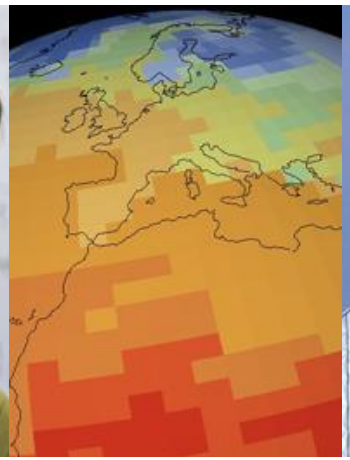
Environmental *Change* Institute

Electricity demand management in a cool climate – a little theory and quite a lot of practice

Sarah Darby







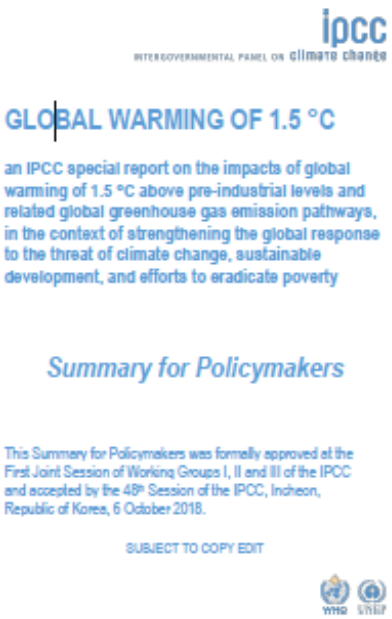

Energy Colloquium, November 6th 2018

Why demand management/demand response? International agreement, scientific consensus

Paris agreement + IPCC scientific report

- *To keep to 1.5°C mean warming, CO_2 emissions need to decline by ~45%, 2010 -2030, and hit net zero in 2050. (For 2°C, ~20% by 2030, net zero by 2075.)*

- *Buildings should use power for 55% - 75% of total energy by 2050; transport should boost low-emission sources to 35% - 65% of supply, from <5% in 2020*



Why? National/local reasons

- Growth of renewable (intermittent) generation, e.g. in 2017 UK generation from coal fell by 27%, gas fell by 4.6%, whilst renewables rose by 19.5%, reaching record high level of 29.3% (DUKES 2018)
- Heat and transport electrification on policy agenda

- New demand and small-scale generation are ‘clustered’ – can strain local networks

What, where, when? Opportunities for flexible demand

- Energy-intensive industry: interruptible contracts

- Commercial/third sector loads eg supermarket freezers, hotel air-conditioning, office lighting

- Residential loads eg 'wet' appliances, water heating, space heating
- In UK, residential el accounts for ~30% of total demand but ~50% of peak demand*

DUKES 2018; Ofgem 2010

Three distributed energy storage technologies

	Electric car	Smart water heating	Smart space storage Heating
			
Typical energy stored per day	10kWh (75km/day)	13kWh (210l /day at 65ºC)	54kWh (80m² home in winter)
Storage Media			
Cost per kWh storage capacity	€300	€0	€15

