

# Assessing the potential of Demand Side Response in the residential and non-residential sectors

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FEEM-IEFE Joint Seminar

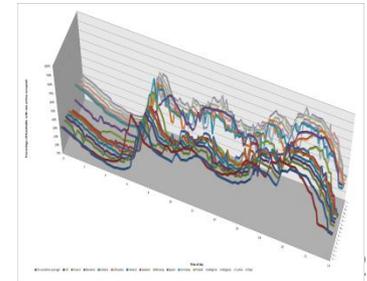
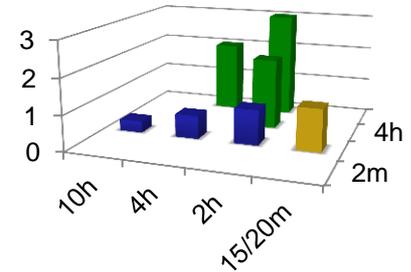
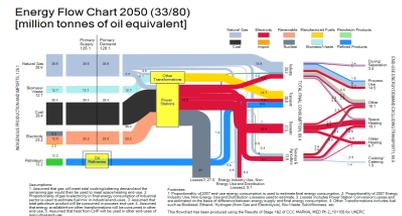
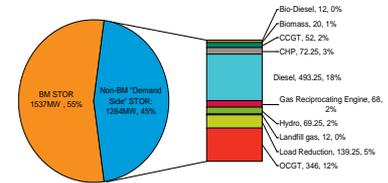
Università Bocconi

Milan

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# Outline

- Demand Side Response (DSR) slow to emerge
- Reasons: the case for DSR
- Potential contribution of DSR to capacity mechanisms (non-residential sector)
- Timing of activities of residential customers in Europe



# Load reduction programmes

Response  
time

months

- Interruptible Programmes for large industries

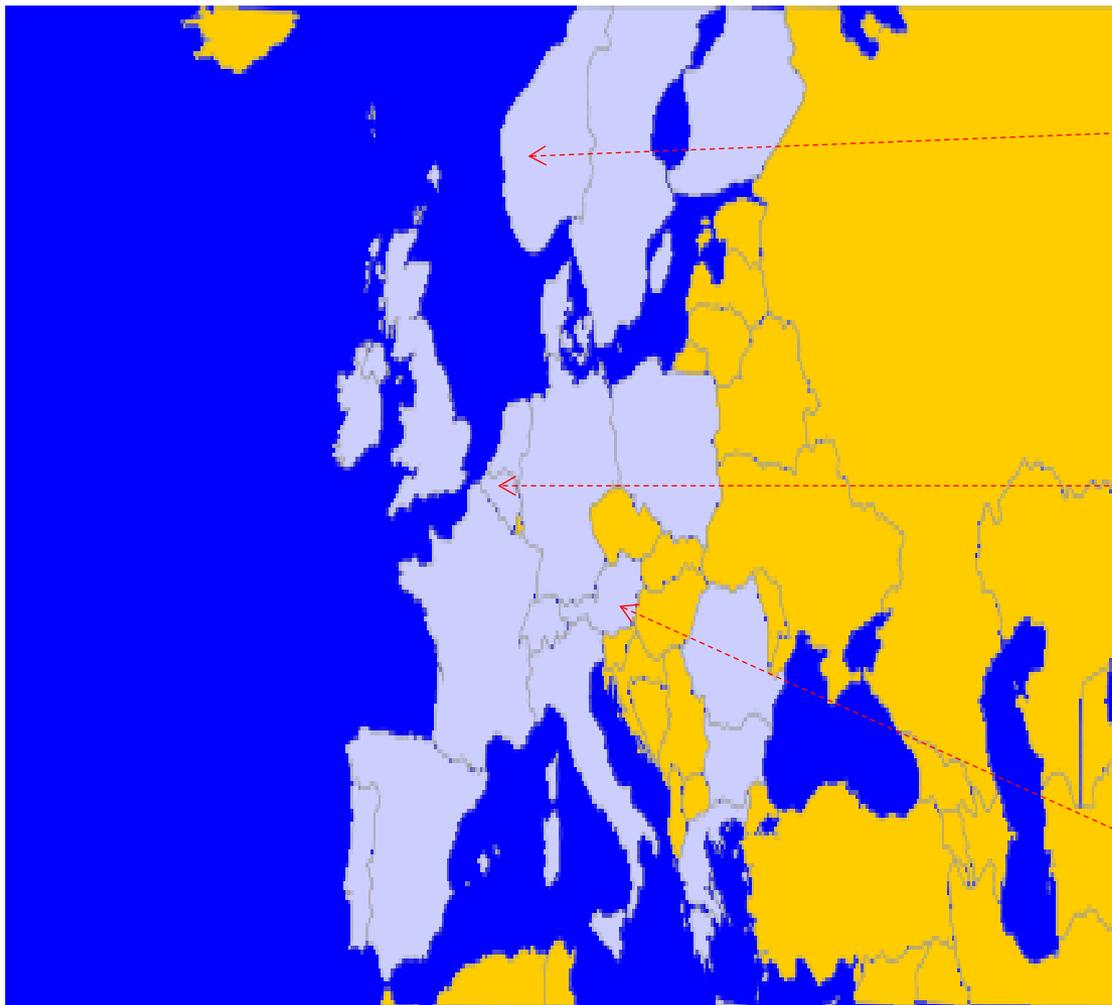


Hours /  
minutes

- DSR programmes: load reduction/shifting from commercial (and residential) customers



