Residential energy, technology adoption and modelling

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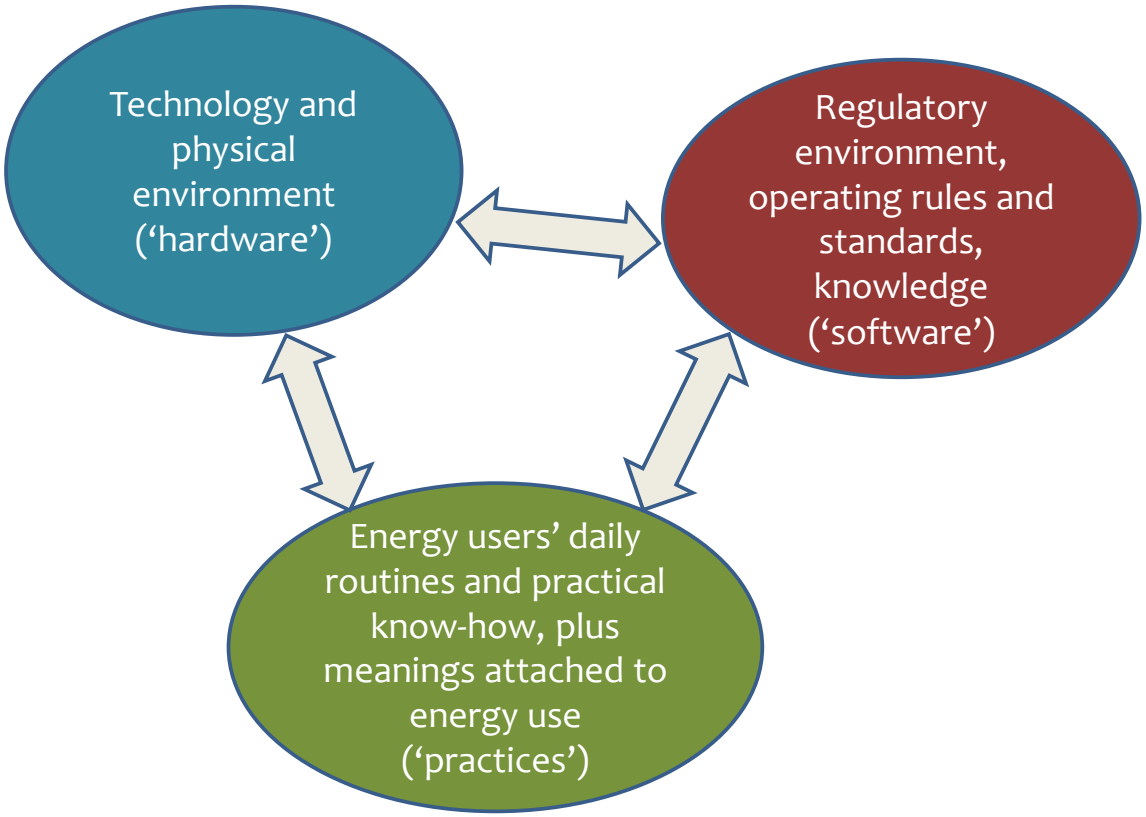
Real Value

Energy systems are technological *and* social, linking people, 'hardware' and 'software'…



Achieving affordable energy services is a skill learned through experience in specific situations, in company with others.

'Improved housing performance will benefit from a comprehensive strategy embracing *user expectations, perceptions, and interactions with building interfaces*, alongside physical monitoring.'

(Stevenson and Rijal, 2010)

Pace of change depends on how easily we can learn from our systems.

How much variability within household demand?

