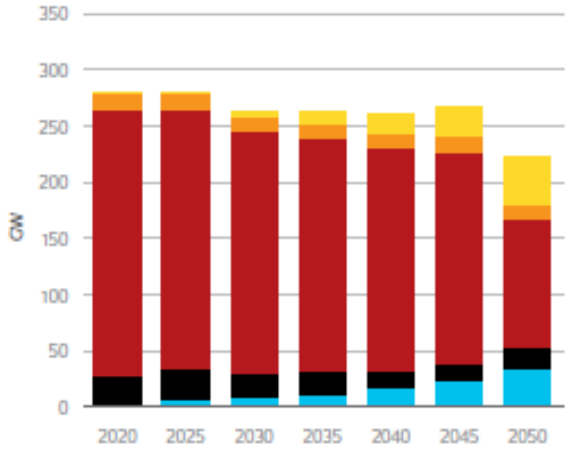
CLOCKWORK

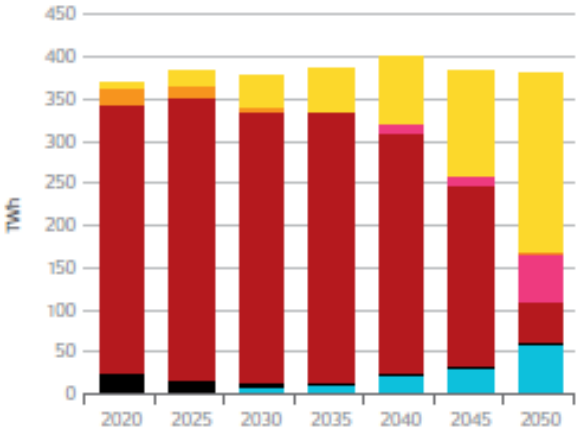
PATCHWORK

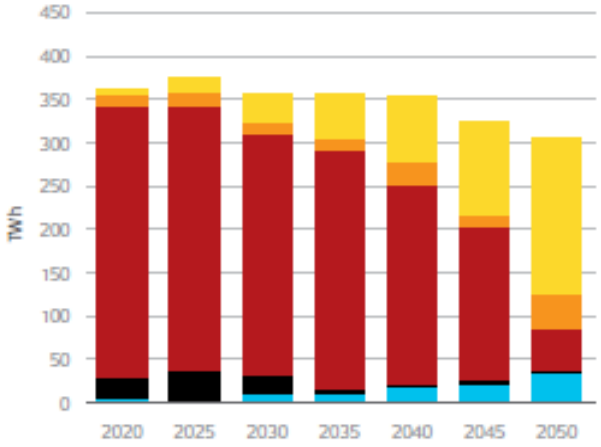
Space Heat CAPACITY (GW)





Space Heat PRODUCTION (TWh)





- Heat Pump
- Electric Heating
- Hydrogen Boiler
- Gas Boiler
- Oil Boiler
- District Heating

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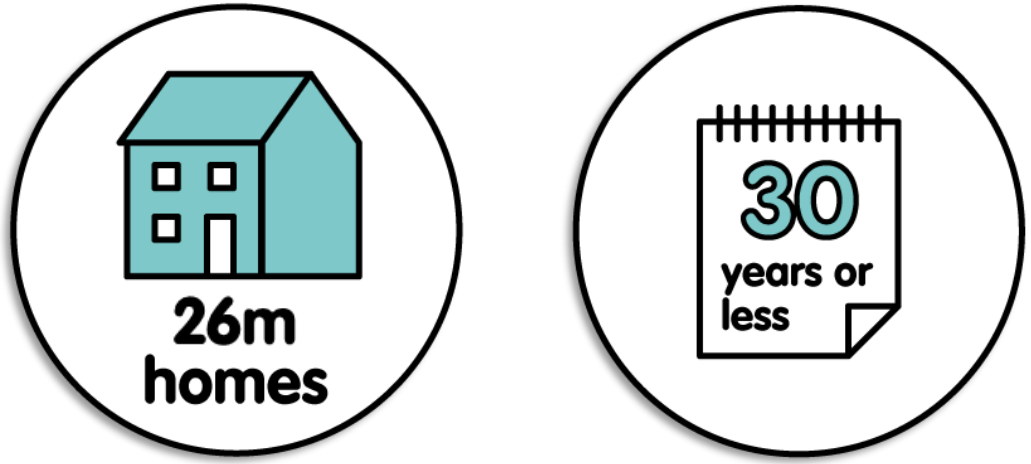
The challenge



At the current rate of conversion, it would take...

1000 to 2000 years

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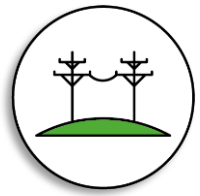
How to decarbonise heat: our hypothesis

Start with the consumer, not the technology

Digitalisation offers significant potential (and some risk)

Heat as a service could be a powerful proposition



Understanding different local energy systems is essential

Heat decarbonisation will require significant market changes/policy drivers

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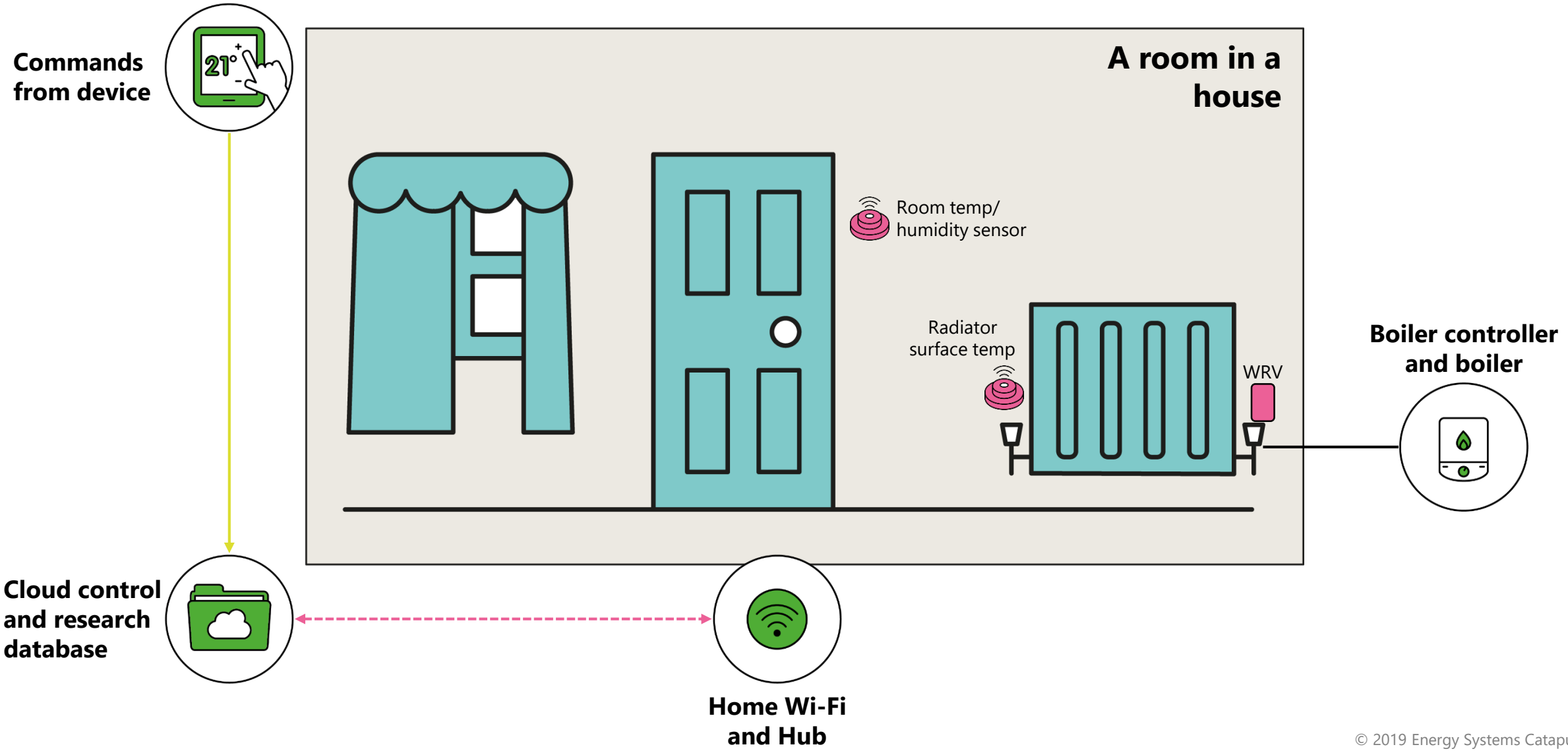
We created a Living Lab to test the potential of the future smart home