# DSR programmes in Europe: Examples



DSR: Remote load control on hot water space heating



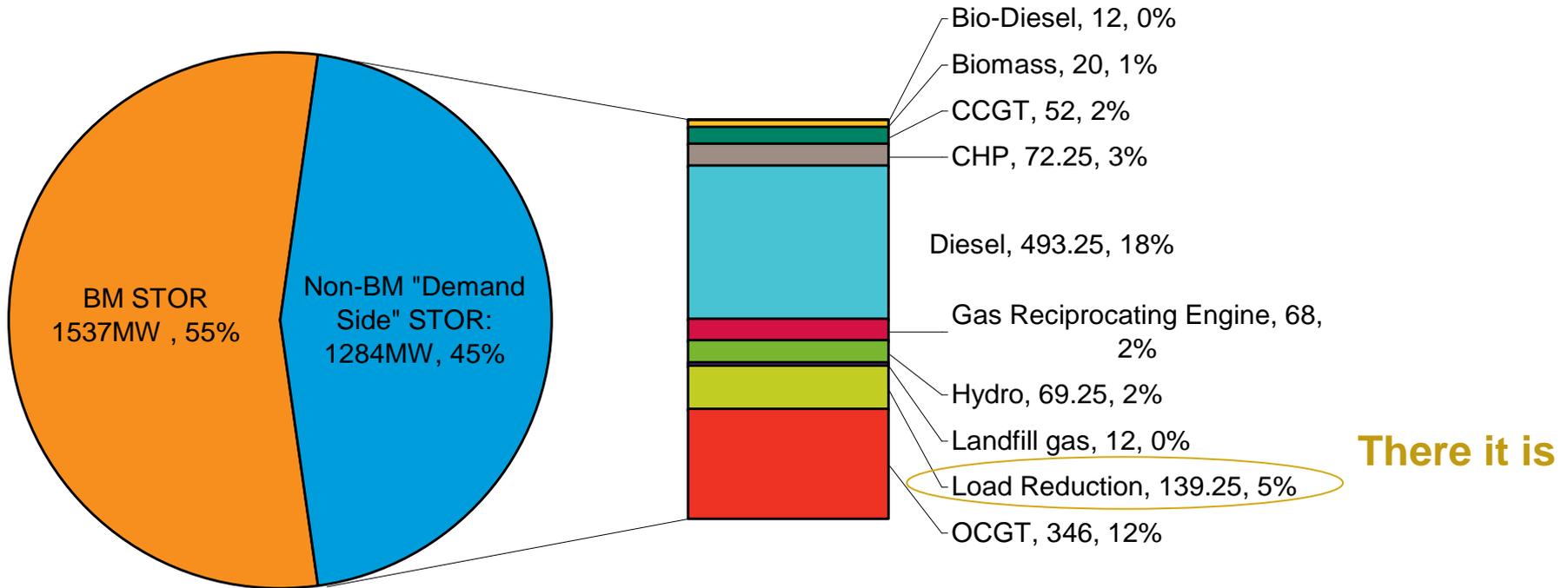
DSR: Cold storage facilities



DSR: Virtual power plant



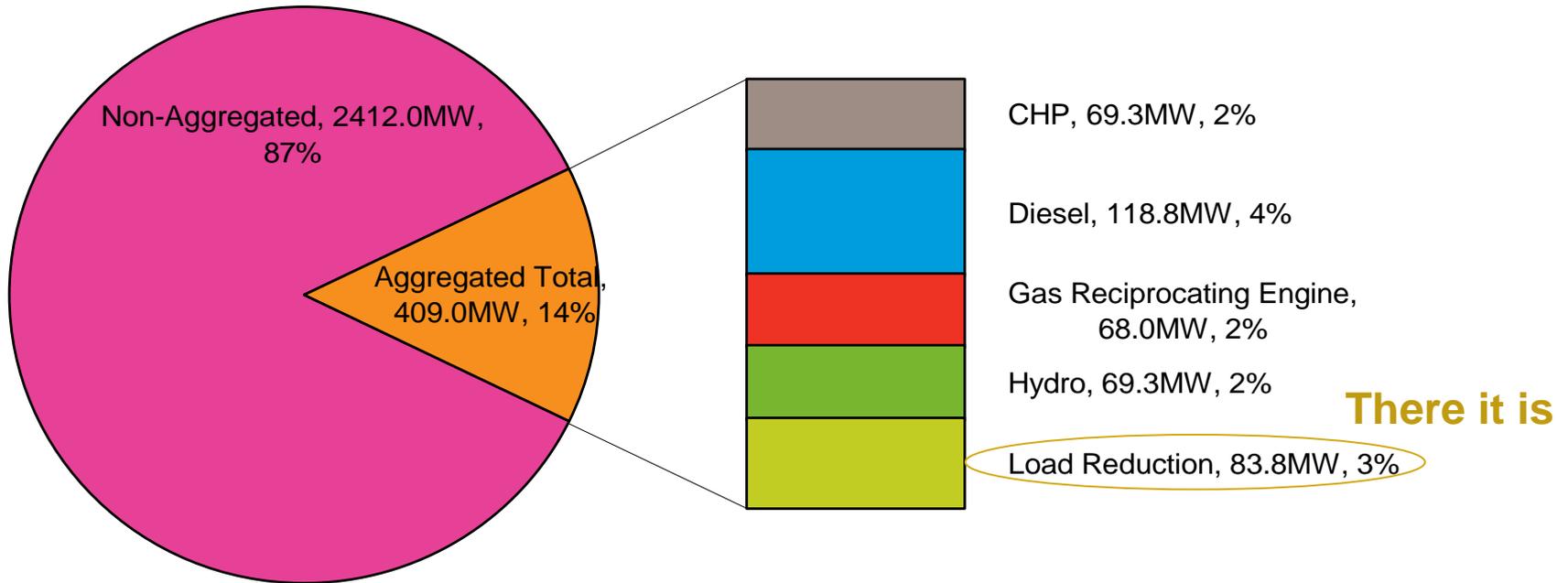
# DSR slow to emerge (1)



There it is

The majority of "Demand Side" reserve is still "Generation"

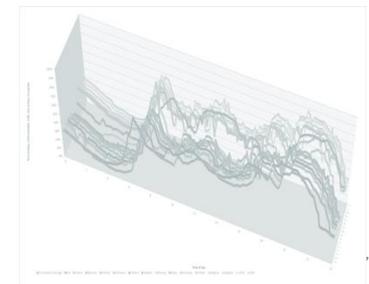
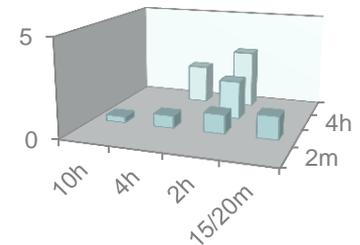
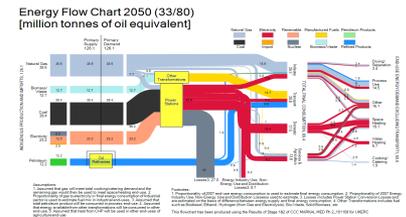
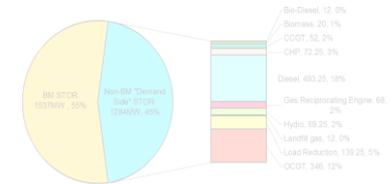
# DSR slow to emerge (2)



The majority of “Demand Side” reserve is still “Generation”



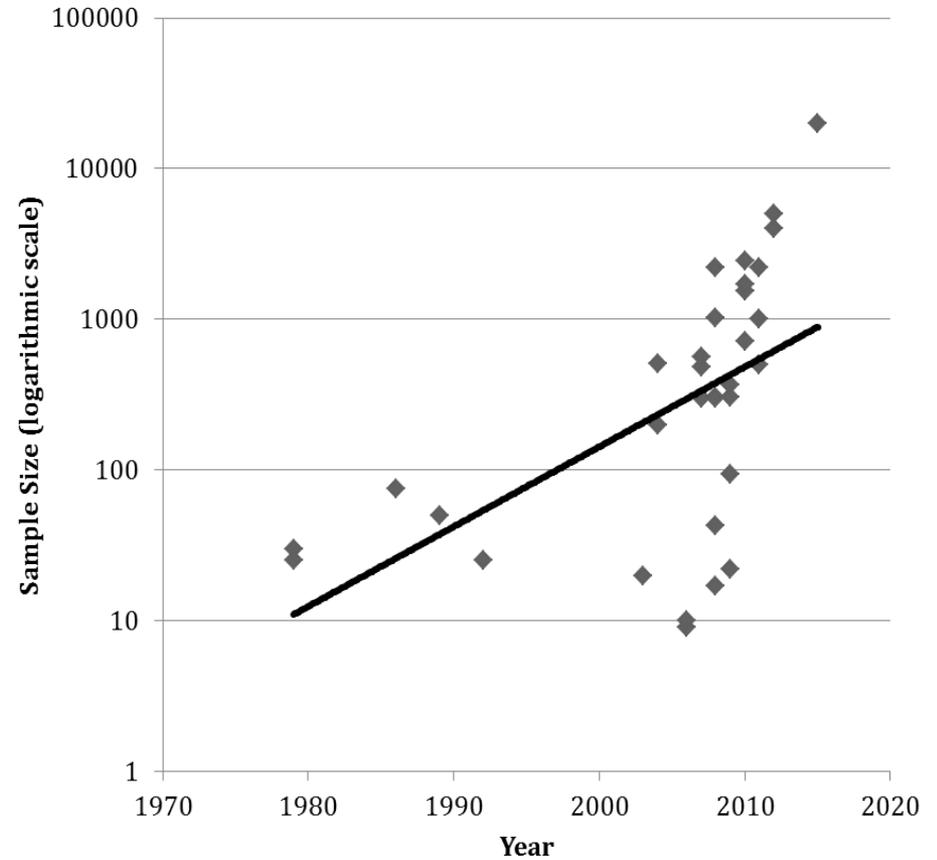
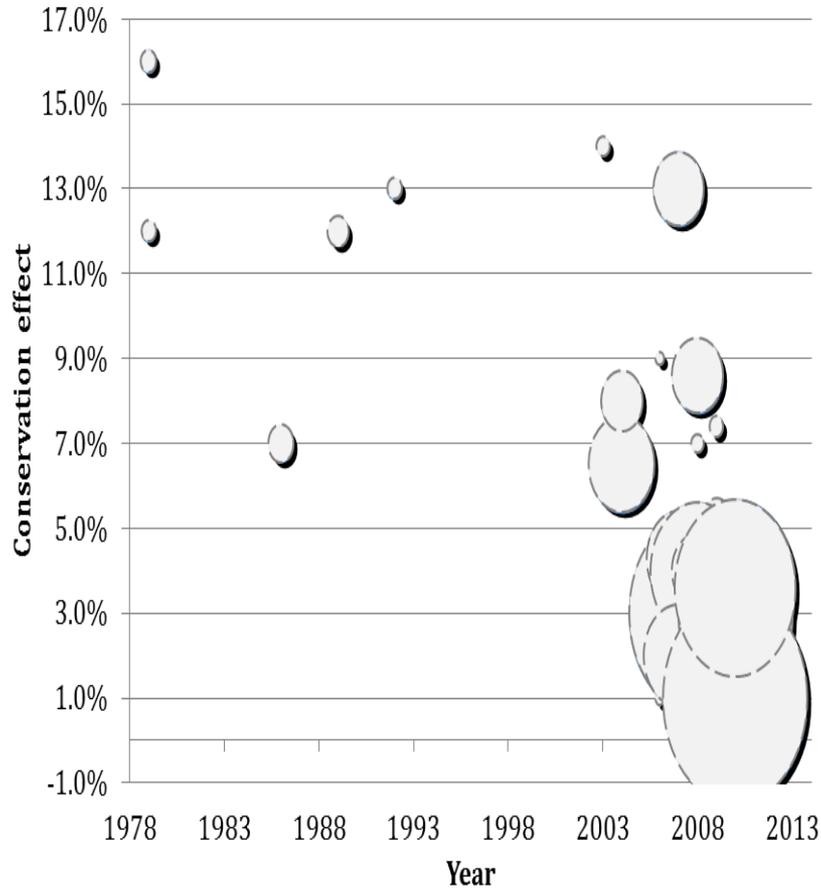
- Demand Side Response (DSR) slow to emerge
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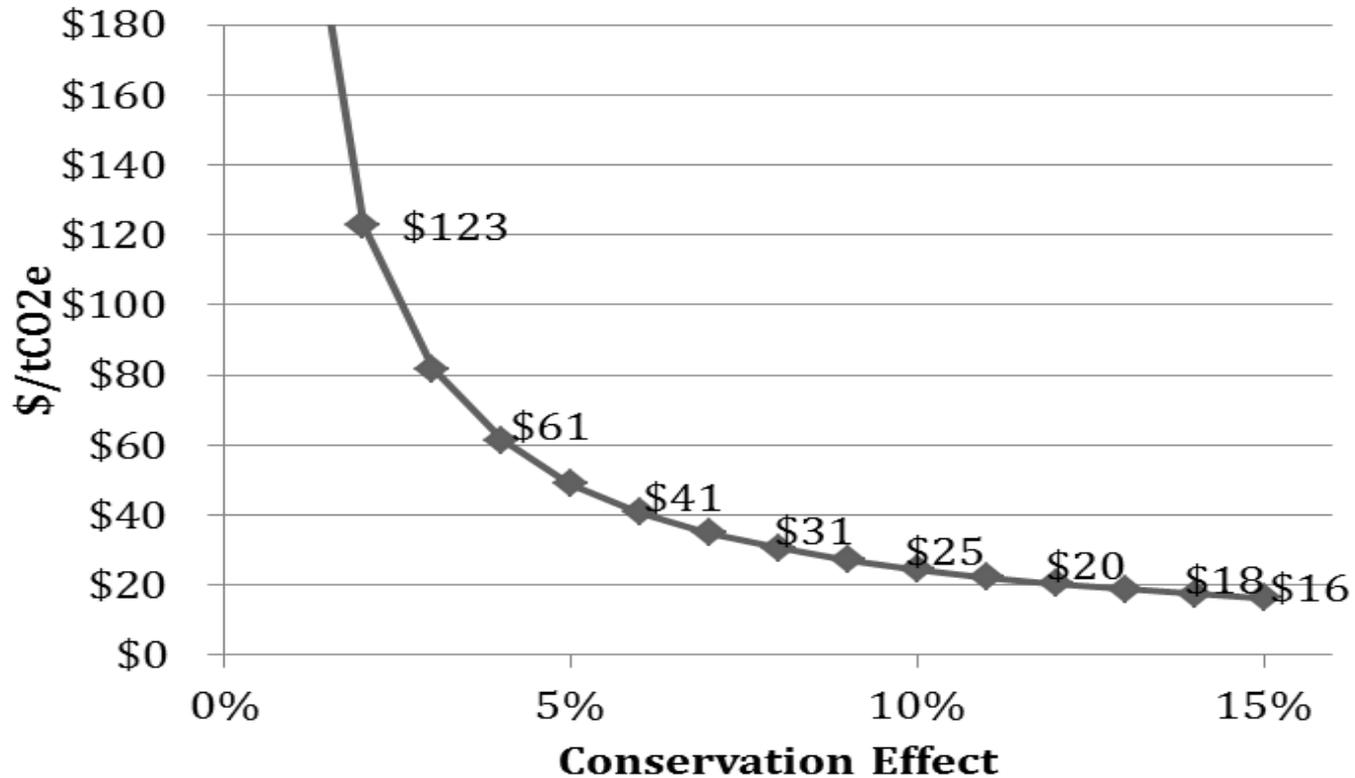
# DSR slow to emerge: why?