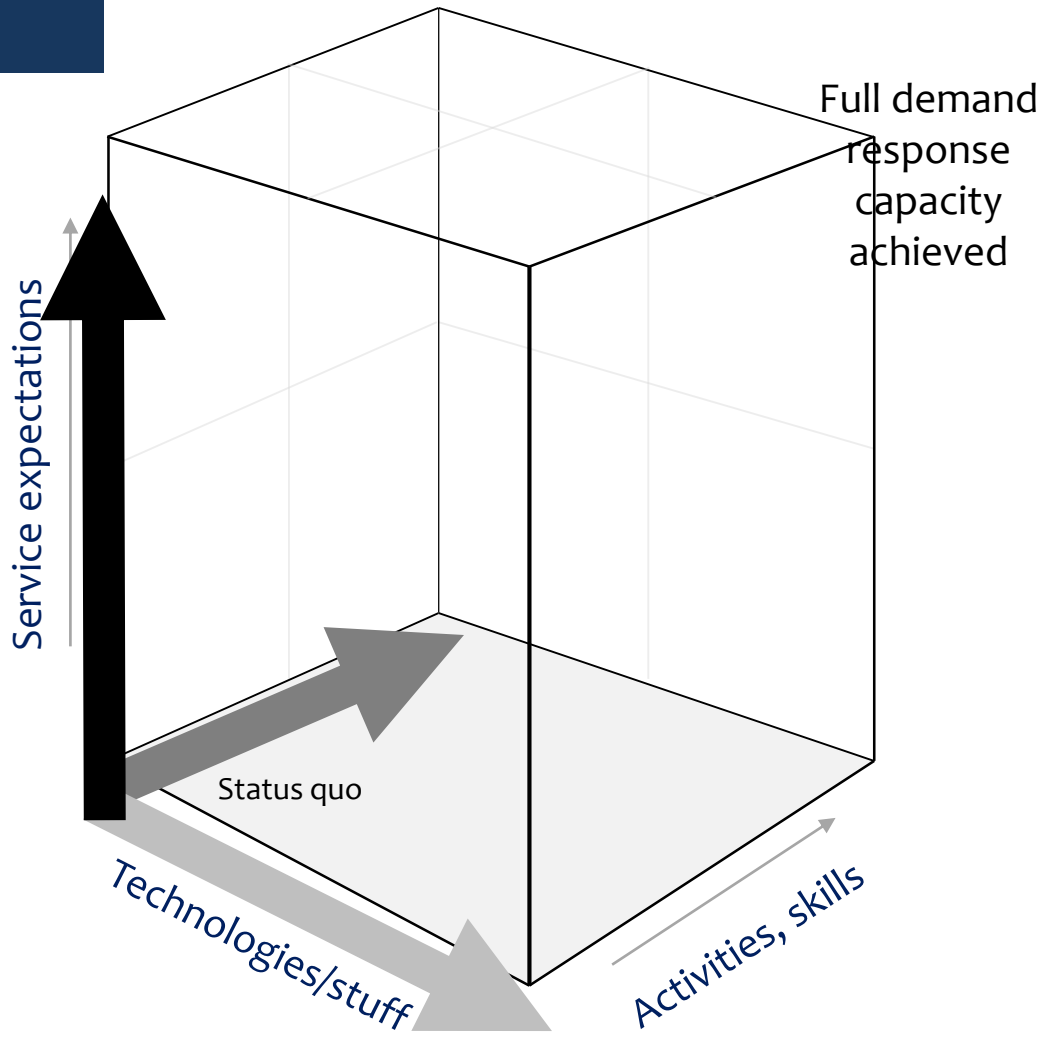
Cost estimates from Glen Dimplex

How do we achieve flexibility?

Change is possible in

- technology
- activities, abilities
- energy service expectations

Demand response potential = total 'volume'



McKenna, E., Higginson, S., Grünewald, P. and Darby, S.J. (2017) Simulating residential demand response: Improving socio-technical assumptions in activity-based models of energy demand. *Energy Efficiency* 10(44), 1-15

The (H2020-funded) *RealValue* trial aimed to demonstrate how small-scale 'smart' thermal storage in three countries could benefit energy market participants throughout EU

Smart Electric Thermal Storage (SETS) in demonstration trials in ~800 homes and businesses in Germany, Ireland and Latvia

SETS could be a direct replacement for electric (night-time) thermal storage heaters and water tanks with a combined load of 55GW across the EU. Could also replace direct electric resistance heaters with further connected load of 93GW.

RealValue

The Oxford contribution: ‘customer impact study’, plus contributions to modelling WPs








http://www.realvalueproject.com/images/uploads/documents/RealValue_Consumer_Impact_Report_-_FINAL_%28Compressed_spread%29.pdf

What happened during the 3-year trial?

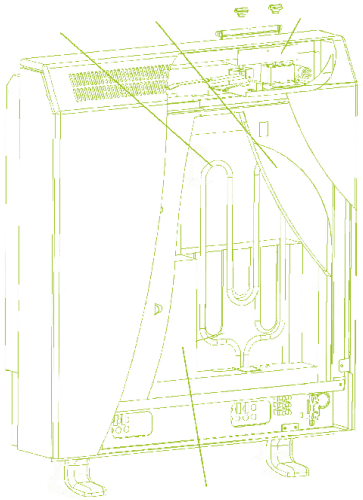
Recruitment of ~800 participant homes and small businesses in Ireland, Germany and Latvia; *installations* of storage heaters and water cyclinders (usually replacements), gateways, sensors, smart meters; data gathering, *modelling, analysis, synthesis*.

Recruitment and installation took longer than expected and connectivity took even longer: heaters were not available for fully-flexible charging until the final 5-6 months of the project.

Findings are mostly about *preparation* for demand response and about customer experiences of smart(er) thermal storage.