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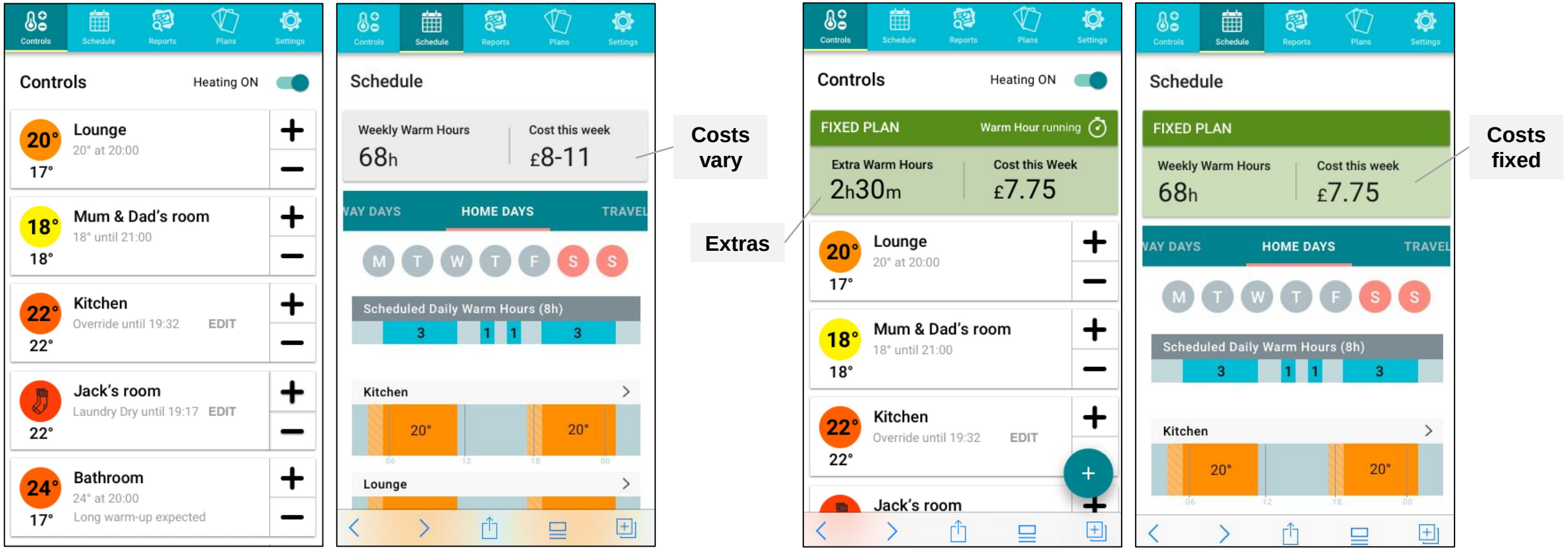
Consumers discover the service they want through experience



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Heat Plans: a starter-for-ten energy service

Warm hours
Hours any room is warm

Pence per warm hour
Like “mpg” for heating

Schedule
Temperature of rooms at any time

Extras
Cost of warmth outside the schedule

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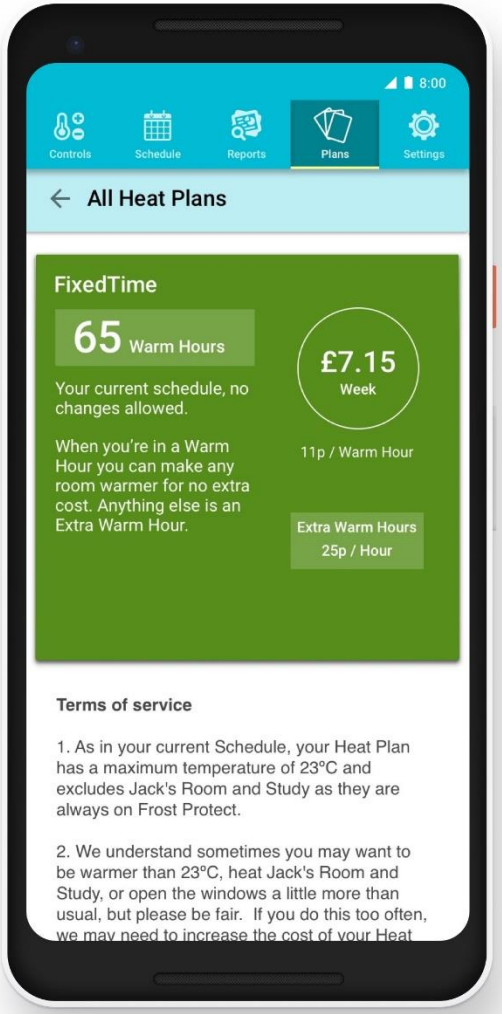
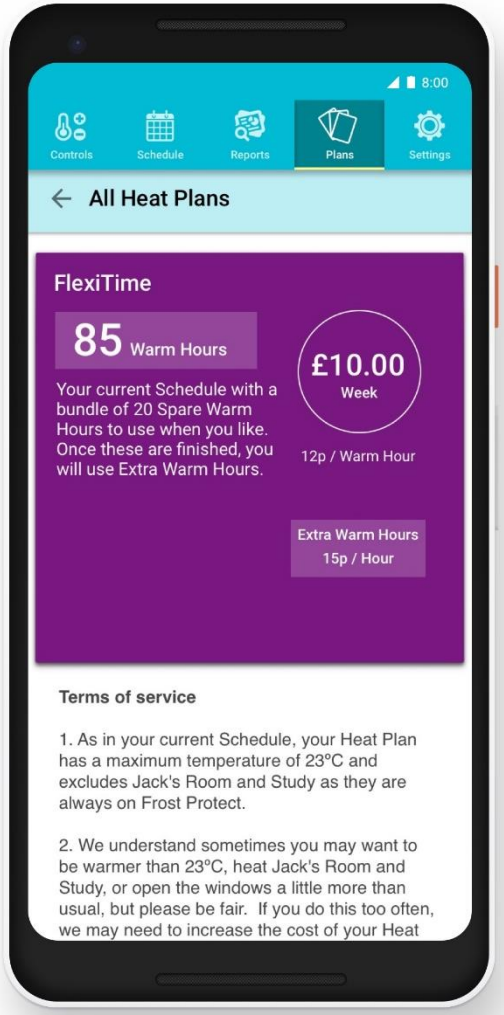
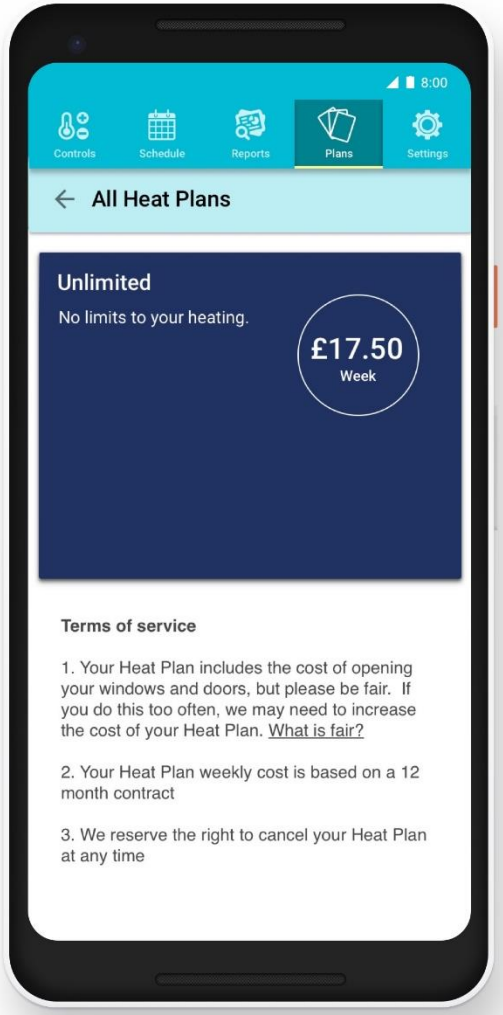
Offered households the chance to ‘buy’ Heat as a Service







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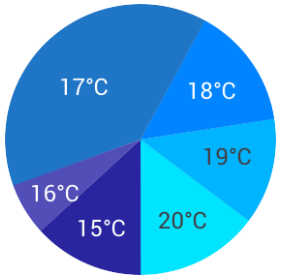
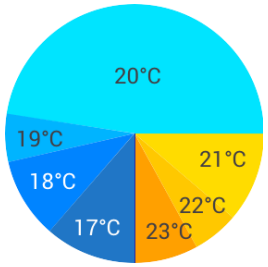
Everyone enjoyed better control, but they used it very differently (e.g. temperature)

Cool Conservers



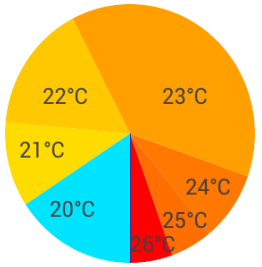
Often adjust temperature to try and cut bills

Hot and Cold Fluctuators



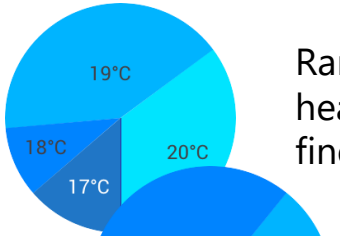
Often adjust temperature to get comfortable