- Limited evidence on DSR net conservation effects
- High cost estimates for DSR technologies and infrastructures
- No significant afternoon peak load (e.g. from air conditioning)
- Regulation/current arrangements holding back DSR?

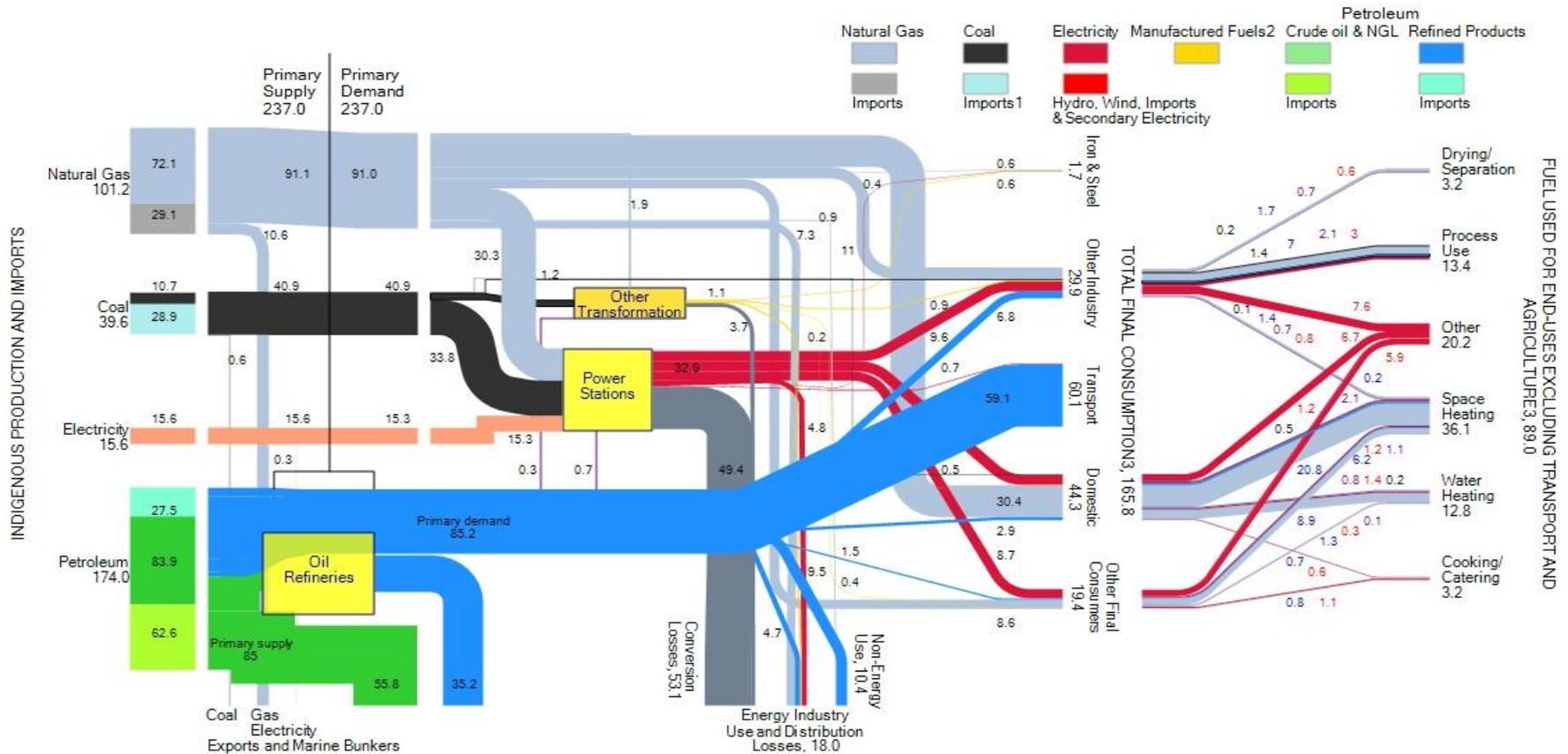
# Conservation effects: meta-studies residential sector