Smart storage heating offer to householders

from



to

Methods


Surveys
Customer Data
(call logs, bills etc.)
Interviews & Focus Groups
Understanding Consumer Engagement
Telemetry / SETS Usage Data
Observation
Engaging with 'middle actors'
(installers, housing managers, call centre staff)

Findings

‘Actors’ involved in making smart thermal storage work for customers and for the system

Customers
Installers
Neighbours

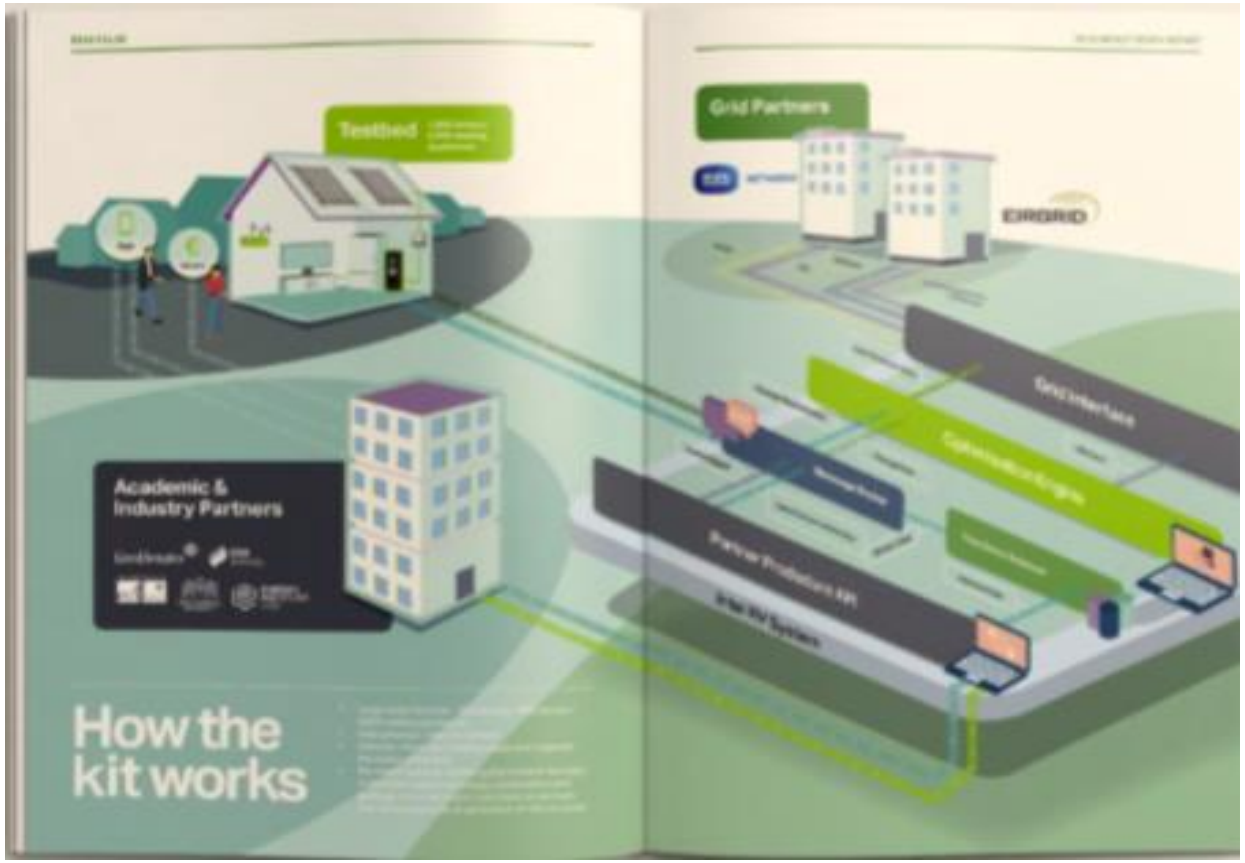
Housing managers

