Heat decarbonisation

1 - costs and impacts
2 - social equity and fuel poverty issues

STIRLING

30TH OCTOBER 2017

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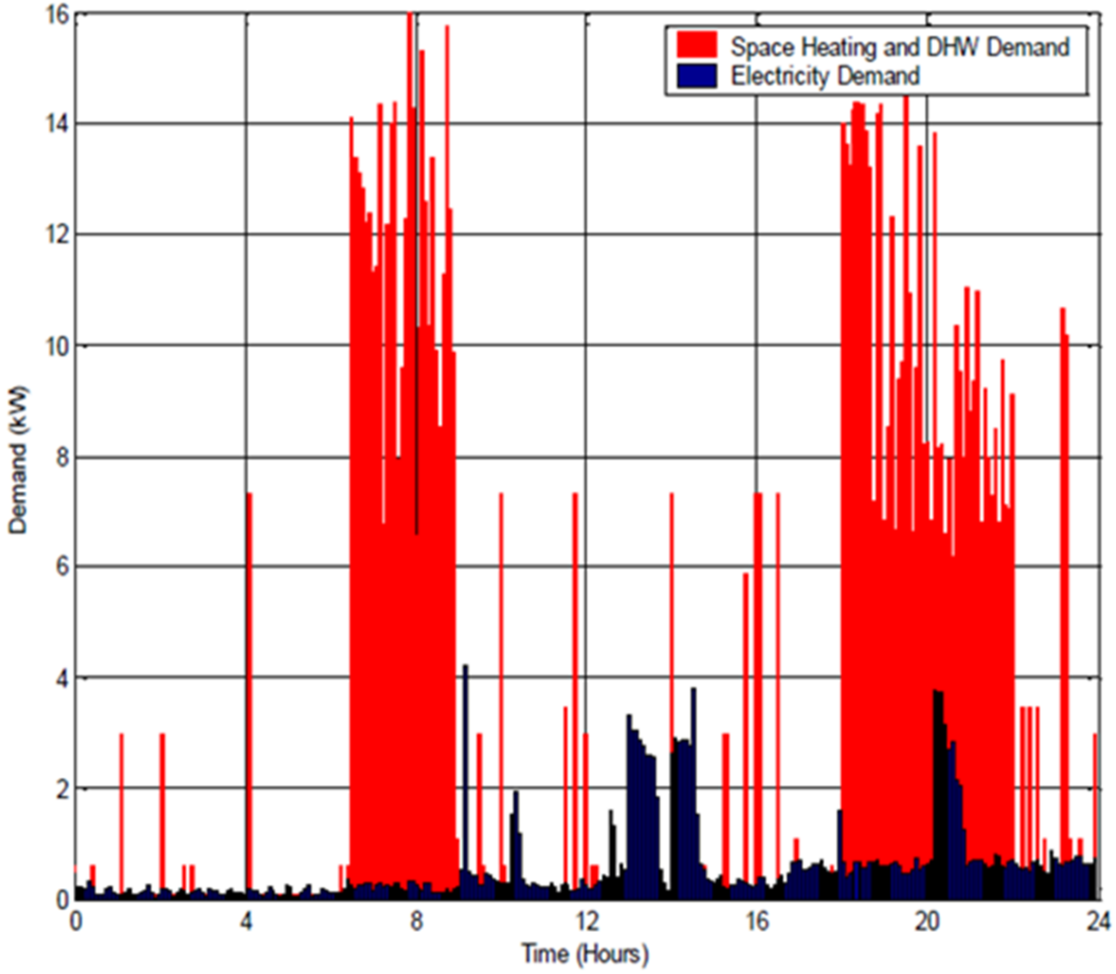
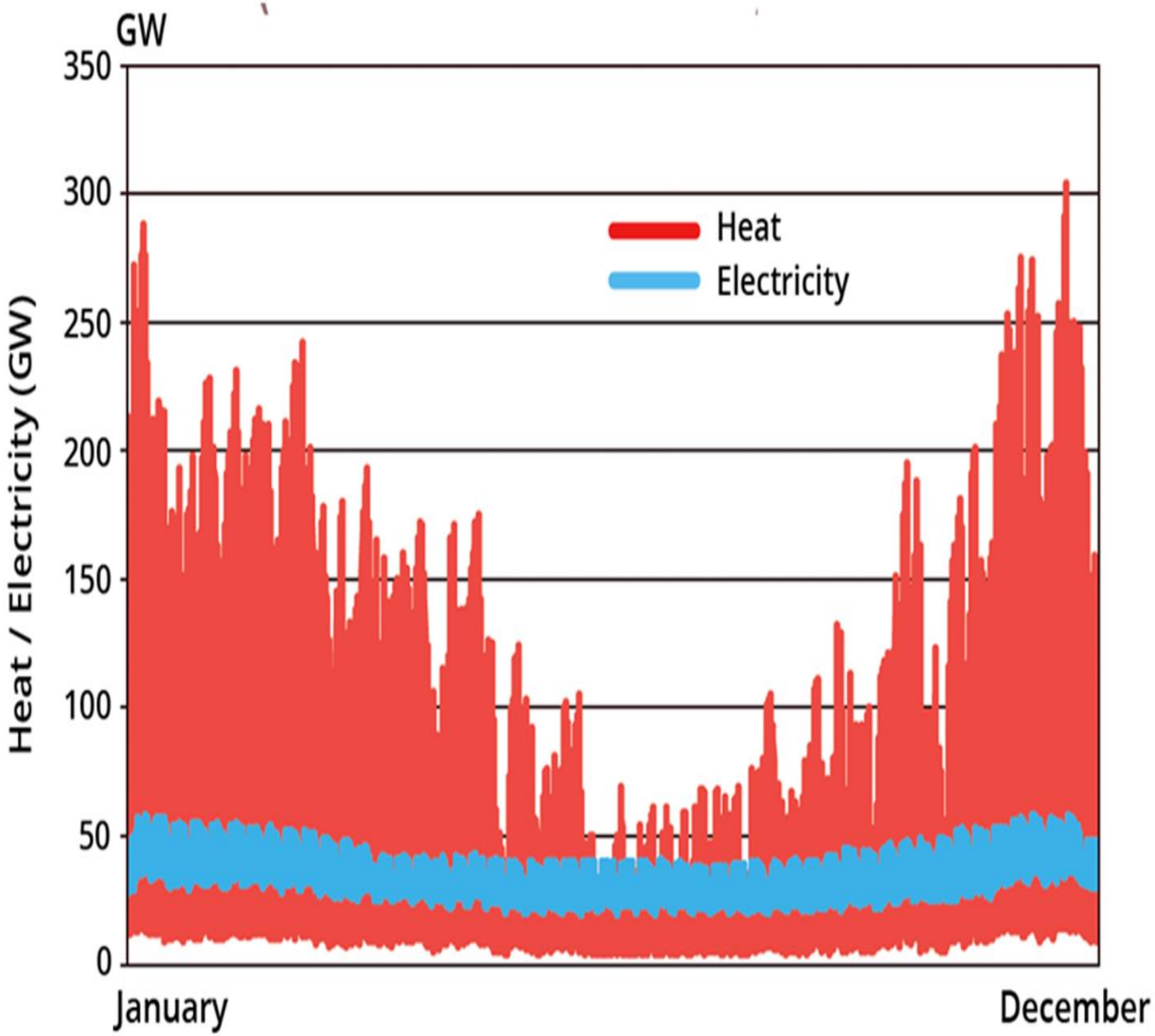
HEAT DECARBONISATION