1. from detailed household-level study of 1627 California households

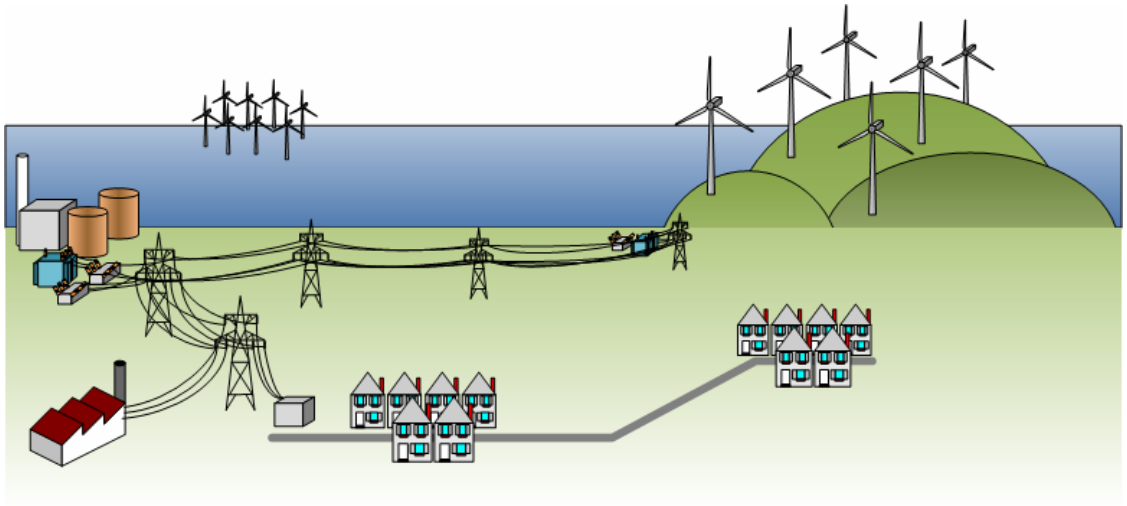
- only 9% variation in electricity usage due to building characteristics
- 17% due to 'environment' (= other physical factors)
- 36% to social variables (eg income, tenure, ethnicity, occupancy)
- 39% to *joint* effects of people, environment and buildings (impossible to differentiate)

(Lutzenhiser and Bender 2008)

2. Heating consumption in similar Copenhagen homes can vary by a factor of 3, and electricity consumption by factor of 5 (Gram-Hanssen, 2013)

3. US Residential Energy Consumption Survey - for almost all income categories, electricity usage varies by a factor of 3-4 (Sanquist et al., 2012)

Smart grids: where are the people?



Designing markets and tariffs

Operating infrastructure

Inventing and installing software and hardware

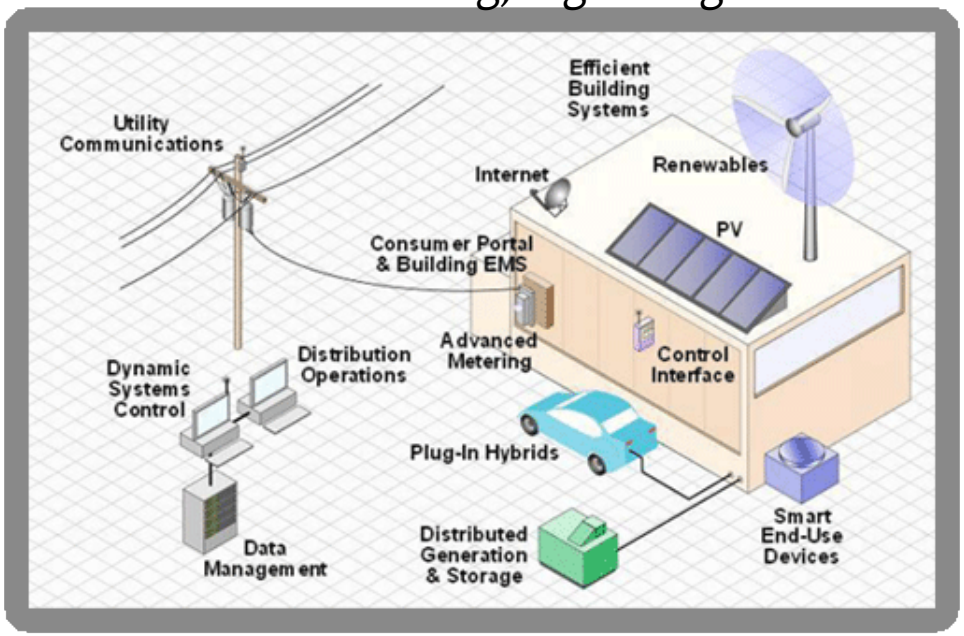
Advising, lobbying, trading, training, regulating …