Designers and manufacturers of equipment, controls, apps

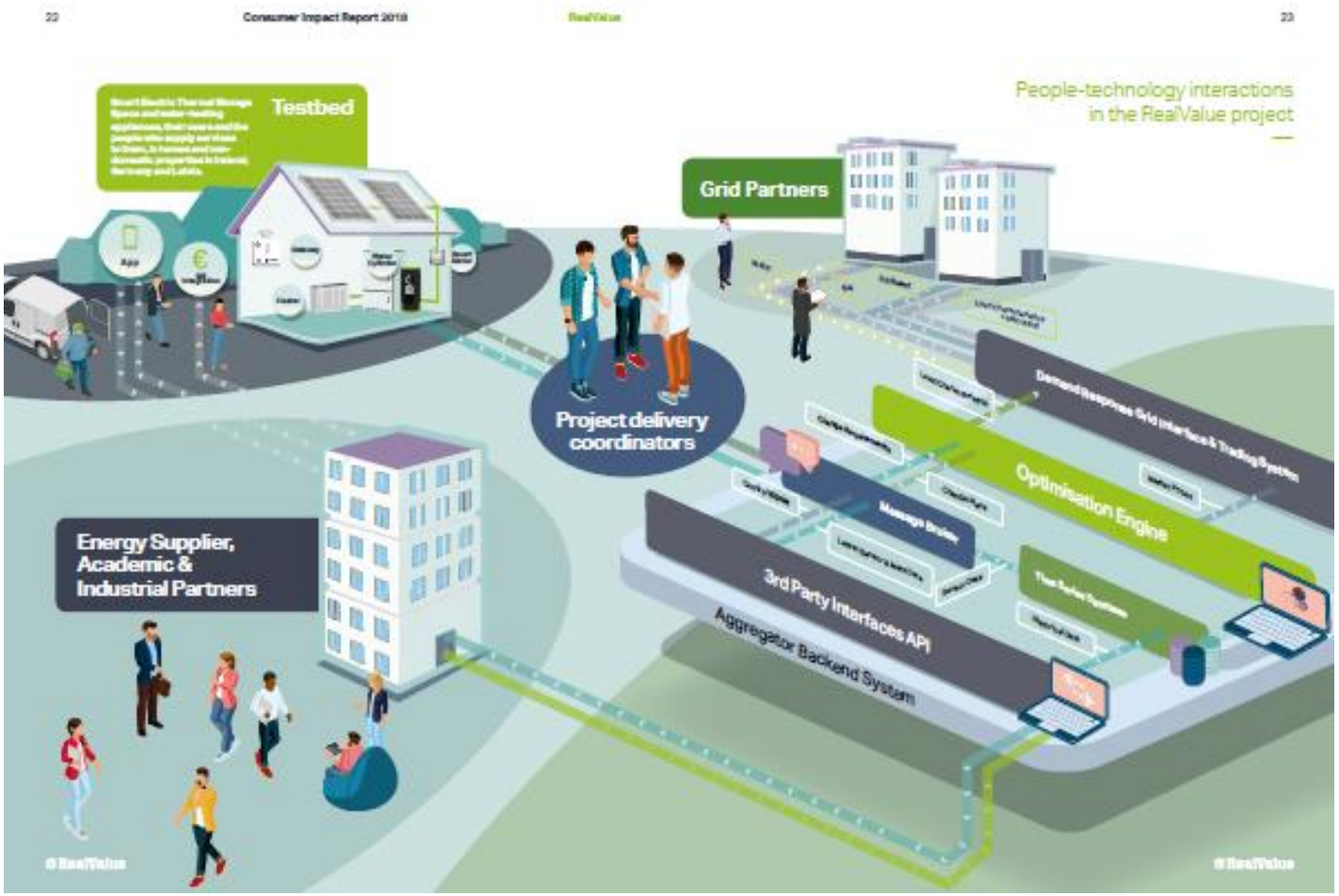
Energy retailers
Aggregators
Network operators
Grid operators

Storage heaters
Hot water cylinders
Buildings
Controls, apps
Gateways, smart meters
Aggregation platform

Initial summary picture of RealValue system



Final guide to the RealValue system



http://www.realvalueproject.com/images/uploads/documents/RealValue_Consumer_Impact_Report_FINAL_%28Compressed_spread%29.pdf