COSTS AND IMPACTS

Residential heat and power demand



Heat and Power Demand over 1 Day in a Typical UK Dwelling



Heat – the challenge

- Twice as much energy as electricity
- Six times peak in winter (100 HPCs)
- Seasonal challenge for resilience/storage
- Lowest renewable heat in EU
- Worst housing
- People are happy
- Least understood/resourced

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Mix of carbon reduction solutions

- Lower consumption through
  - building efficiency improvements
  - operational efficiency through e,g, district heating
- Decarbonisation of heat generation
  - repurpose gas grids with hydrogen
  - electrification (as grid carbon intensity reduces)
  - others? (bio-sources, solar thermal, geo-thermal)
- All major infrastructure investments

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Analysis objectives

- Retrofit (UK-wide = 20,000 properties/week over 20-25 years)
- Assess cost, impact and practicality of
  - Hydrogen in repurposed gas grid
  - Electricity
  - District heating
- For different housing types
  - Urban
  - Suburban
  - Rural
  - Flats

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Impact and cost assessment

Urban and suburban properties	Repurposed gas grids (hydrogen)	Electrification (heat pump)	District heating
Cost/impact of decarbonised heat supply			
Cost/impact of network activities			
Cost/impact of activities in customer premises			
Need for new regulation			

Urban property – networks

	Network type				
	Gas grid			Electricity	District heating
	Natural gas	Hydrogen		Heat pumps	Large heat pump
Evaluation criteria		SMR+CCS	Electrolysis		
Network investment cost (£k/home)		0.3		2	9
Homes converted per year (thousand)		1,000		400	100
Trench size (m)		N/A		1	3
Traffic and access disruption					

Urban property – consumer + regulation

	Network type				
	Gas grid			Electricity	District heating
	Natural gas	Hydrogen		Heat pumps	Large heat pump
Evaluation criteria		SMR+CCS	Electrolysis		
Criticality of energy efficiency					
Appliance costs per household (£k)		0 - 1		5 - 15	0 - 1
Household disruption					
Customer acceptance					
Visual and noise impact					
Regulation issues					

Urban property – heat supply

	Network type				
	Gas grid			Electricity	District heating
	Natural gas	Hydrogen		Heat pumps	Large heat pump
Evaluation criteria		SMR+CCS	Electrolysis		
Heat production efficiency (%)	85%	85%	85%	270%	340%
Energy supply cost (£/MWh in 2016)	50	>75	>125	130	100
Heat supply cost (£/MWh in 2016)	60	>90	>150	50	45
CCS criticality					
Seasonal storage cost (£/MWh)	30 - 80	100 - 250		> 50,000	80 - 8,000

Conclusions - hydrogen

- Feasible thanks to the ongoing programme to install new pipework in the local gas mains
- Could be used in 85% of buildings connected to the gas network
- Little additional impact on roadworks or in consumer homes
- Relies heavily on the development of new large scale, low cost hydrogen production facilities (potentially CCS)

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Conclusions - electrification

- Heat pumps, can be suitable for less densely populated environments where disruption and cost can be
  - minimised for electricity system upgrades
  - kept to acceptable levels for building installation work
- Direct electric heating is suited to properties like flats in high rise buildings where
  - gas-fired boilers cannot be used
  - space heating requirements are low

Conclusions – district heating

- Can supply heat efficiently and at low cost
- Well suited to
  - areas of mixed use with strong anchor clients
  - new developments
- Retrofit can be suitable
  - in less densely populated areas,
  - for flats in multi-storey buildings
- Suitable low carbon heat sources needed
- Benefit from regulation

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Conclusions - general

- Each solution has a role to play, but none is a silver bullet
- Big task, more manageable with
  - appropriate energy efficiency investment
  - an early start, good planning and preparation
  - long-term infrastructure investment programmes
- New governance arrangements should be introduced
  - strong city and local authority level involvement
  - skills knowledge and resource will be needed
- Choice and/or the rate of deployment depend on
  - the non-cost impacts, not just simple economics
  - customer acceptance
- Coordinated pilot developments should be initiated quickly

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HEAT DECARBONISATION

SOCIAL EQUITY AND FUEL POVERTY

Analysis of potential impacts

- Order of magnitude and relative significance estimated for:
  - monetary impacts compared to the status quo
  - cost differentials across choice of solution and timing of conversion
  - capital and running costs
  - potential impacts on fuel poverty

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Potential impact summary
(if costs recovered through bills rather than tax)

- Additional total annual costs could rise by £200 to £800 per household
- £4,000 - £16,000 difference between first and last converted
- £0 to £15,000 in up-front capital required
- annual running costs could reduce by £200 or increase by £600
- 15 - 65% cost increases could create additional 0.6 to 2.6 million fuel poor across UK