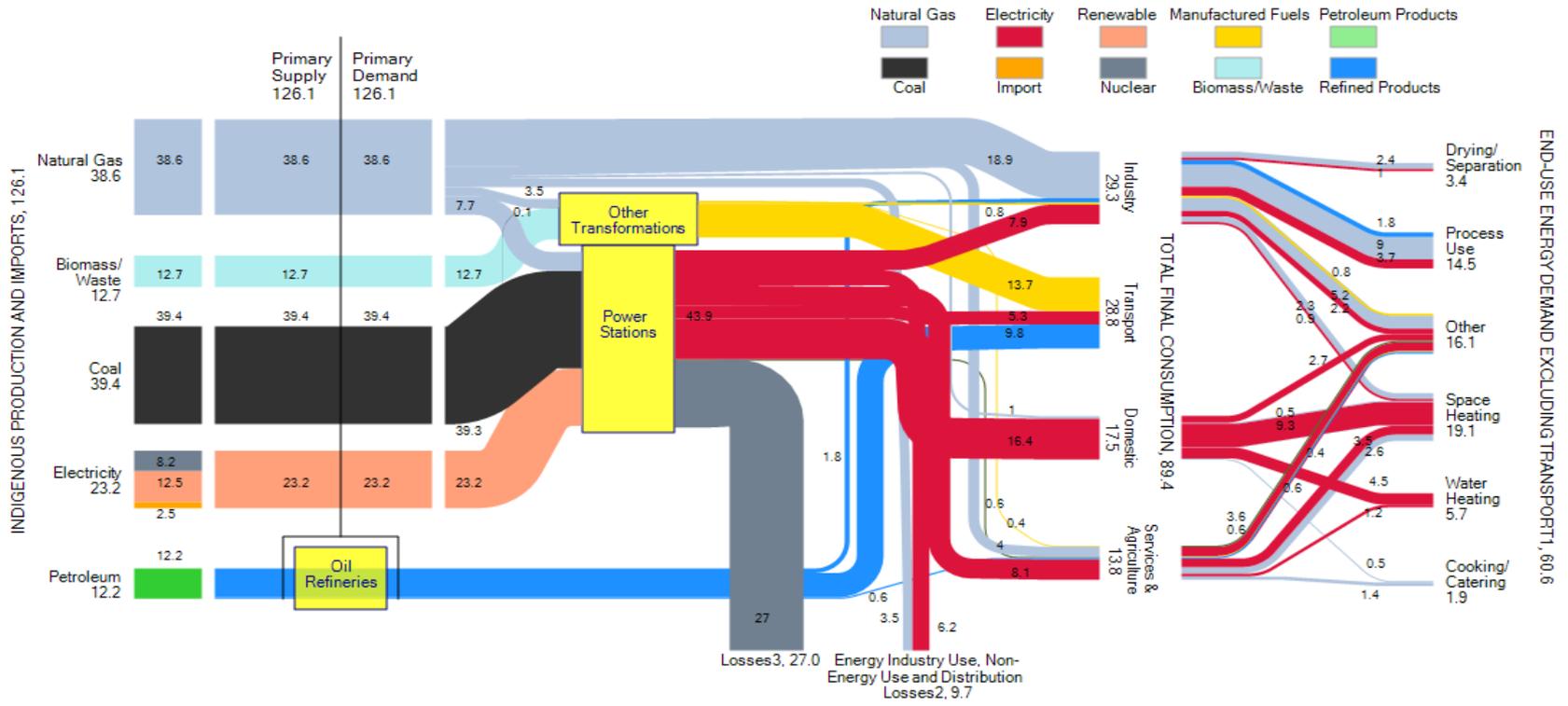
# It only makes economic sense if...



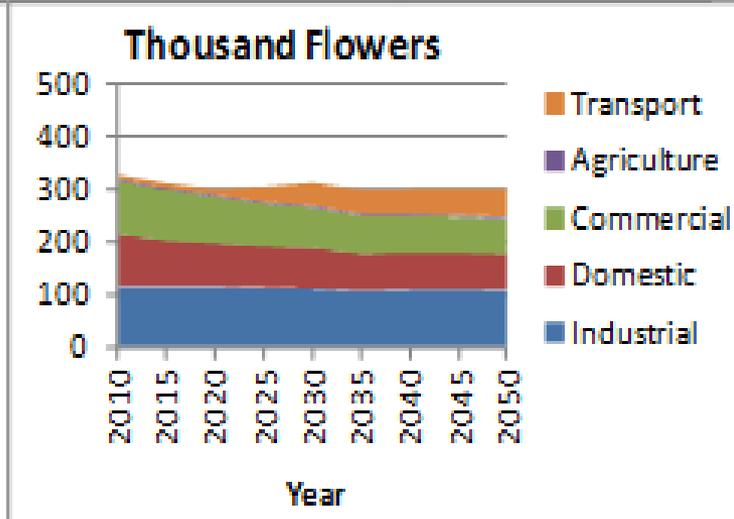
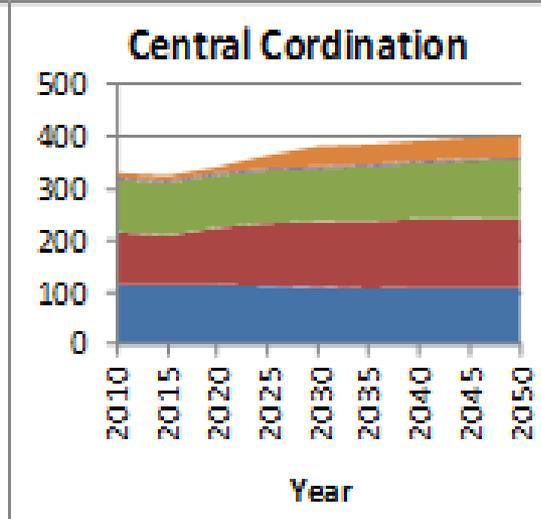
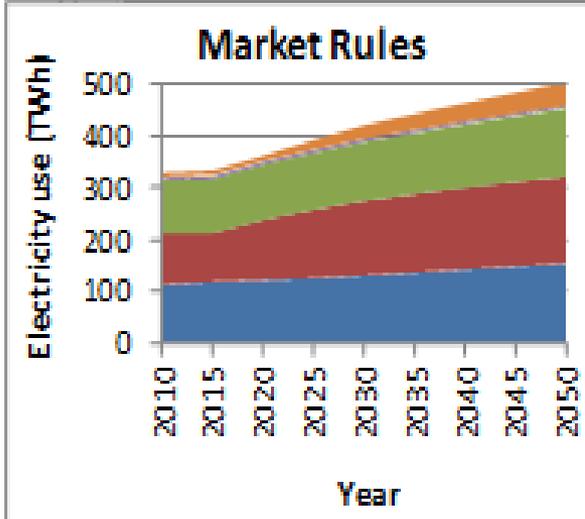
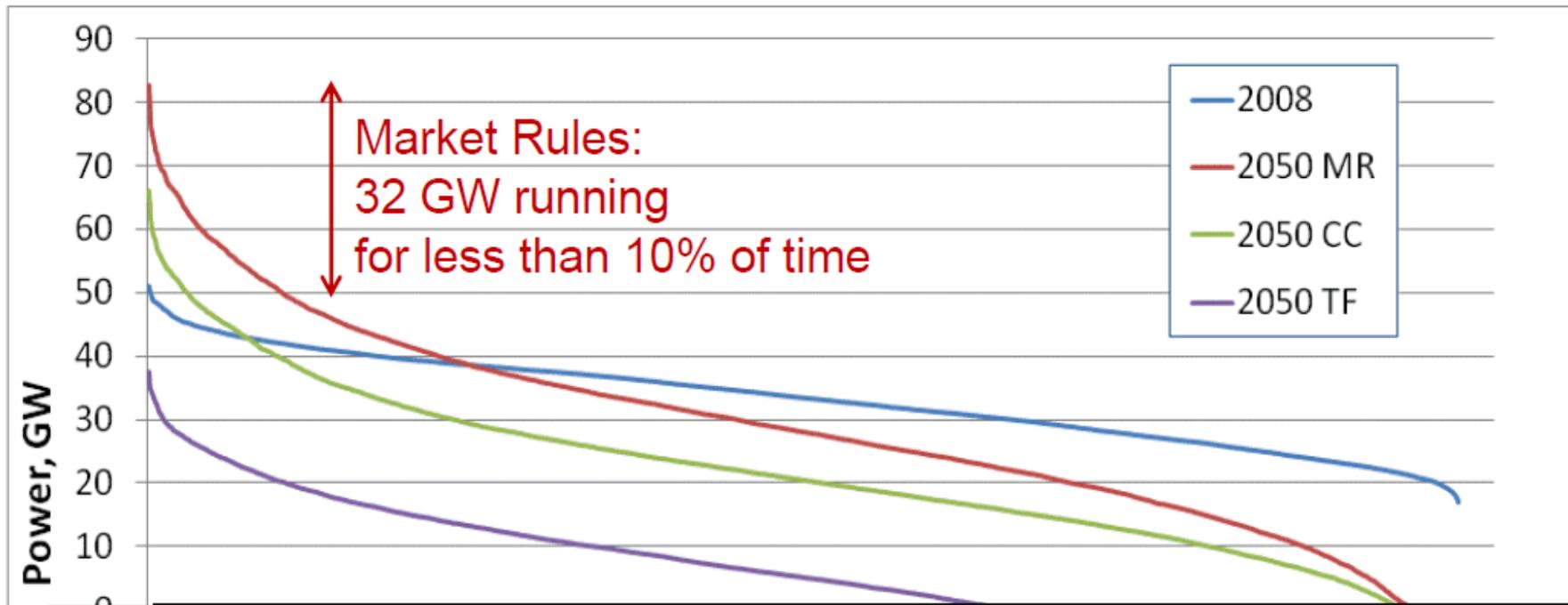
# Energy flow diagram of the UK (adapted from DECC, 2009)