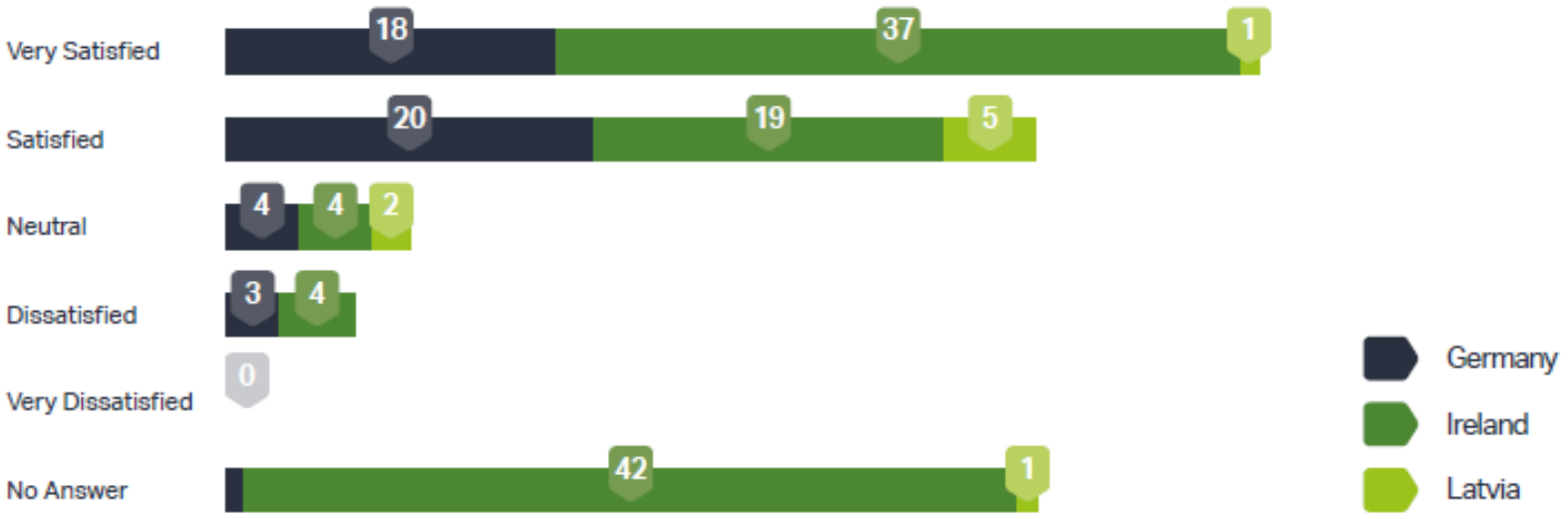
Actors needed to manage customer issues with SETS

Customer problem	Retailer / supplier	Appliance provider	Gateway provider	Product installer	Housing provider / adviser	Broadband provider
Invoice / bill / usage	√				√	
Heater/ cylinder	√	√		√		
Broadband	√					√
Smart meter	√					
Gateway	√		√			
Plumbing				√	√	
Comfort levels	√				√	

High levels of satisfaction with new Quantum storage heaters (more heat when needed, better design)

Figure 7: Responses to survey question: How do you rate your new heating system in general, compared with your old system?

Customer satisfaction with installation process



"(The) first few days (of having the appliances) it was difficult…. I think it was two weeks I was asking for help. I was asking to show this, to show this, to show this. But now it's okay. For me it takes maybe a week or two"