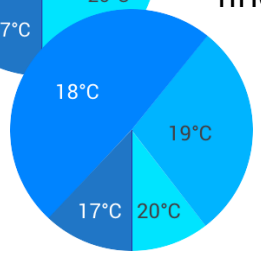
On-Demand Sizzlers



Some like it hotter or want to spend more than others in their home

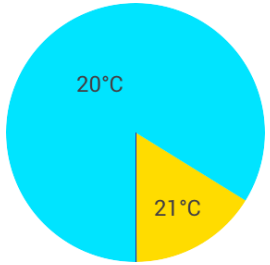
Steady and Savvy





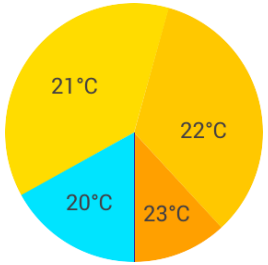
Rarely adjust their heating as they are fine with 18-20ºC

On-off Switchers



Turn it on and off to try and make sure home is only warm when someone is in

Toasty Cruisers



Love feeling cosy and prefer not to put clothes on if they're cold

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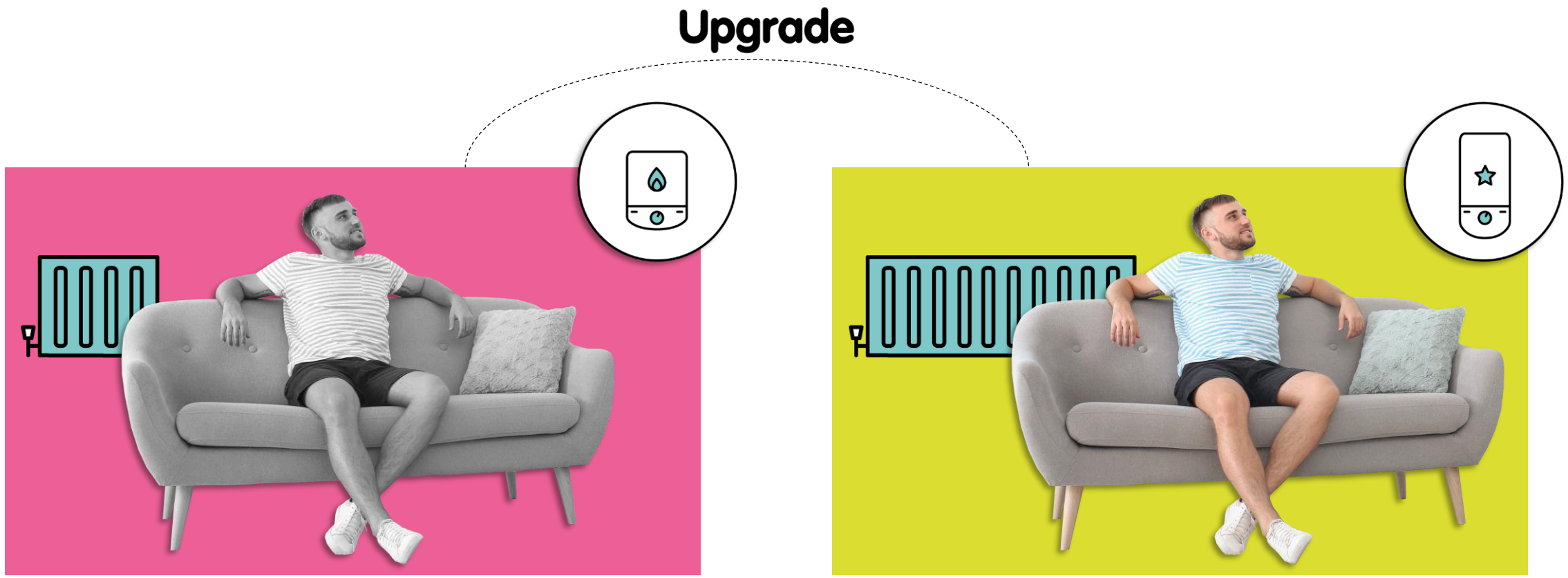
If energy services could guarantee people got the comfort they wanted, they might not care how it was delivered



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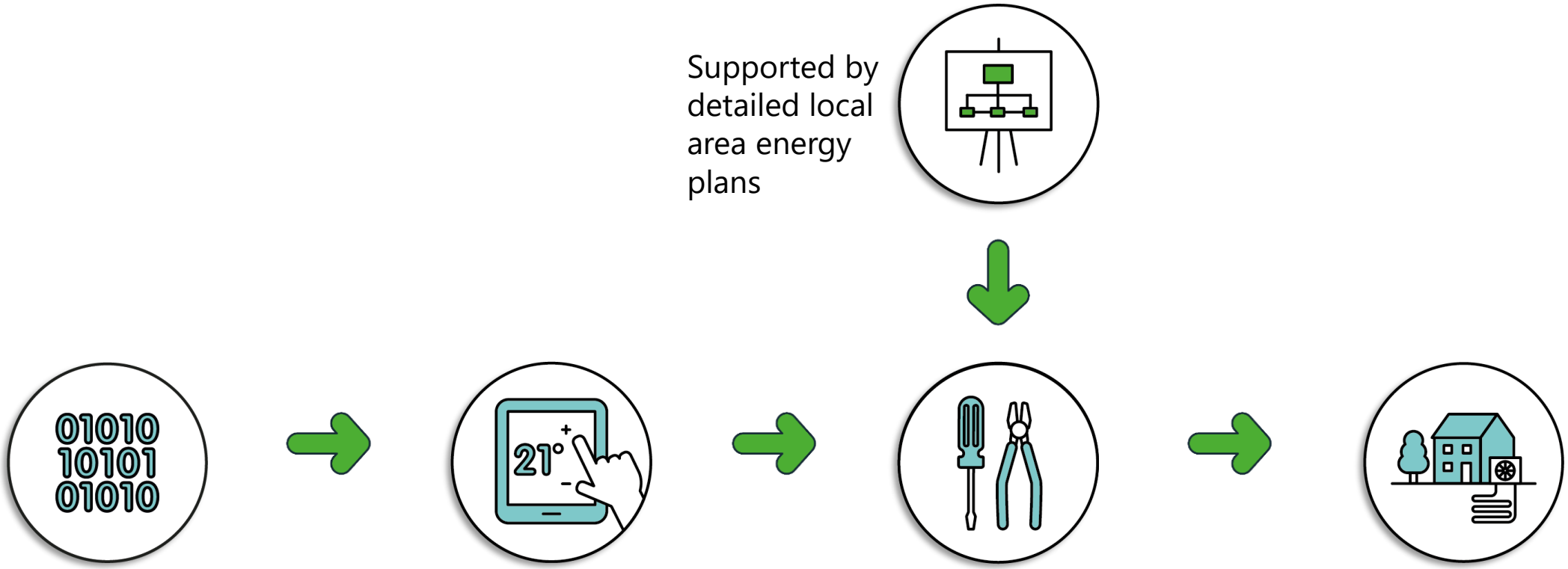
Demonstrated the potential of richer consumer data to offer households better products and services, including tailored retrofits that prepare their homes for low carbon heat



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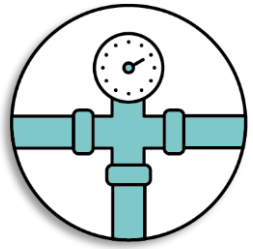
Some of the toughest challenges for decarbonisation will likely require local and regional coordination and action

How to decarbonise buildings and what combinations of fabric upgrades, heating systems and infrastructure in different local areas



The future of the gas network (including the potential of hydrogen)

How to minimise the costs of the transition for consumers, including integration of electric vehicles and low carbon heating