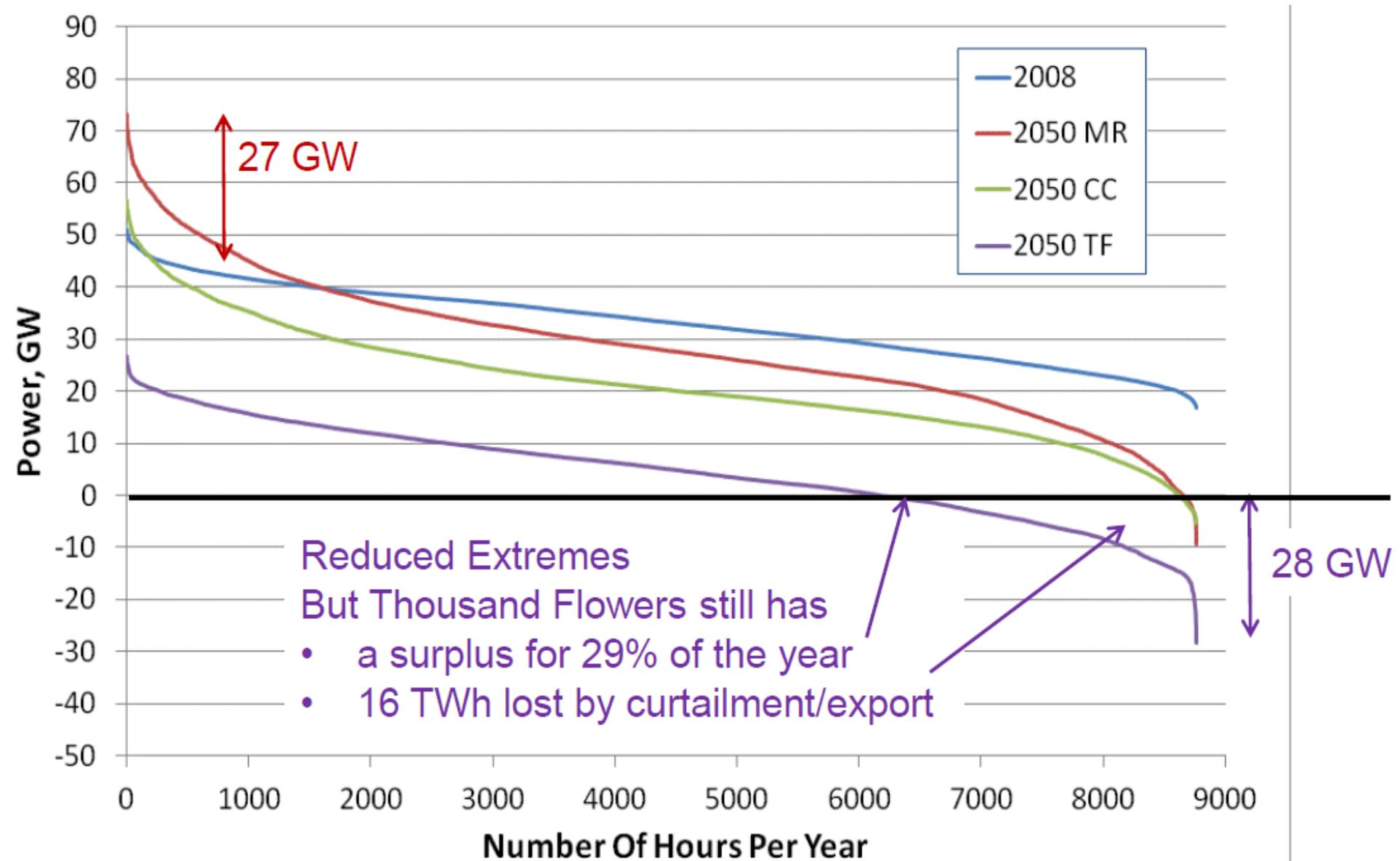
# Energy flow diagram of Committee on Climate Change 33/80 scenario for UK in 2050