Irish customer interviews

Perceived change in electricity bills by end of project

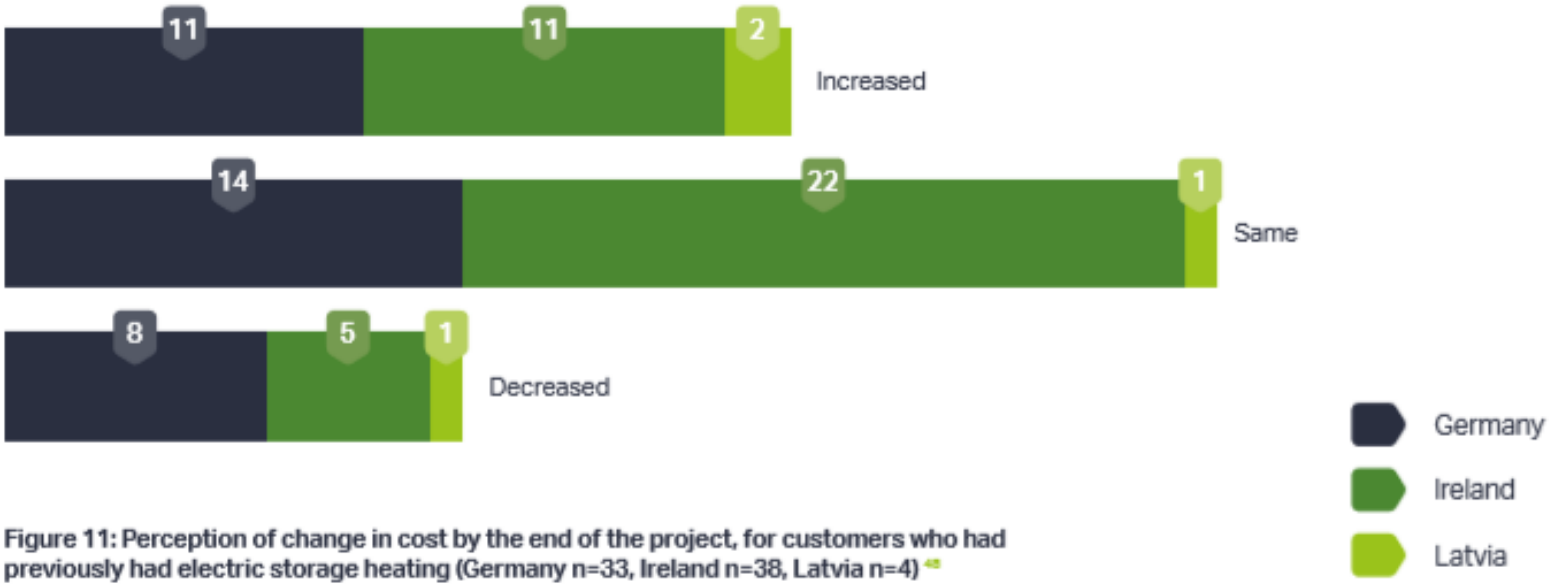
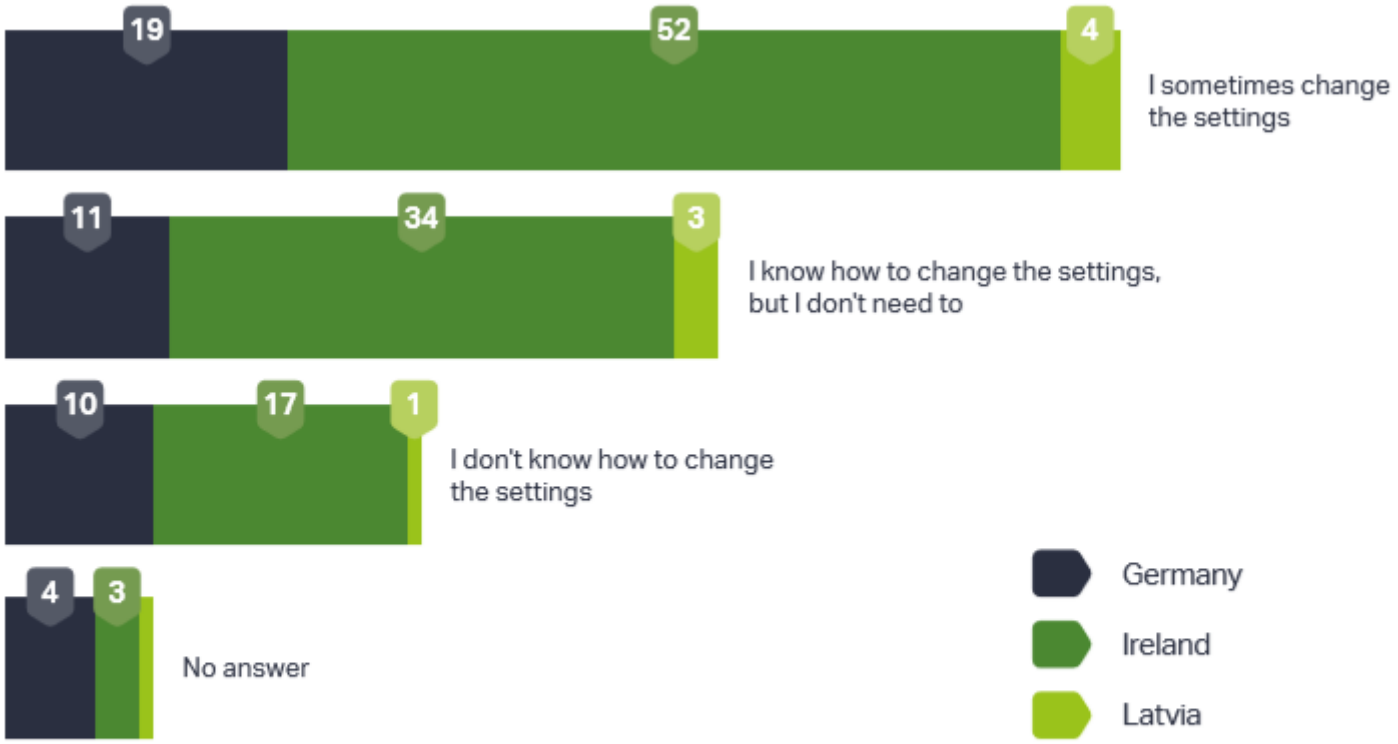