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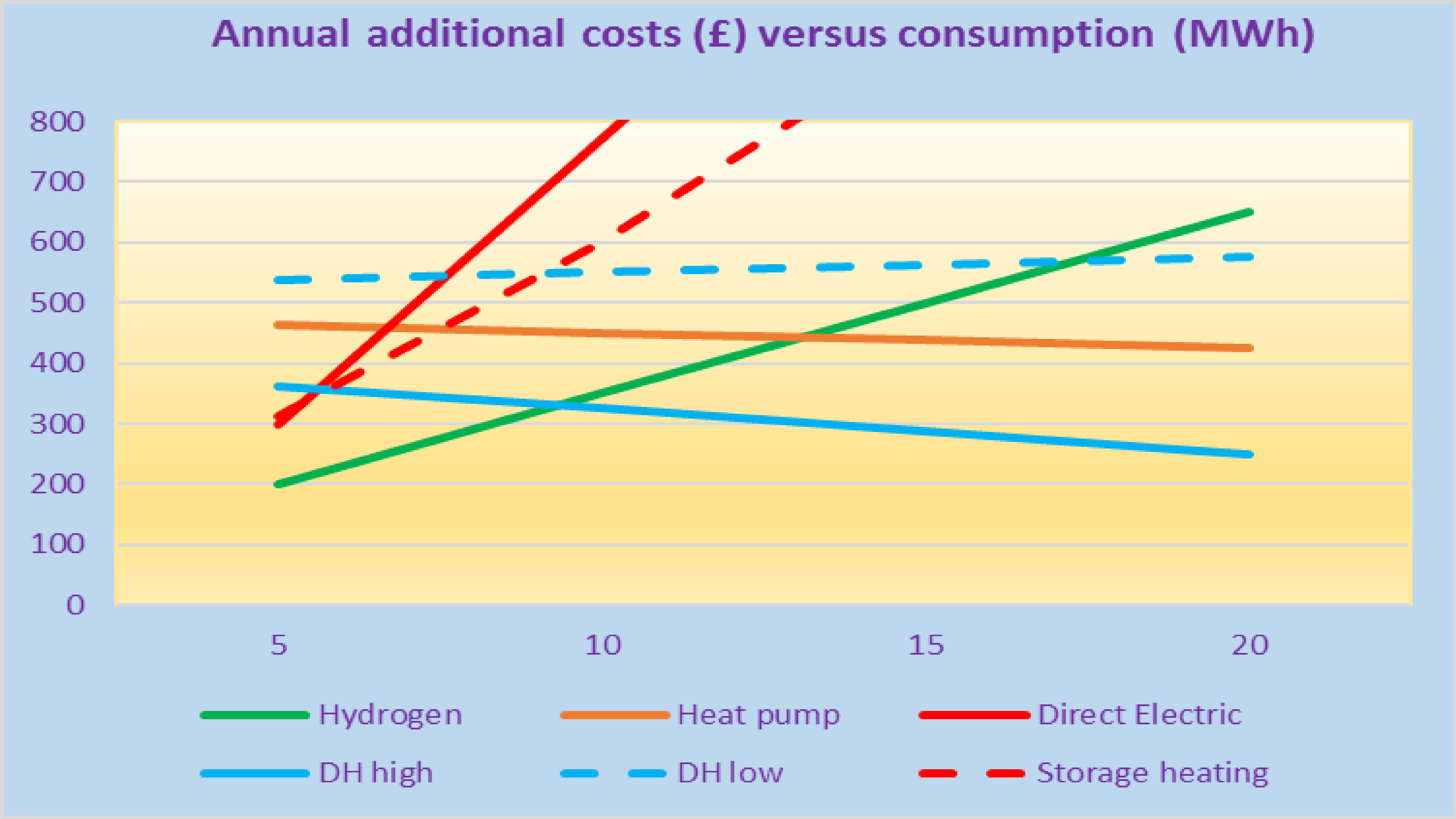
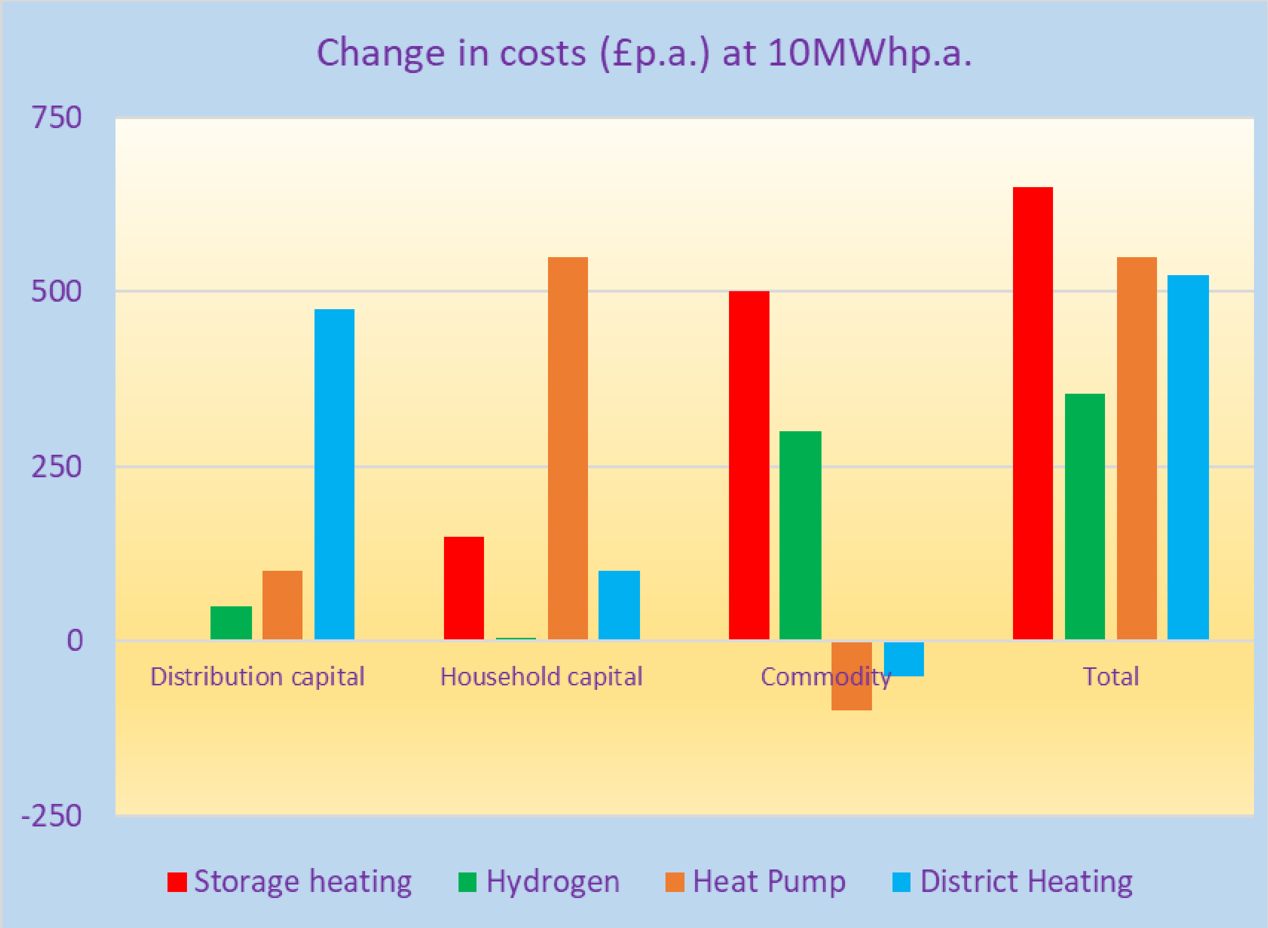