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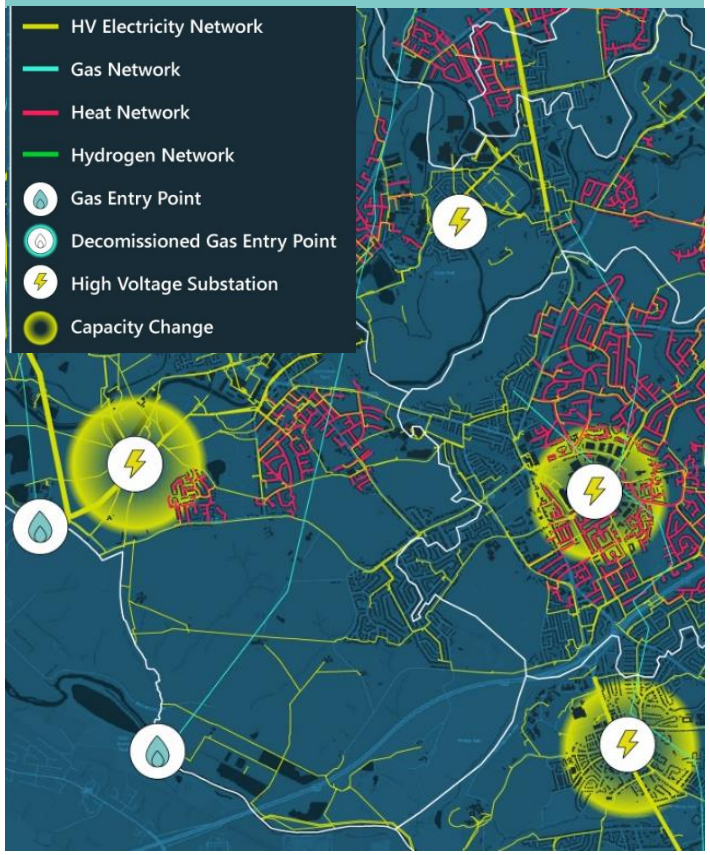
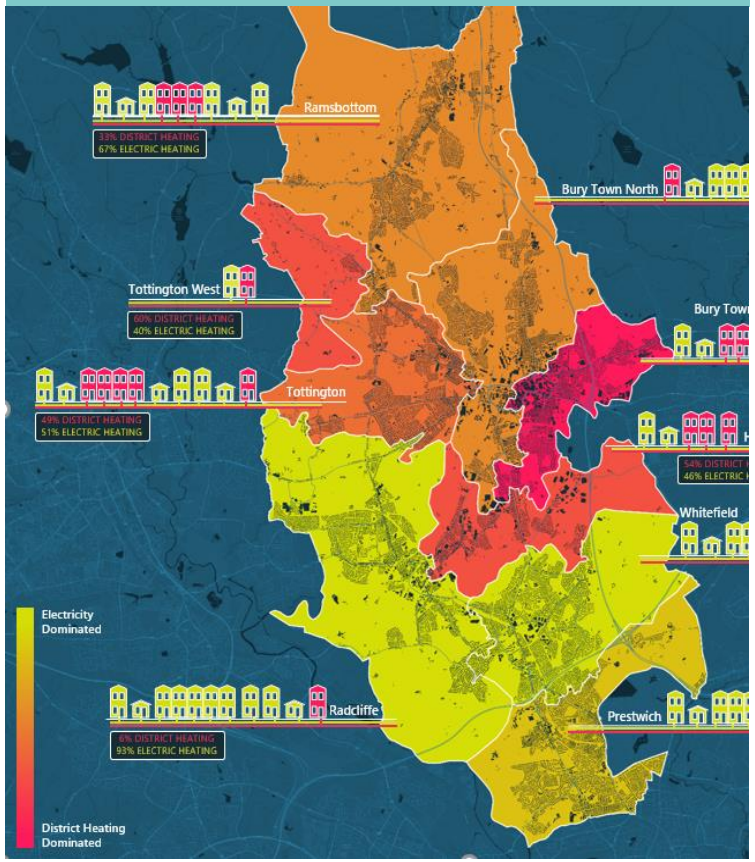
Developed a structured & repeatable framework

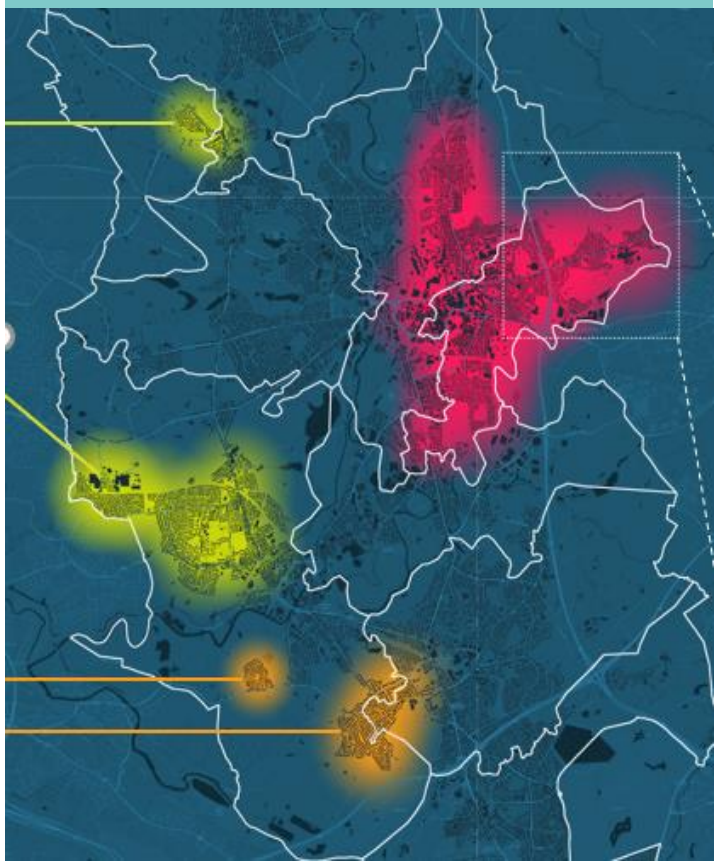
Understand **local options and choices for heat** in whole system context



Collaboratively develop a **long term evidence based plan** to decarbonise



Resulting in data and insight to **target innovation and deployment** projects



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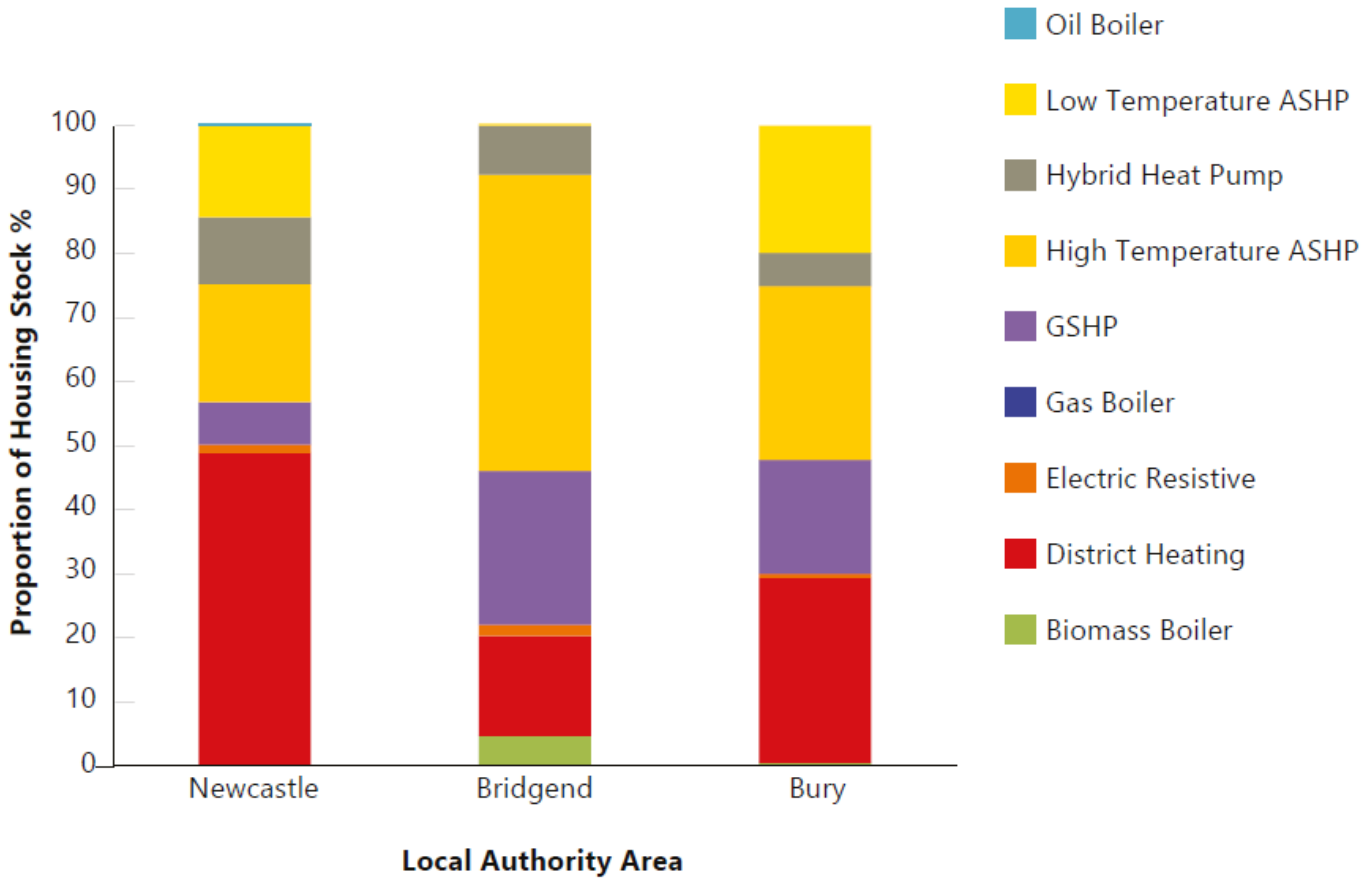
Local Perspective

Proportion of different heating solutions by 2050 in different local areas



Modelled Heat Pump uptake	NCC	BCBC	GM Bury
Existing Homes	125,000	60,000	80,000
Low Temp Heat Pump	19,000	1,000	16,500
High Temp Heat Pump	25,000	25,000	20,000
Ground Source	6,000	15,000	16,500
Hybrid Heat Pump	12,500	4,000	4,000

* Numbers given are indicative only based on stakeholder inputs to Local Area Energy Planning engagement