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

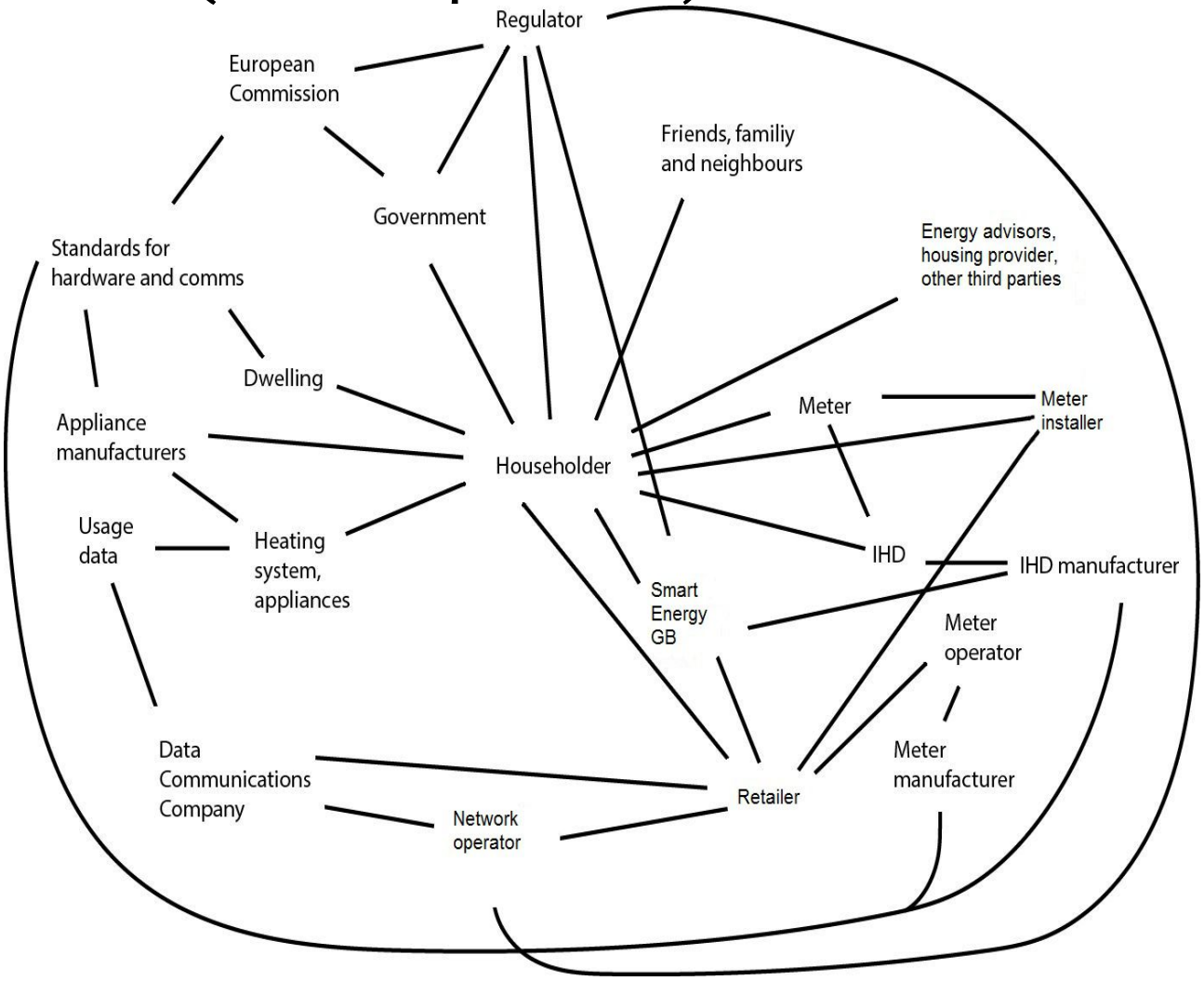
Adopting and adapting technologies

Buying and maintaining buildings and appliances

… maybe assisting with network management through load reduction and load-shifting.