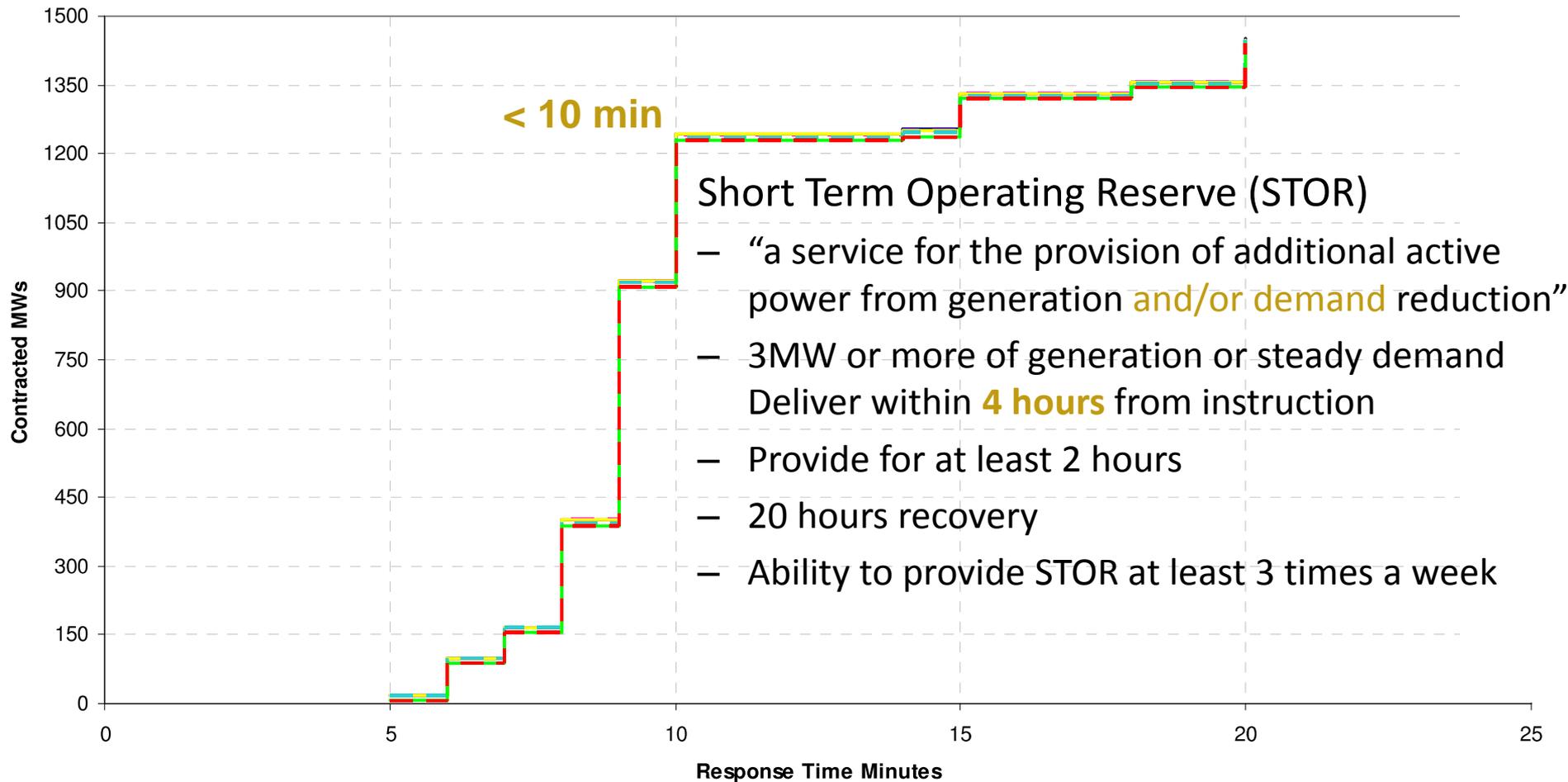
# Net demand duration curve before DSR



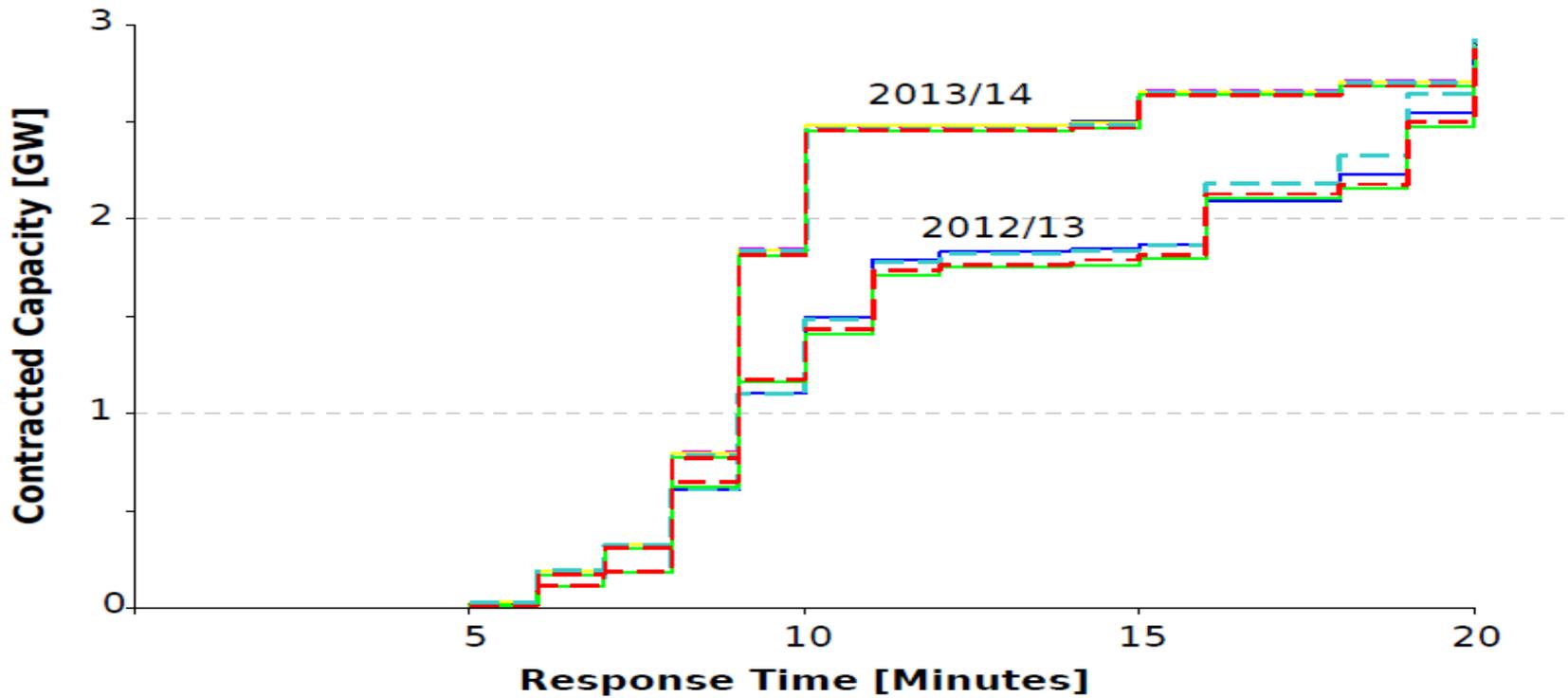
# Net demand duration curve after DSR



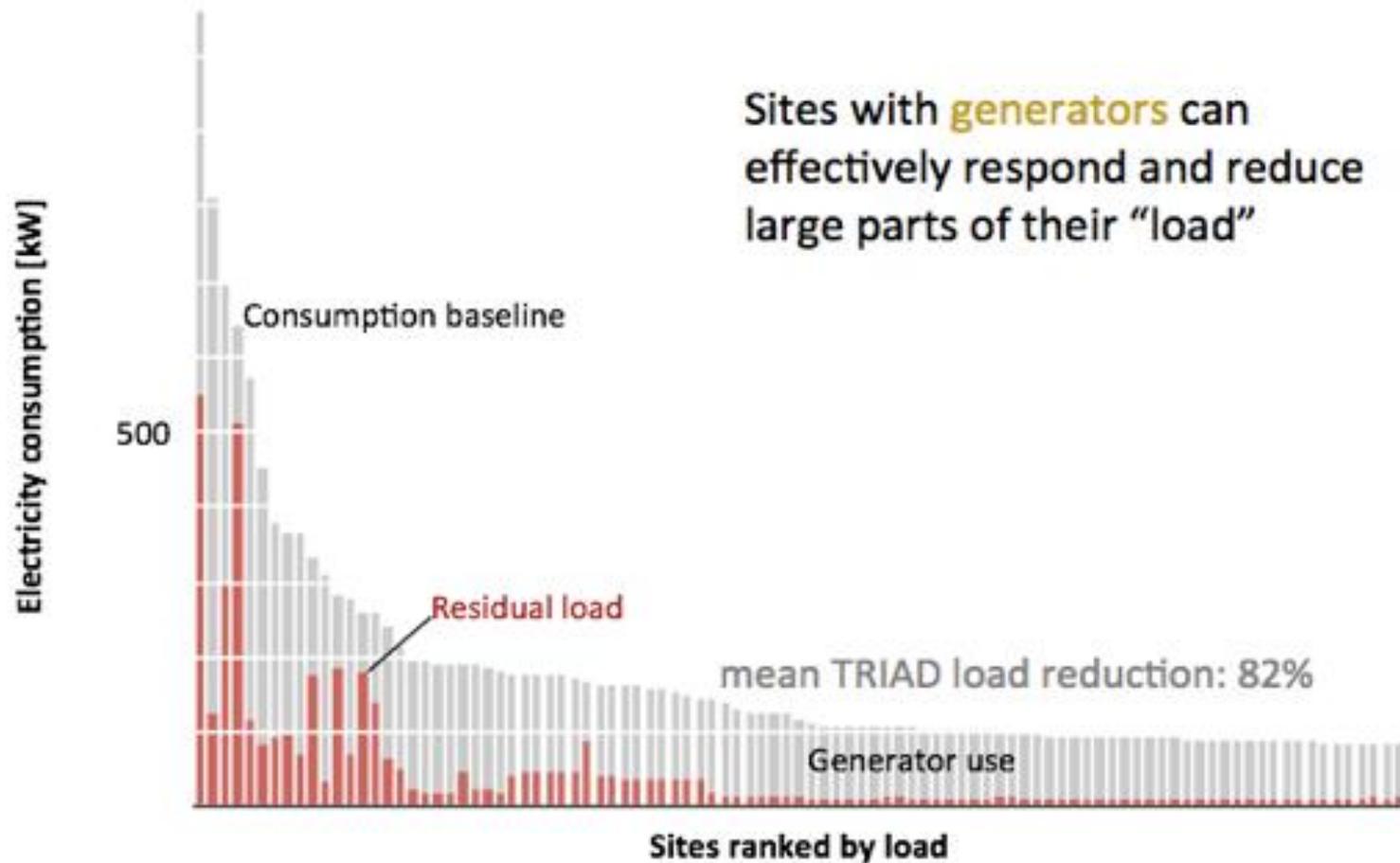
# Do current arrangements hold DSR back? (1)