Figure 11: Perception of change in cost by the end of the project, for customers who had previously had electric storage heating (Germany n=33, Ireland n=38, Latvia n=4) [43]

Cost was important – but so was comfort

Figure 12: Customer assessment of cost vs. comfort at the start of the project

Customers’ stated confidence in operating controls



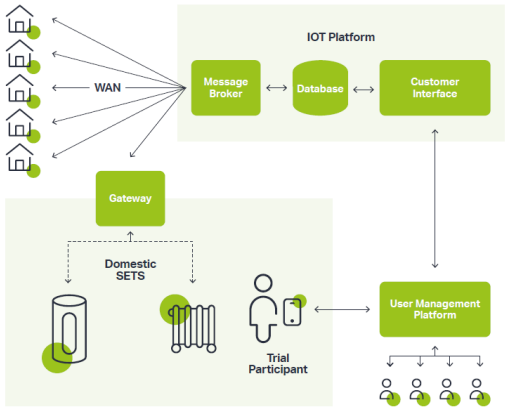
Technical reliability was essential – and not always straightforward

Internet of Things is in the news… clean technology, all these buzzwords are always being used, but yet, when it comes to the practicalities of doing a project with [hundreds of] *houses, it was … simply difficult in all those other technology categories, I would say.*

Project delivery coordinator, Ireland

In the beginning I was very enthusiastic about the heaters. This has however been increasingly diminished when weaknesses in the control became apparent due to the control software.

Customer, Germany



Five ‘C’s for good customer experience

- Comfort – accounted for most of customer satisfaction
- Cost – anxieties about this for many; some evidence (Germany) that costs fell when customers used heating ‘properly’
- Control – some customers found the new digital controls an improvement; many did not fully understand them
- Care – person-to-person guidance, e.g. from installers, advisers, housing managers and helpful neighbours
- Connectivity – tech functioning reliably

Big picture: reflections from project leaders

What we've improved … was the customer contact. We've really had discussions about how to contact the customers, via email, via letters … maybe, we will use social media more than before… sort of an invisible outcome. And another … with this complex situation… distribution network, billing, sales and the legal department, communications and metering… we have established a new network so that we can establish new products more easily and the understanding of all the issues by every department has grown immensely… I would say 30% of the funding should go to customer engagement.

Doris Wittneben, MVV Energie

Sometimes … negative things are more interesting than the positive… it's very interesting, these behavioural things because sometimes, as a technician, I am very oriented on the technical part, on the calculation… and not take into account what people think and that we need maybe another approach… to involve the people to our project… it's a good experience.

Diana Zalostiba, Riga Technical University

Recent developments

In Mannheim

… the most probable and worthwhile business case for beegy [part of MVV] as an aggregator would be to offer flexible charging (Flex Control) together with hardware components as a value- added service…

The first service is for the flexible charging of electric vehicles… based on the Virtual Power Plant developed by beegy, acting as an aggregator for flexible charging of SETS, during the RealValue project. Together with the charging service comes an App, providing transparency to the customer on flexible charging and its effects on comfort as well as on cost and CO_2 savings.

The service is commercialized under the name of "Hermine – die Ladesteuerung", announced during the Intersolar Europe fair in May 2018 and the emove360 fair in October 2018.

Beegy report to funders; https://www.beegy.com/loesungen-fuer-ihre-kunden/hermine-die-ladesteuerung/.