An actor-network for residential smart metering in Great Britain (it's complicated)



Potential significance of smart grid functionalities at various levels (from a SG modelling exercise, 6 EU countries, 2020)

Table 3 Indicative smart grid functionality support in selected EU markets

Smart grid functionality support	Austria	France	Germany	GB	Portugal	Spain
Energy efficiency—commercial	2	2	3b	3b	0	0
Energy efficiency—residential	2	2	2	3b	0	0
Smart meters—real-time and billing feedback	2	2	2	3b	0.5	0.5
Static TOU tariffs	0.5	2	0.5	3b	0	0.5
Critical peak pricing tariffs	0.5	2	0.5	3b	0	0.5
Spot prices/feedback alerts	0	0.5	0.5	0.5	0	0.5
Home and office automation—autonomous control	0.5	0.5	2	2	0	0.5
Home and office automation—direct control (aggregated)	0	0.5	0	3b	0	0
Home and office automation—autonomous (price responsive)	0.5	0.5	0	2	0	0.5
C&I demand response	0	3a	3a	4	0	0.5
Electricity storage, micro	2	2	3a	4	4	4
Micro/macro CHP support	2	3b	3a	4	3a	3a
Electric vehicles—night charge	2	2	2	2	3b	2
SG functionality points	14	22	21.5	36.5	10.5	12.5
Generation decarbonisation	3a	3a	0[a]	4	4	4
Increase transmission interconnection	2	2	3b	3b	2	2
Microgeneration wind and PV	3a	4	4	4	4	4
Efficiency measures unrelated to SG	3a	3a	4	4	3a	3a
Overall market points	25	34	32.5	51.5	23.5	25.5

4 existing strong policy, *3a* existing weak policy, *3b* planned and funded, *2* planned, weak, *0.5* undecided, *0* unsupported

Darby, Strömbäck and Wilks, 2013

Modelled emissions savings in two SG scenarios, from detailed wholesale market model and high-level ancillary services model