# Do current arrangements hold DSR back? (2)

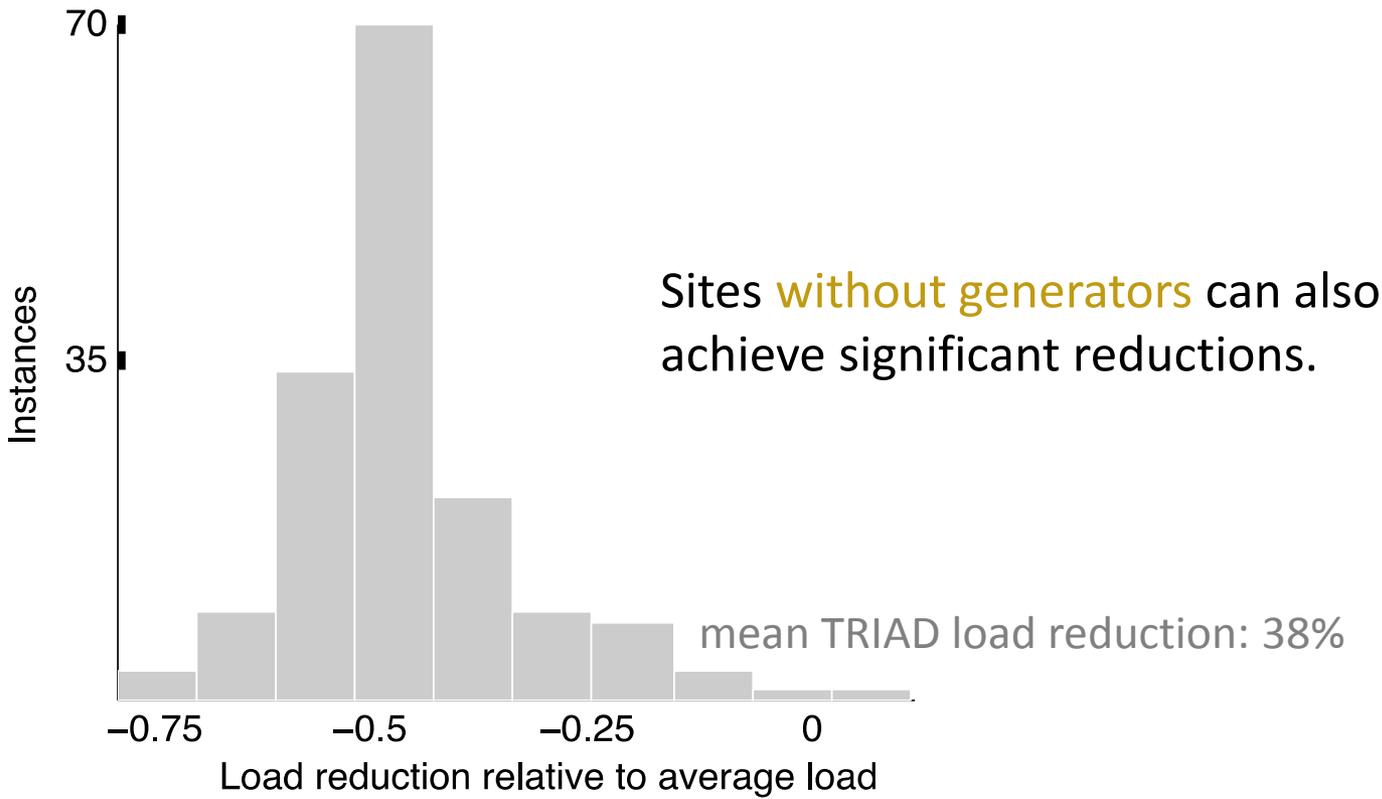


# Load response of generation sites in the telecommunications industry



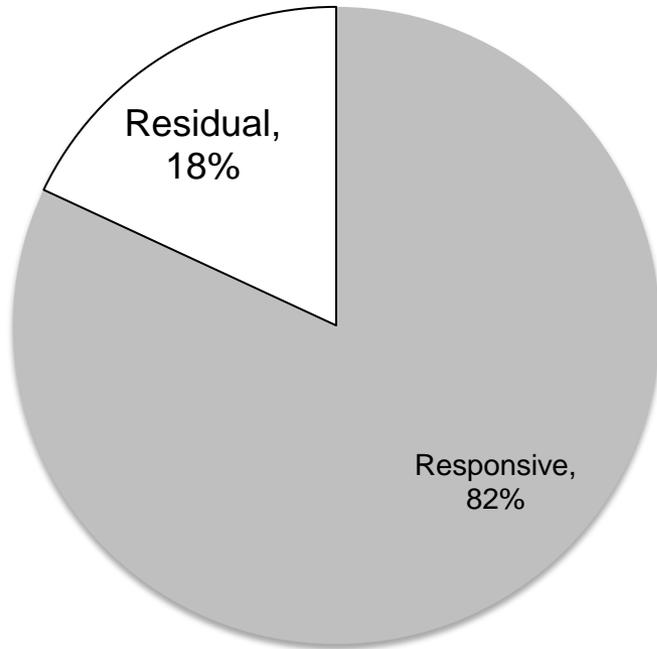
Virtual load reduction in the telecoms sector where generators are present

# Distribution of load reduction (relative to baseline) during DSR trial in the hotel sector

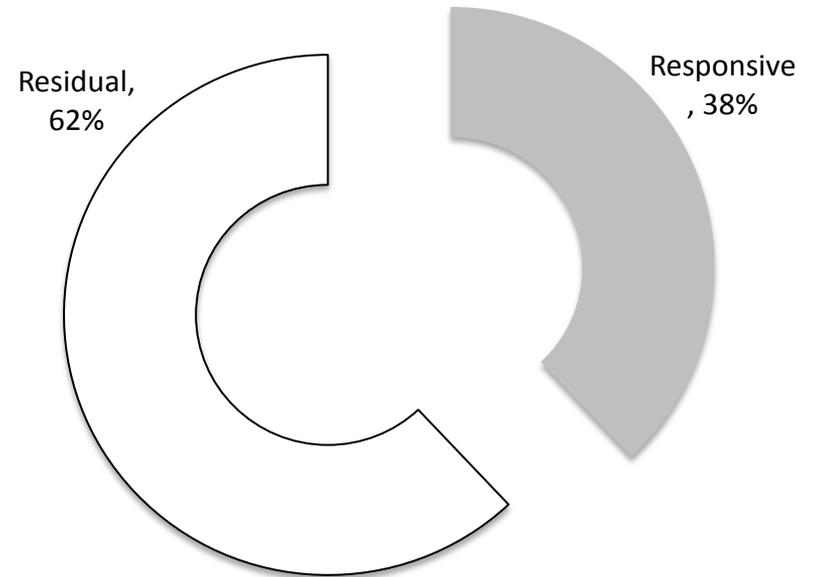


“Real” load reduction in the hotel sector based on TRIAD response of 98 hotels

## Sites with back-up generation

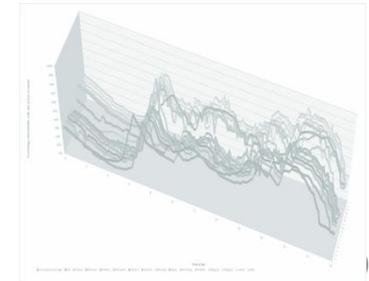
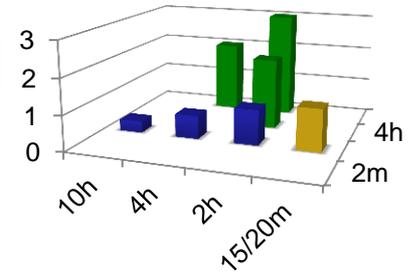
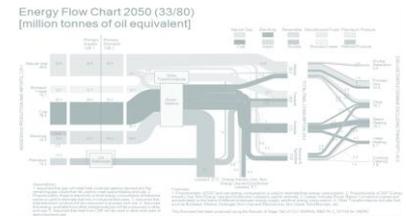
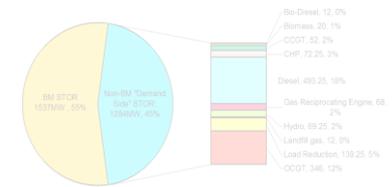