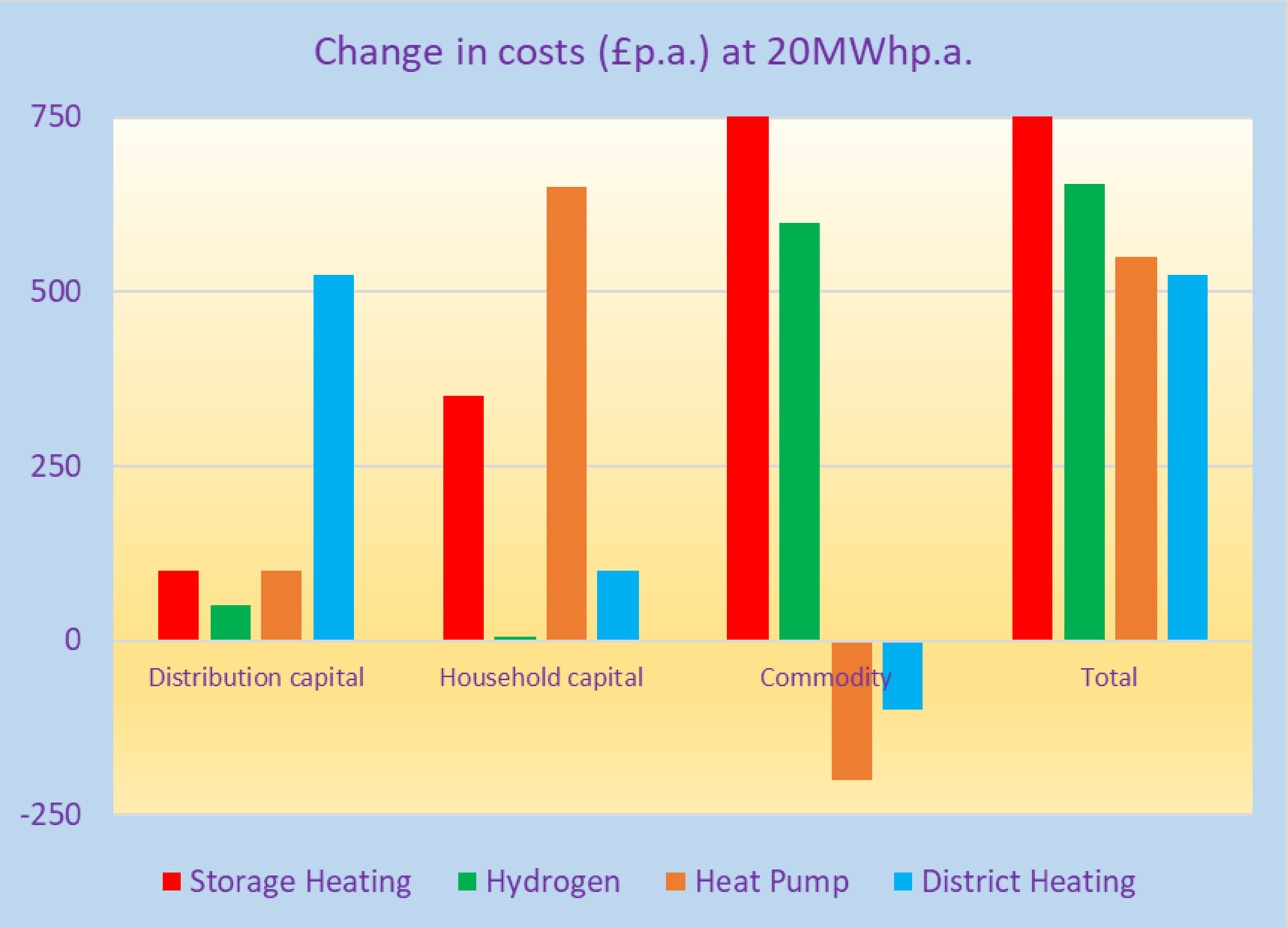