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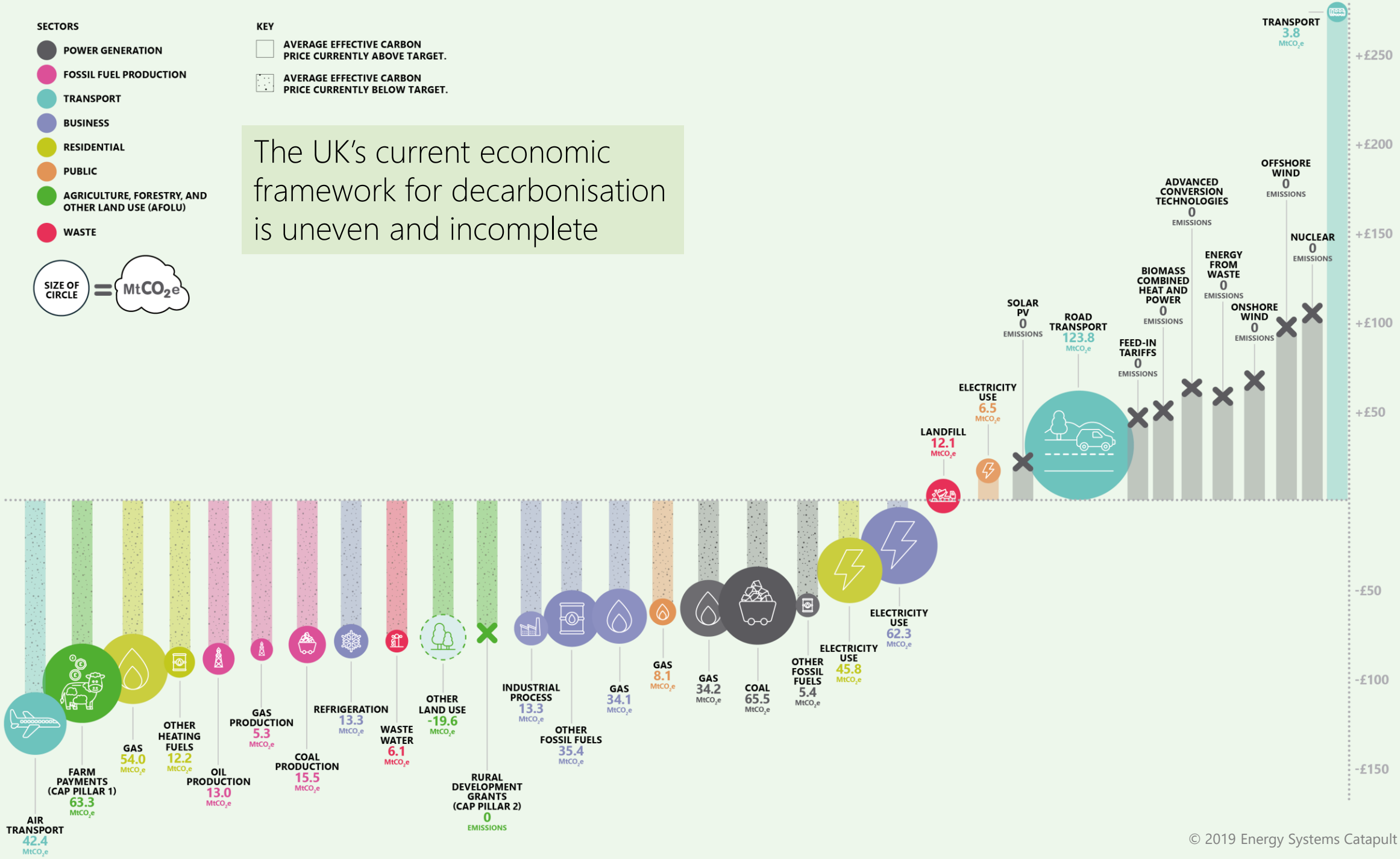
The UK's current economic framework for decarbonisation is uneven and incomplete



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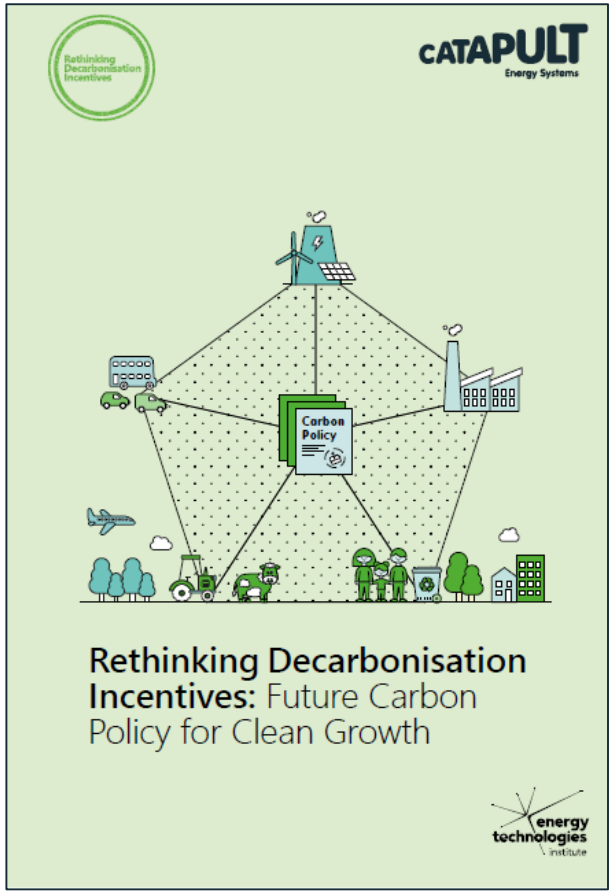
Rethinking Decarbonisation Incentives recommendations: market driver for low carbon heat is a crucial gap



1

Take opportunities to improve the current framework of policies by adjusting existing mechanisms to align incentives to reduce emissions across the economy.

2

Take immediate steps to progress a carbon policy driver for residential heat, including detailed design of an enduring framework of carbon standards.

3

Consolidate and streamline existing measurement, monitoring, and verification of all emissions and related incentives.

4

Develop a pathway towards a coherent set of interlocking sectoral instruments covering all emitting activities throughout the economy, with a linked market for greenhouse gas removals.

5

Integrate carbon reduction into the measurement of economic productivity, potentially through the Industrial Strategy Council.

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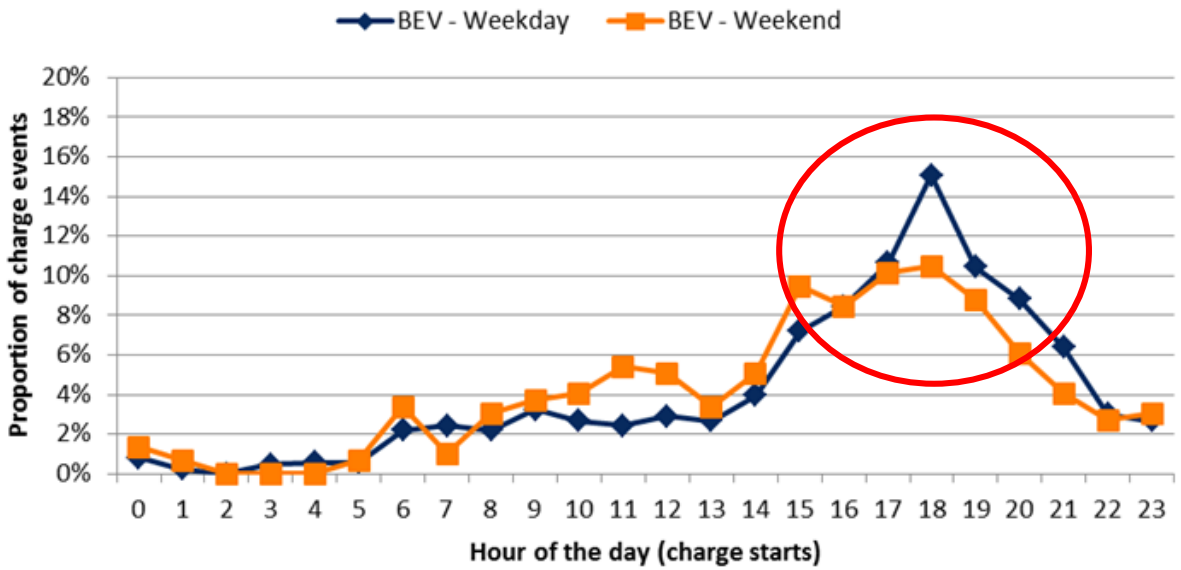
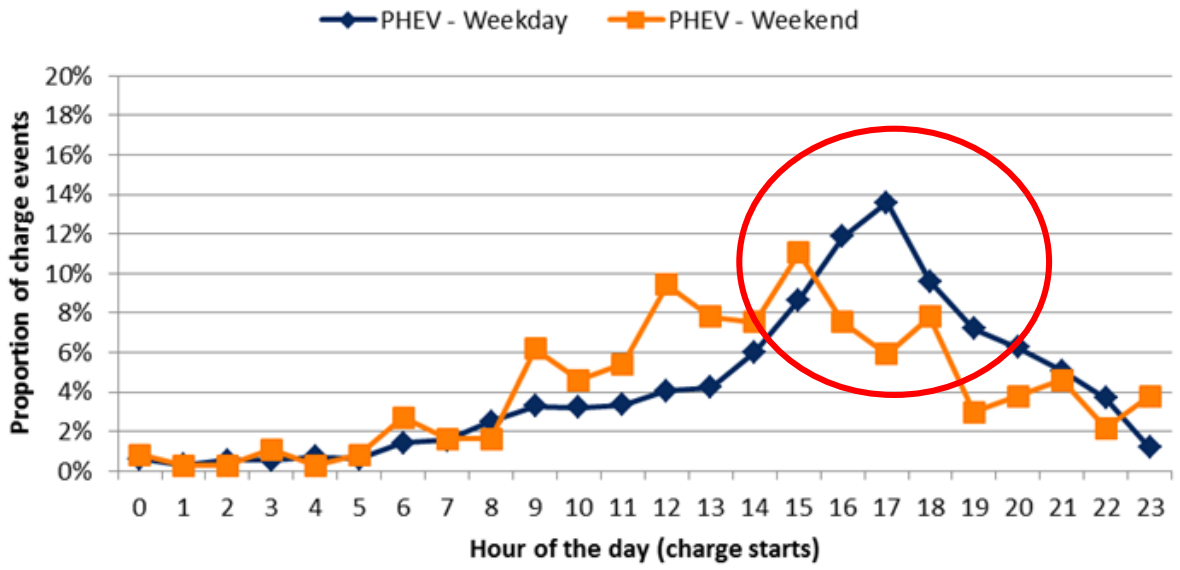
With unmanaged charging, consumers charge at existing peak times (16:00-19:00)