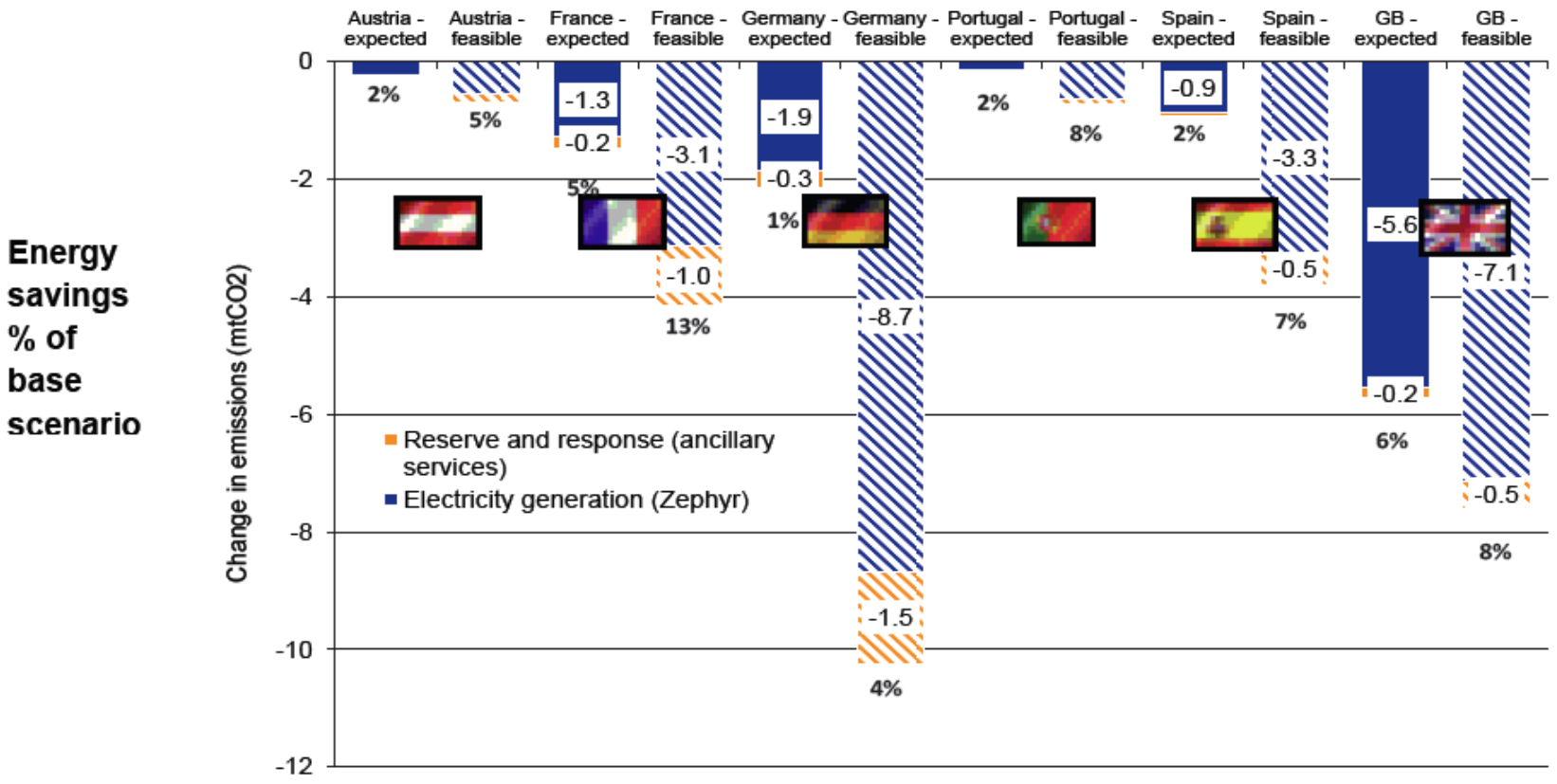