Annual additional costs (£) versus consumption (MWh)
800
700
600
500
400
300
200
100
0
5
10
15
20
Hydrogen
Heat pump
Direct Electric
DH high
DH low
Storage heating

Capital versus running costs





Energy efficiency – different drivers

- Fuel poverty
  - anything which reduces ongoing costs can reduce fuel poverty
  - Investment should be in its own right
- Carbon
  - Reduced consumption reduces emissions
- Economics
  - Upper limit on cost effective investment
  - Balance between reducing demand and decarbonising supply
  - Difference between high capital/low running cost and low capital/high running cost options

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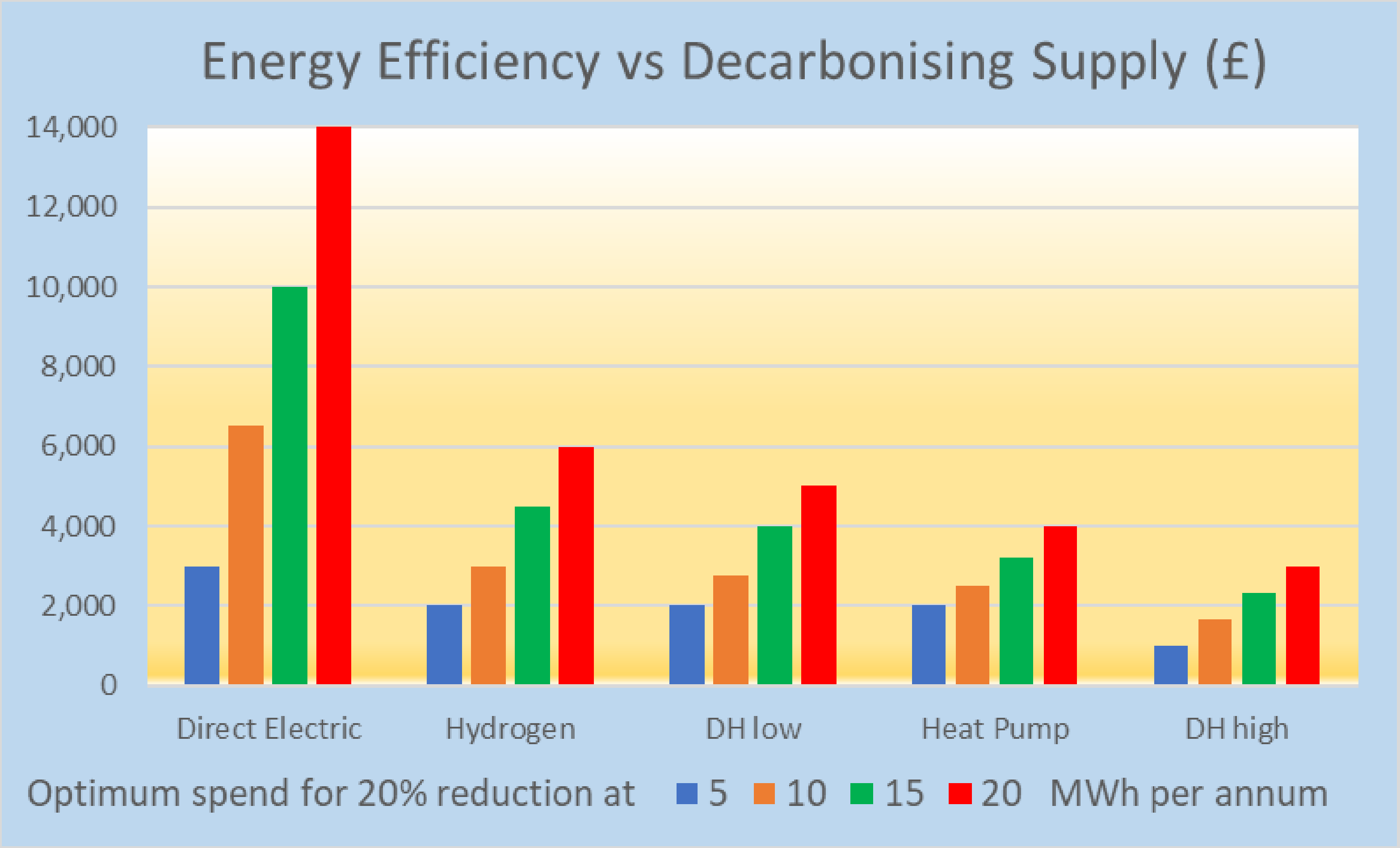
Impact of energy efficiency investment



Energy efficiency summary

- Optimum spend on energy efficiency before decarbonising supply is more economic
- Optimum level depends on decarbonisation cost structure
  - Higher for high fuel cost solutions
  - Lower for high capital cost solutions
- Choice of decarbonisation technology depends on consumption levels
- Hot water energy and capacity needs important for low consumption households

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Framework for government interventions

- Enduring support – to address externalities
- Short term support – to build supply chain, provide learning and consumer experience
- Financing – to help with up front costs
- Tackling fuel poverty and distributional issues – including those raised by the above:
  - Helping fuel poor access schemes
  - Compensating for differential levels of access
  - Mitigating impacts of costs of funding support

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Scheme design - learning from experience

- Who benefits? – Targeting
  - Grants versus loans versus payments
- Who pays? - Levies versus taxes
  - Monitoring overall bill impacts
- Obligations versus incentives
- Monopoly network regulation -> district heating (alternative models)
  - Network charging and stranded assets

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keith.maclean
@provpol.com

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