CVEI
Consumers, Vehicles and Energy Integration





- Without intervention, plug-in vehicles likely to accentuate existing peaks in electricity demand
- Could lead to issues in supply-demand balancing or local network capacity

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Managed charging is effective at shifting demand away from peak times

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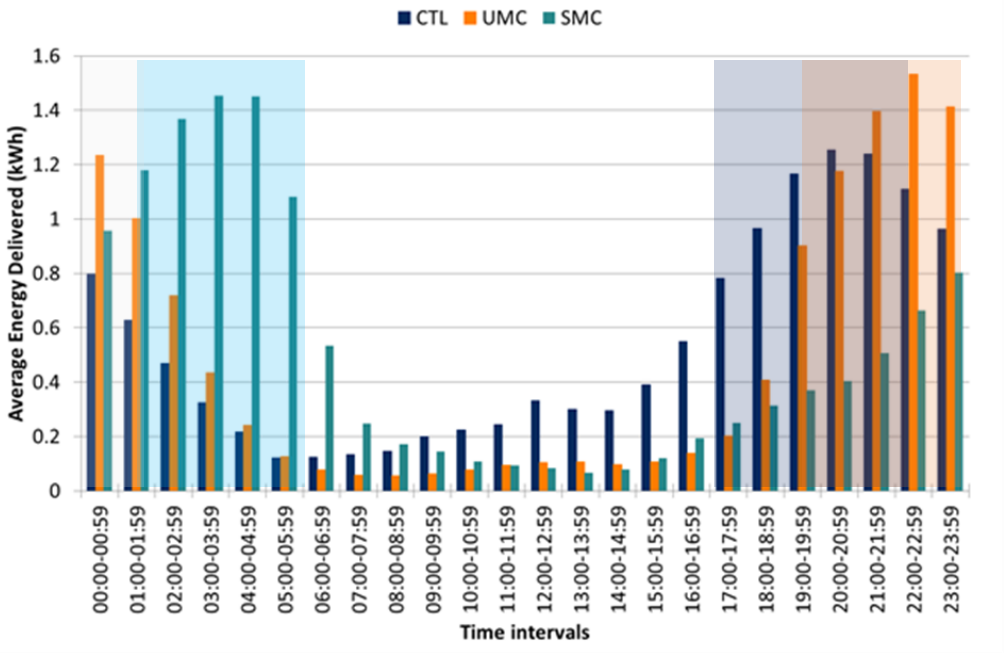
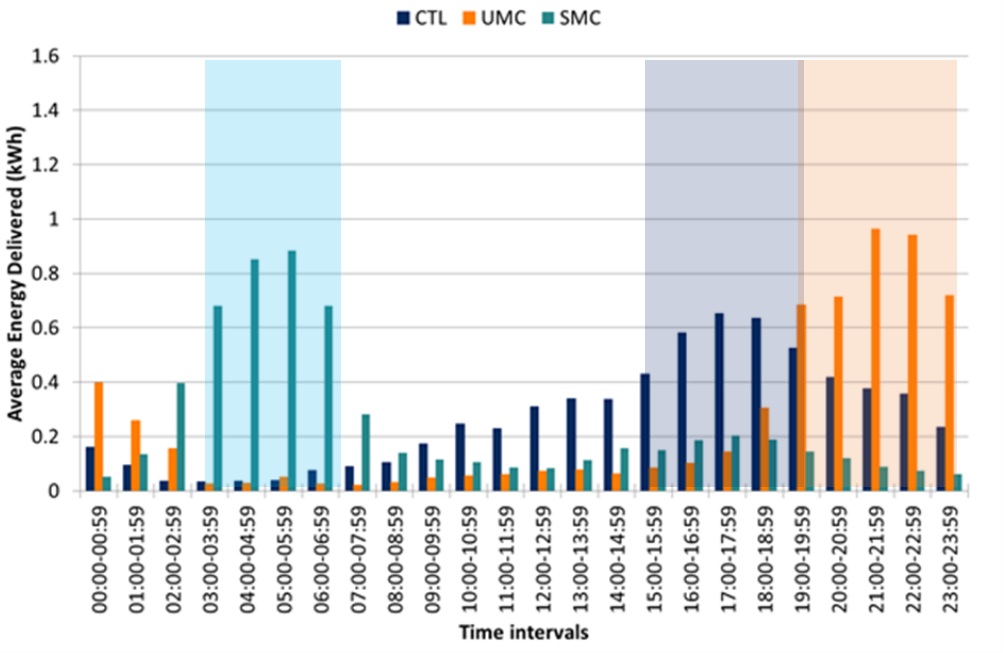
BEV



PHEV



Average energy delivered, per participant, per hour of the day

- UMC shifted charging to later in the evening; SMC shifted charging into the overnight period
- UMC and SMC-type systems can be effective solutions for managing demand

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Role of Demand Management

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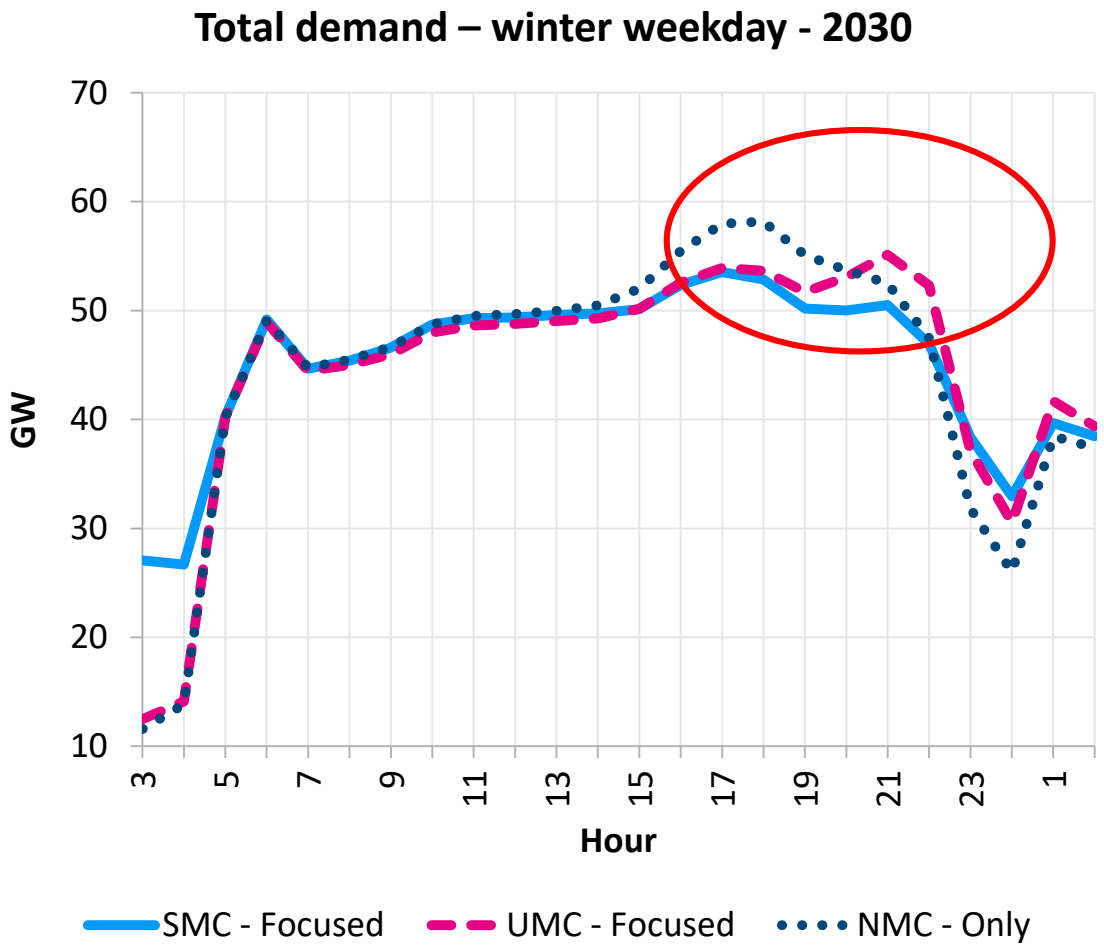