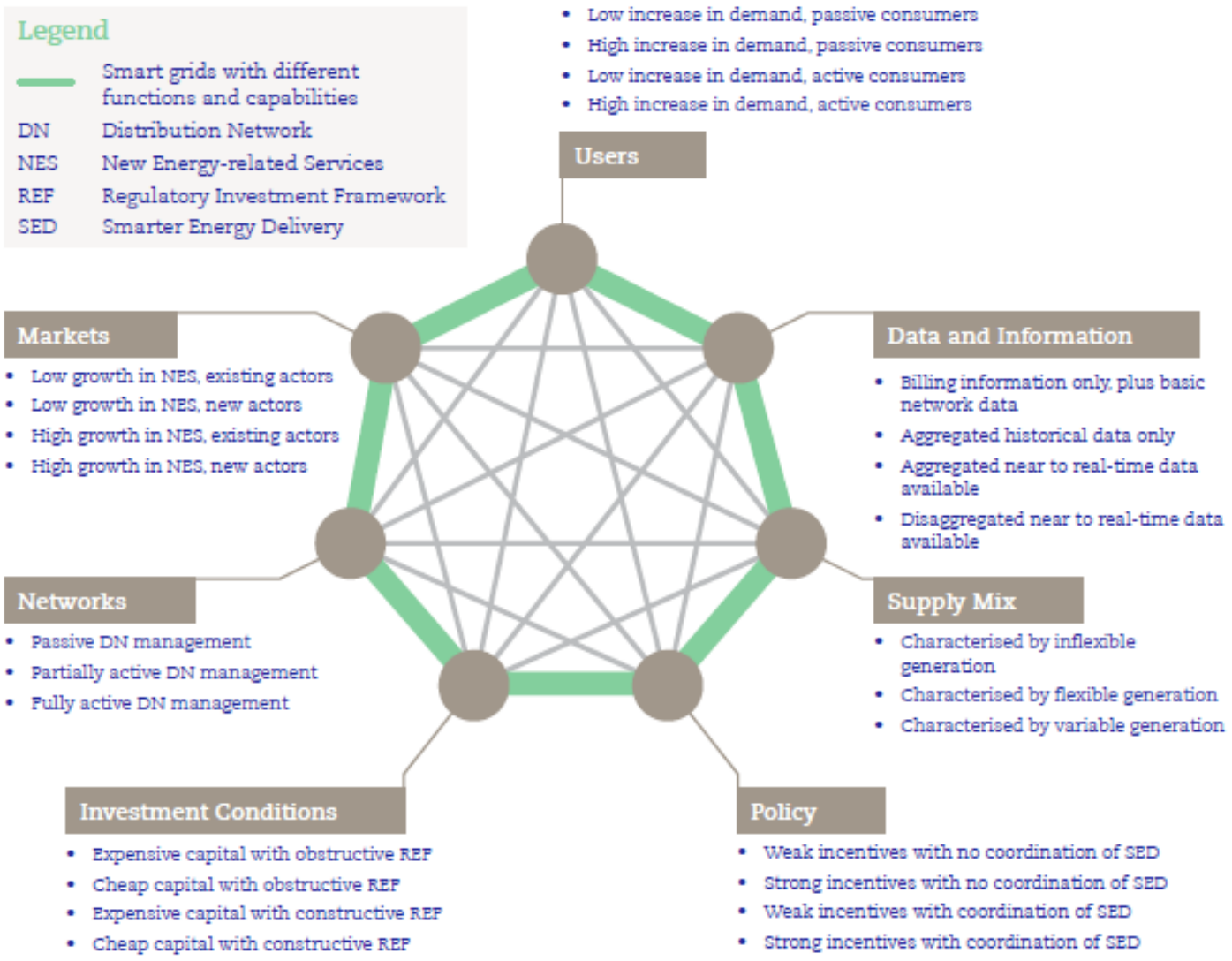