In the UK

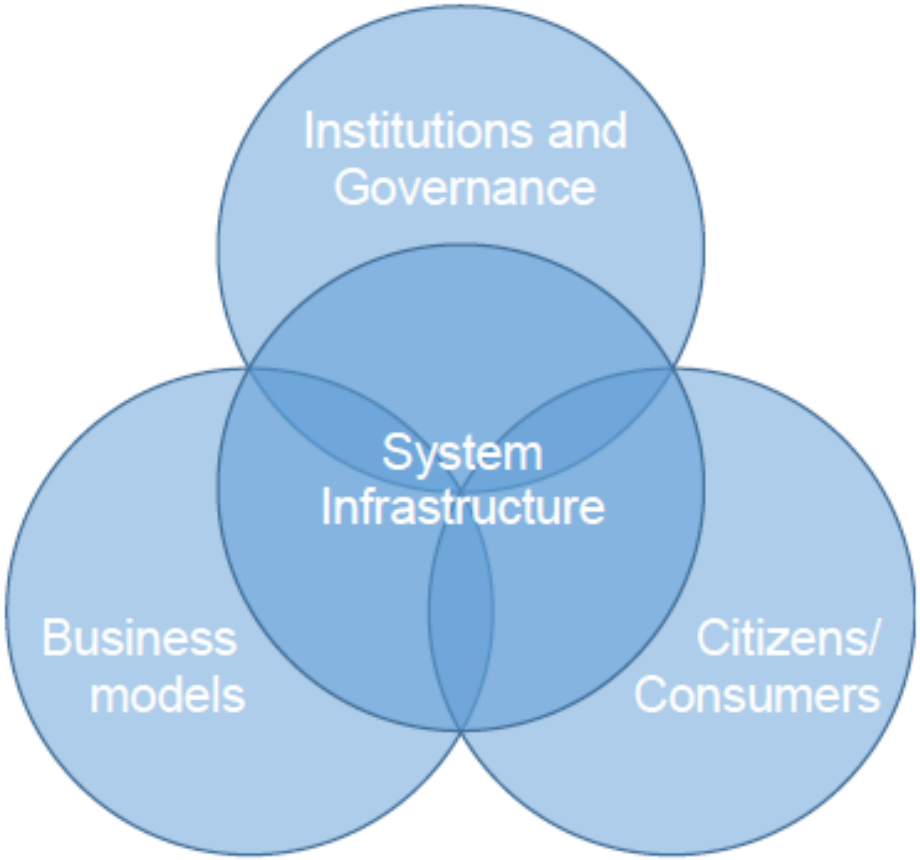
Heat Dynamo

The OVO Energy team launched … the Heat Dynamo… an ultra-low latency, IoT-connected, multi-purpose load switch that can be retrofitted to an electric storage heater to give it smart controls."

… OVO is also working with manufacturers of electric storage heaters to build its V[ehicle]Charge intelligence directly into them. The first appliances with this capability baked in will be launched later in 2018.

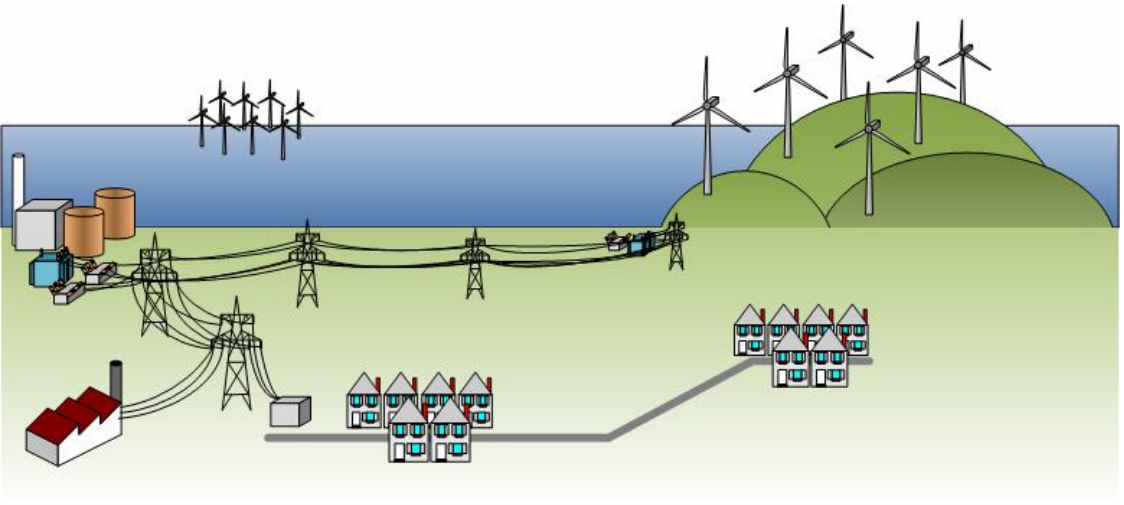
https://cleantechnica.com/2018/04/19/ovo-energy-drops-4-product-bombshells-including-new-vehicle-to-grid-charger/

Four categories of change needed for rapid decarbonisation (and flexibility)



Eyre, Darby, Grünewald, McKenna and Ford, 2018

Smart grids: where are the people?



Designing markets, tariffs, algorithms

Operating infrastructure

Inventing and installing software and hardware

Training, trading, regulating, lobbying…

Keeping warm, fed, clean, connected, entertained and mobile

Adopting and adapting technologies;

Buying, maintaining and tweaking /hacking buildings and appliances

Contributing to network activity + flexibility through demand response, generating, storing., trading…