- Trial participants appear responsive to tariffs
- Significant ability to manage load
- Potential UMC ‘herding’ impacts

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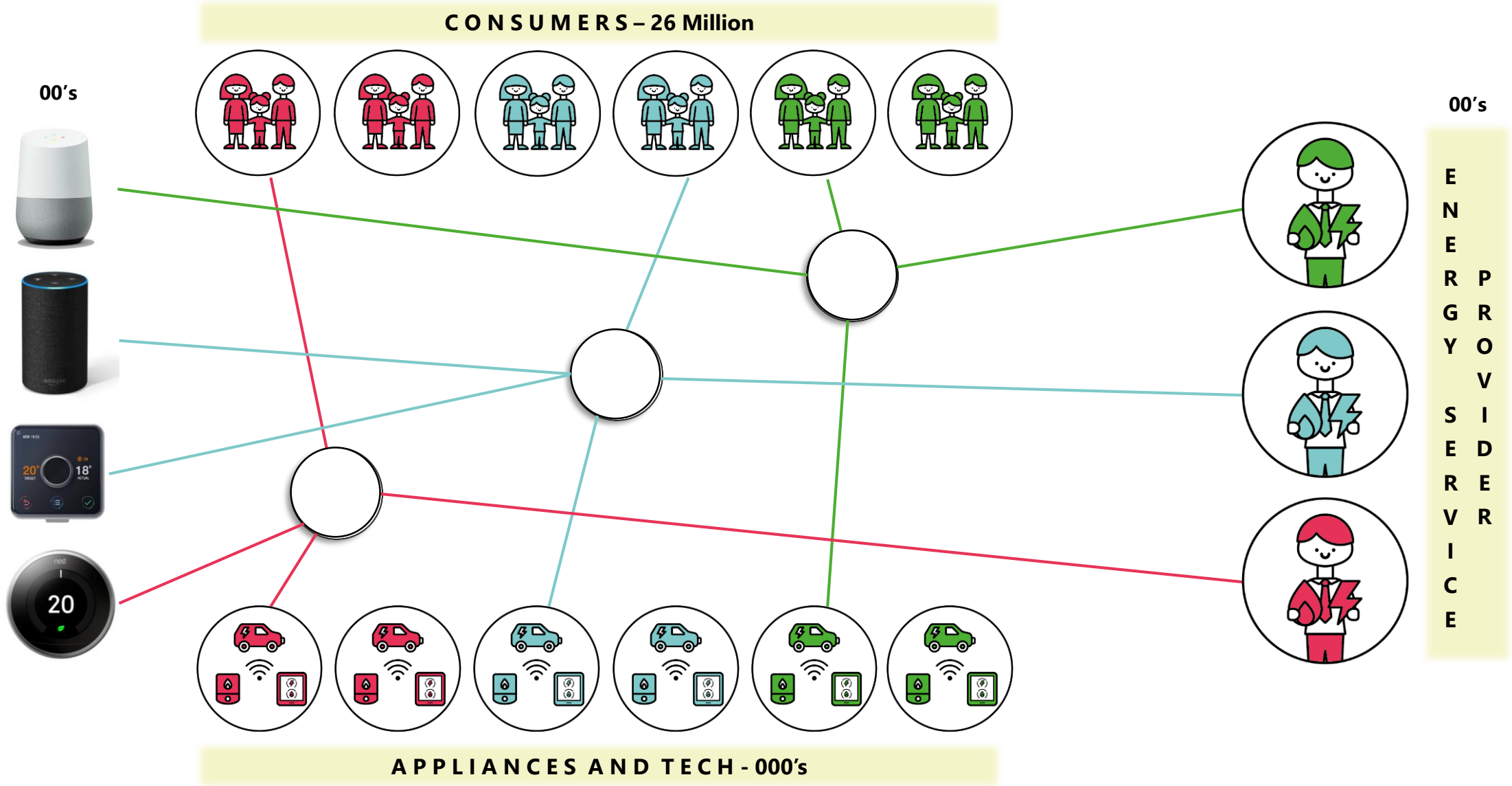
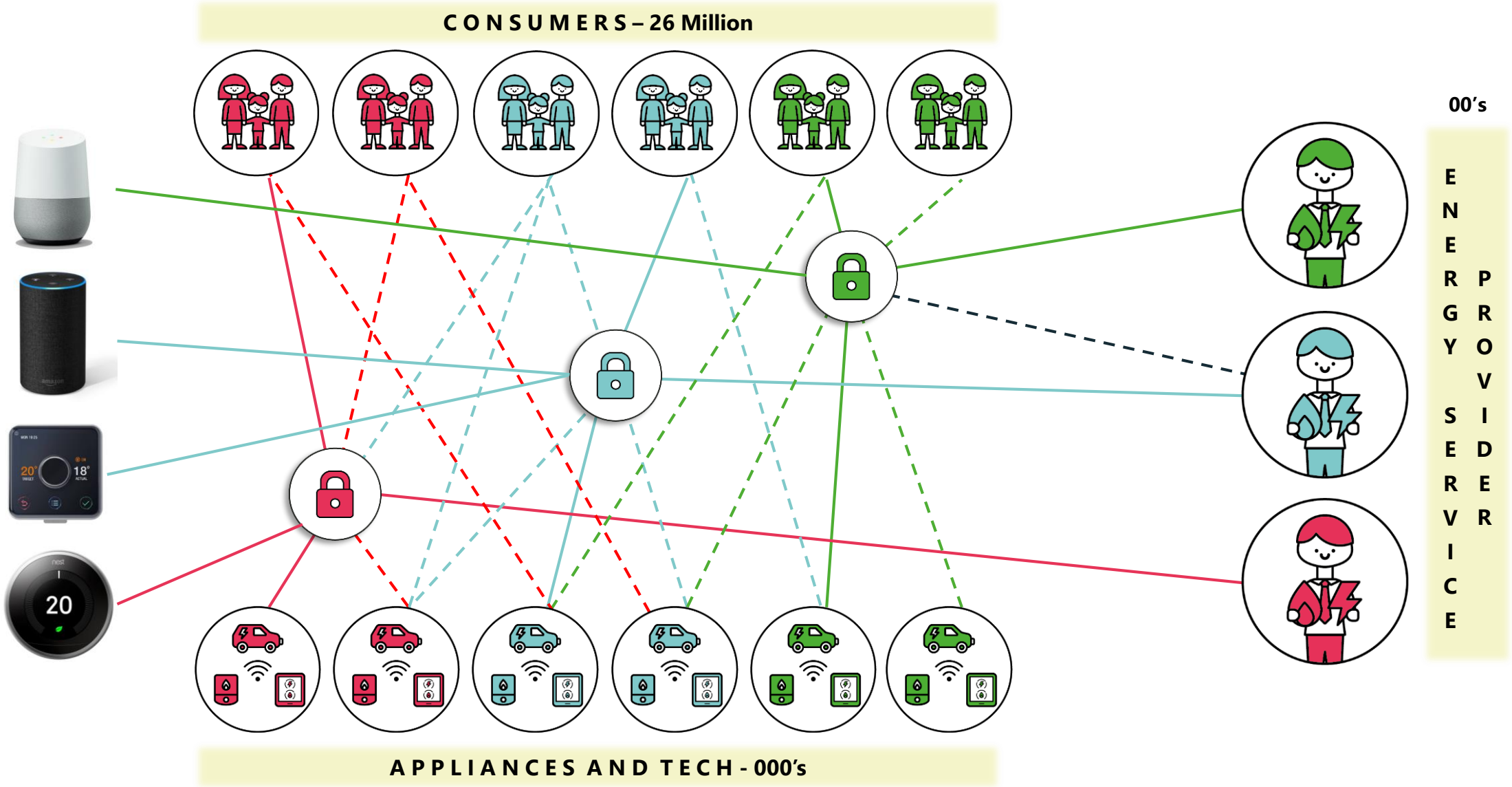
Today – digitalisation is starting to change energy market



But risks creating multiple bespoke solutions and “lock-in”