Figure 2: Composition of annual emissions savings in each market in each scenario

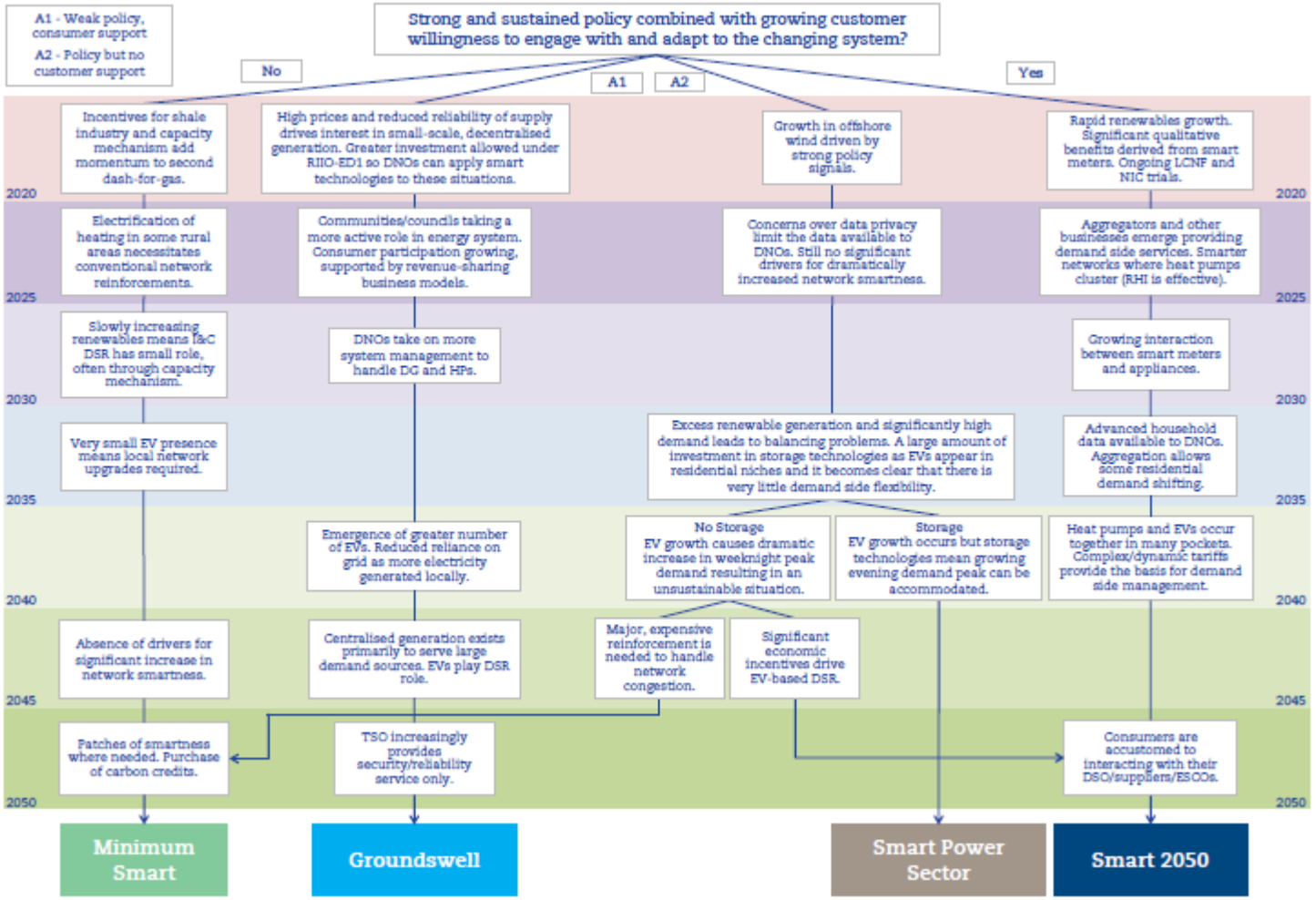
http://www.eci.ox.ac.uk/research/energy/downloads/darby12-eusmartgrids.pdf

Figure 3. Smart grid scenario sectors and factors



Balta-Ozkan et al.,
http://orca.cf.ac.uk/57649/1/Scenarios_for_the_Development_of_Smart_Grids_in_the_UK_Synthesis_Report%5B1%5D.pdf

Figure 5. Key scenario steps



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What sort of practices does 'active demand' require? Summary of four 'active demand' options, from the user's standpoint

Options for users	Main objectives	User 'activity'	Comments
Demand reduction (all seasons)	Energy management; investment in efficiency and changes in practice	Question and change practices, invest in efficiency, develop energy literacy.	The most conscious and 'active' option. Enabling technology can be very simple.
Static time-of-use tariffs (TOU) (day to day)	System management to reduce peak load	Choose tariff; decide whether and how utility can control your usage; change timing of some activities.	Must have 'smart' metering. Some equity and data management issues. May assist microgenerators.
Real-time pricing (RTP) (hour to hour)	System management to reduce peaks *and* use wind / solar/ marine generation efficiently	Choose tariff/ contract, and enabling technologies.	More risky than TOU, but may be needed for variable supply. Central to idea of the smart grid.
Dynamic demand, smart appliances (second by second)	Maintain constant grid frequency	Choose smart appliances	May be the least problematic option, BUT needs very reliable technology.

Source: Darby, 2012

‘Customer engagement’ with new heating can occur at many levels, e.g. with …

- *Technology* designed to particular specifications
- *Surveyor, utility reps and installer,* during visits
- *Other household members:* negotiating temperatures and timing, learning how to use equipment
- *Control display, billing and other information*
- *Informal contacts beyond the household* – social learning
- *Support services beyond the household*, e.g. advice programmes, insulation installers, energy retailers, DNOs, housing associations, Central Delivery Body (publicity, campaigns)
- *initiatives and incentives* to adapt practices, e.g. new tariffs, adoption of efficiency measures or low-carbon technology, demand response programmes

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