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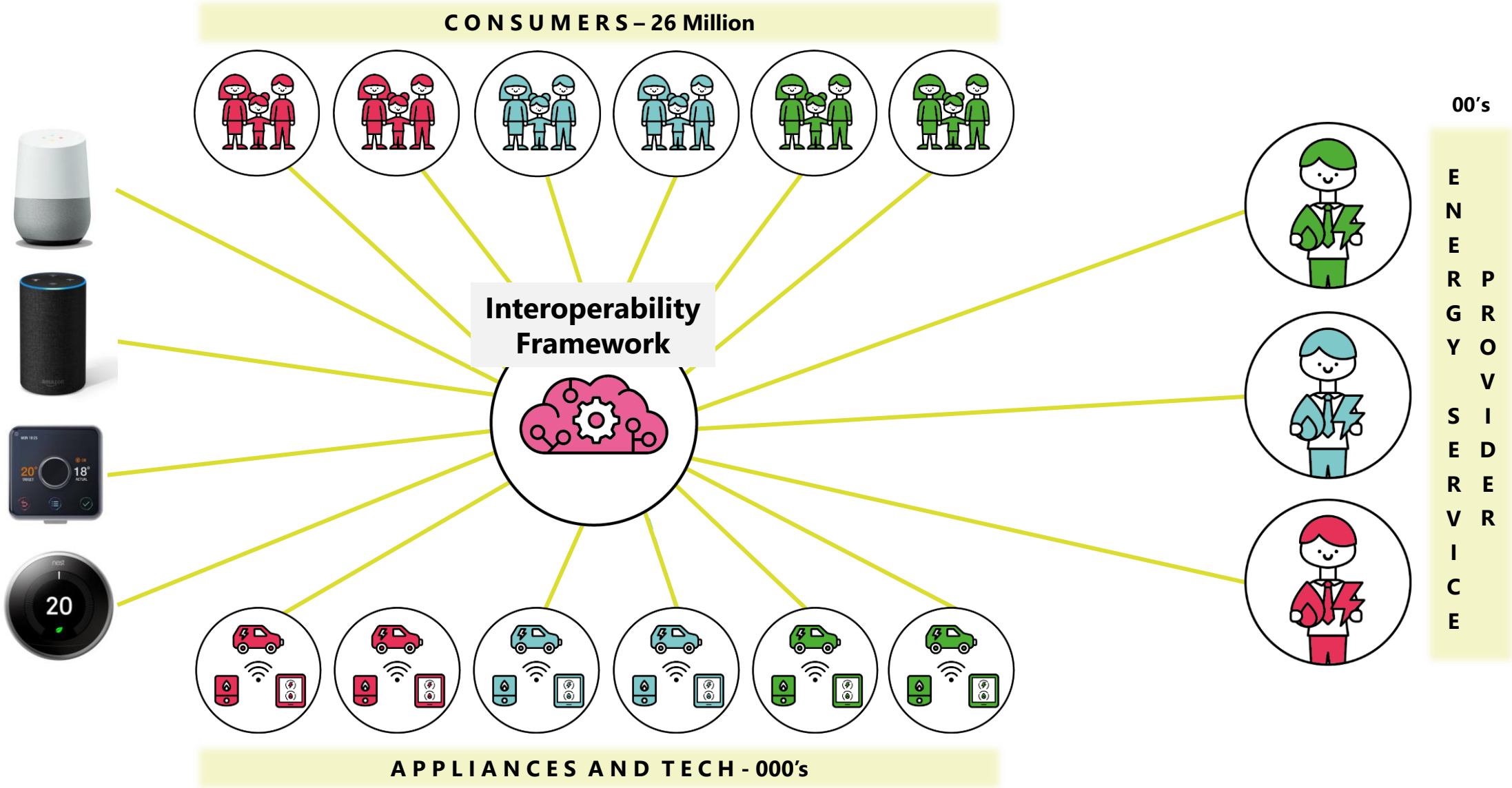
Open Interoperable & Competitive Market



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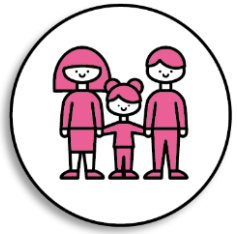
Future energy/heat system needs to be interoperable in different ways



Consumer

ensuring that provisions exist for consumers to switch between both different commercial offers and technology choices.

Commercial

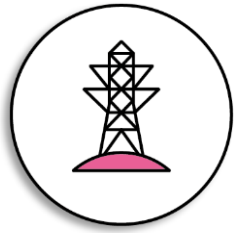
to ensure that incentives are aligned across the energy system to ensure that value can flow where it needs to, driven by market forces.

Data

to ease the sharing and portability of data between different systems.

Devices

to ensure that devices are swappable, replaceable and exchangeable as needs change and technologies develop and to allow consumers to make informed choices between open and closed eco-systems.



Physical

to ensure that end-to-end systems function as changes happen to parts of the system.

Vector

to ensure that energy provision across gas, electricity, heat, transport fuels etc. are compatible with one-another and that coordination occurs in a timely fashion.

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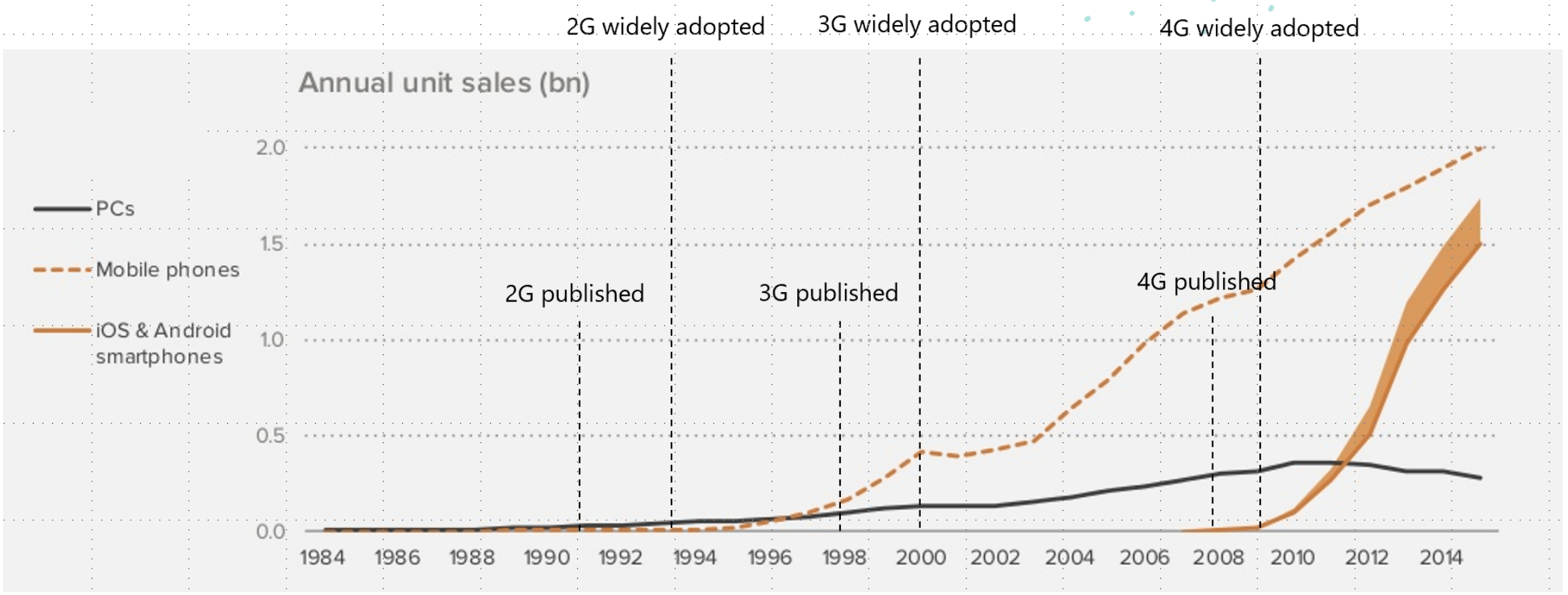
Need to learn from the success of the telecoms sector



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Key technologies and innovations for net zero

- Broad consensus on key technologies These include CCS, biomass, nuclear, offshore wind, low-carbon heating (electrification, district heating, hydrogen) and low-carbon transport solutions (electrification)
    - Innovation is important in these areas, but **increasing the availability and deployment of these technologies is critical and in some cases (e.g. CCS) significantly more valuable than innovation per se**
- **Innovation** is likely to deliver most value in terms of reducing overall energy system transition costs:
    - **Transport** – specifically cost reduction in low carbon light vehicles (e.g. EVs and batteries specifically), HGVs
    - **Nuclear (in particular Small Modular Reactors)** – accelerating cost reduction, developing heat recovery systems to enable the provision of heat for district heating, etc
    - **Offshore Wind** – continued cost reduction, particular focus on floating offshore wind technology
    - **Low carbon heat solutions** – improvements in the quality, performance and cost of heat pumps, building fabric improvements, supply chain and technical innovations within new-build and retrofit markets, etc
    - **Biomass** – improving resource availability through more sustainable land management practices, yield improvements, etc
    - **Hydrogen** - whole value chain improvements in low carbon / low cost hydrogen production (primarily via biomass with CCS)
- **Some technologies that are likely to have been undervalued in ESC analysis** (e.g. technologies delivering system flexibility services, including some types of energy storage). Further analysis is needed.
- Understanding the risks and opportunities of **digitalisation** will be central to the transition

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Key messages

- 80% target was hard. Net Zero is **very hard**
- Modelling can get only you so far. Significant unknown is **how consumers will respond** to necessary changes
  - Heating, Transport
- **Broad consensus on key technology options needed.** Inc. CCS, biomass, nuclear, offshore wind, low-carbon heating (electrification, district heating, hydrogen), EVs. But **inherent uncertainty** about 'right' mix
- Net Zero very unlikely to happen without **robust policy.** An **ecosystem** of low carbon regulation, planning/co-ordination, markets, pricing, innovation required
  - Inc. need for more granular price signals (Rethinking Electricity Market Design)
- Understanding the opportunities *and* risks of **digitalisation** is essential

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