## Sites without back-up generation (turn down only)



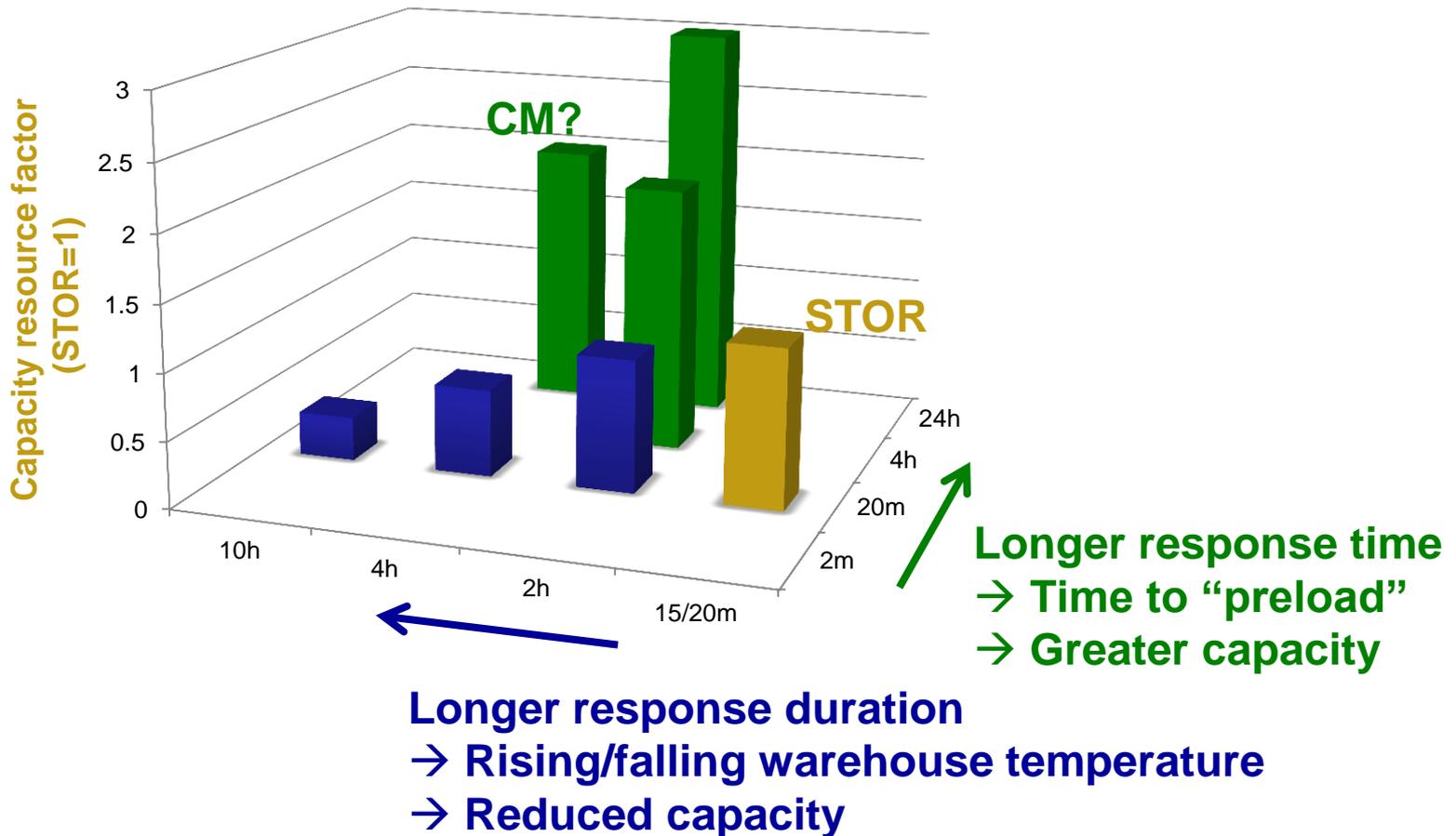


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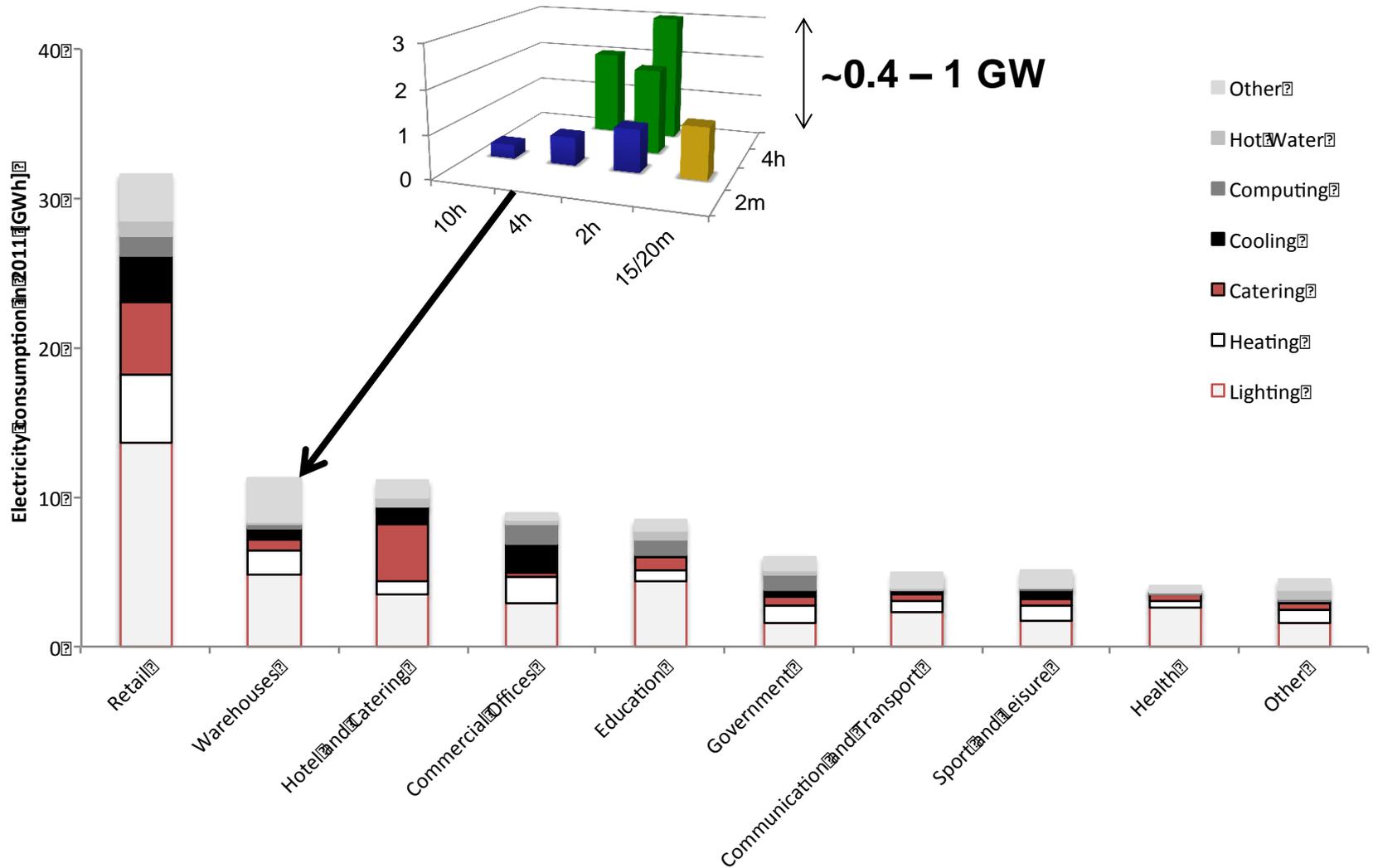


# What if conditions were relaxed?

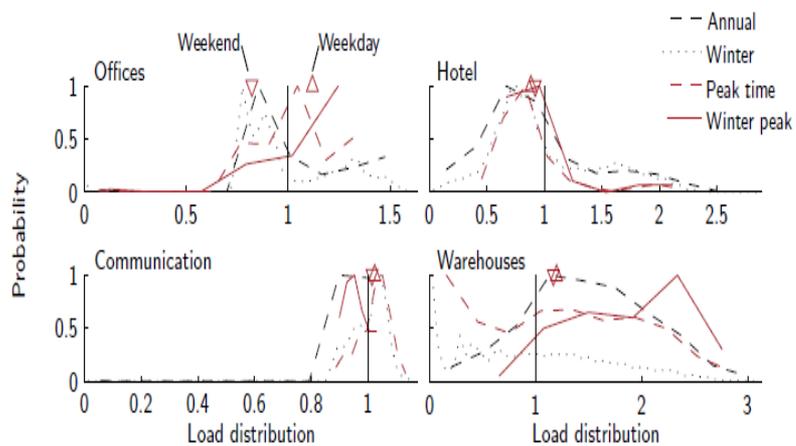
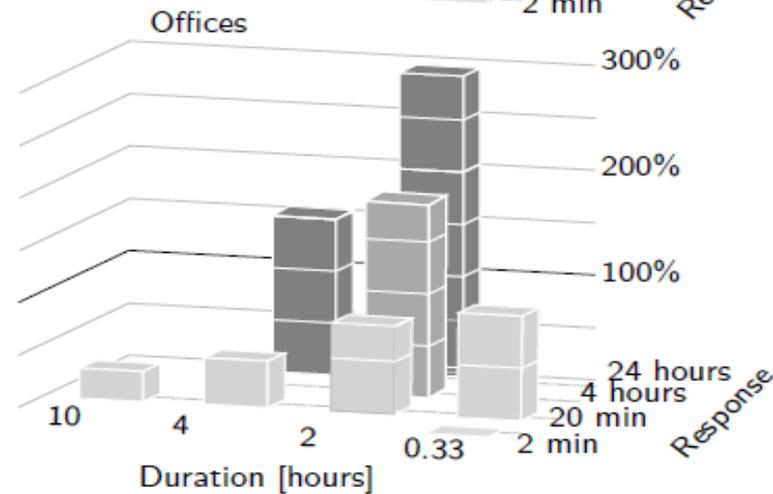
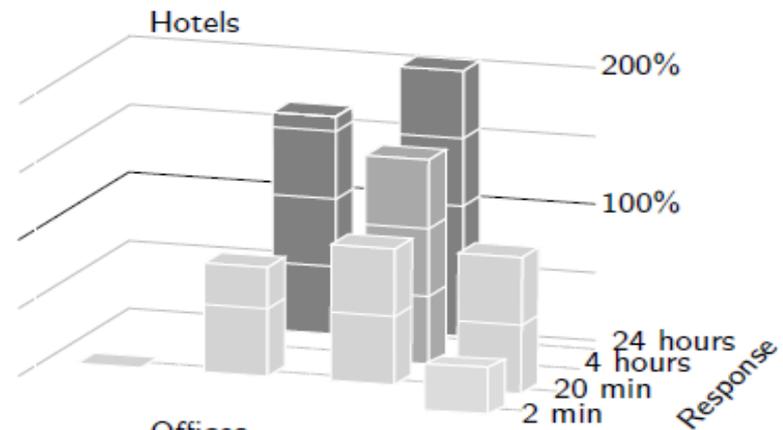
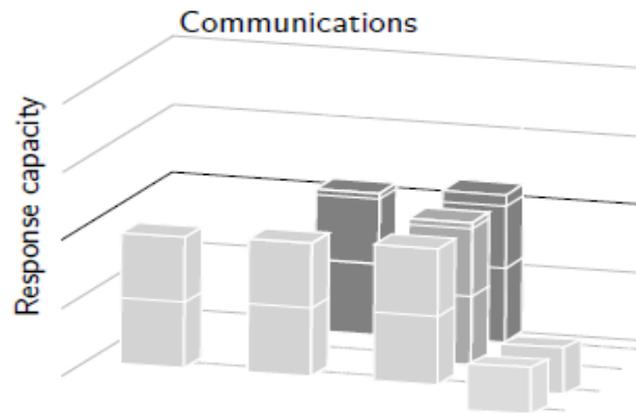
Response capacity availability from UK warehouses  
(illustrative example)



# What if conditions were relaxed?

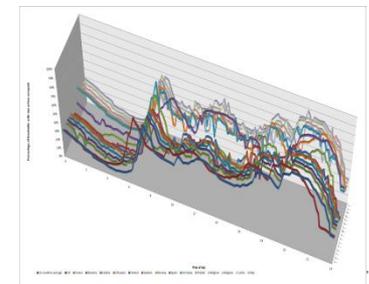
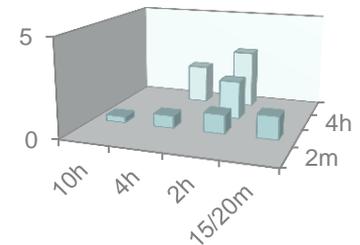
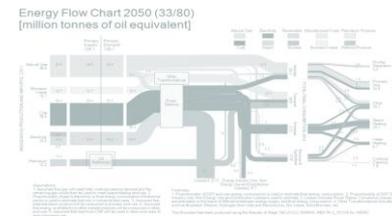
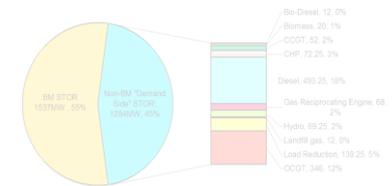


# Examples of expected response capacity for given response time and durations relative to present provision under STOR



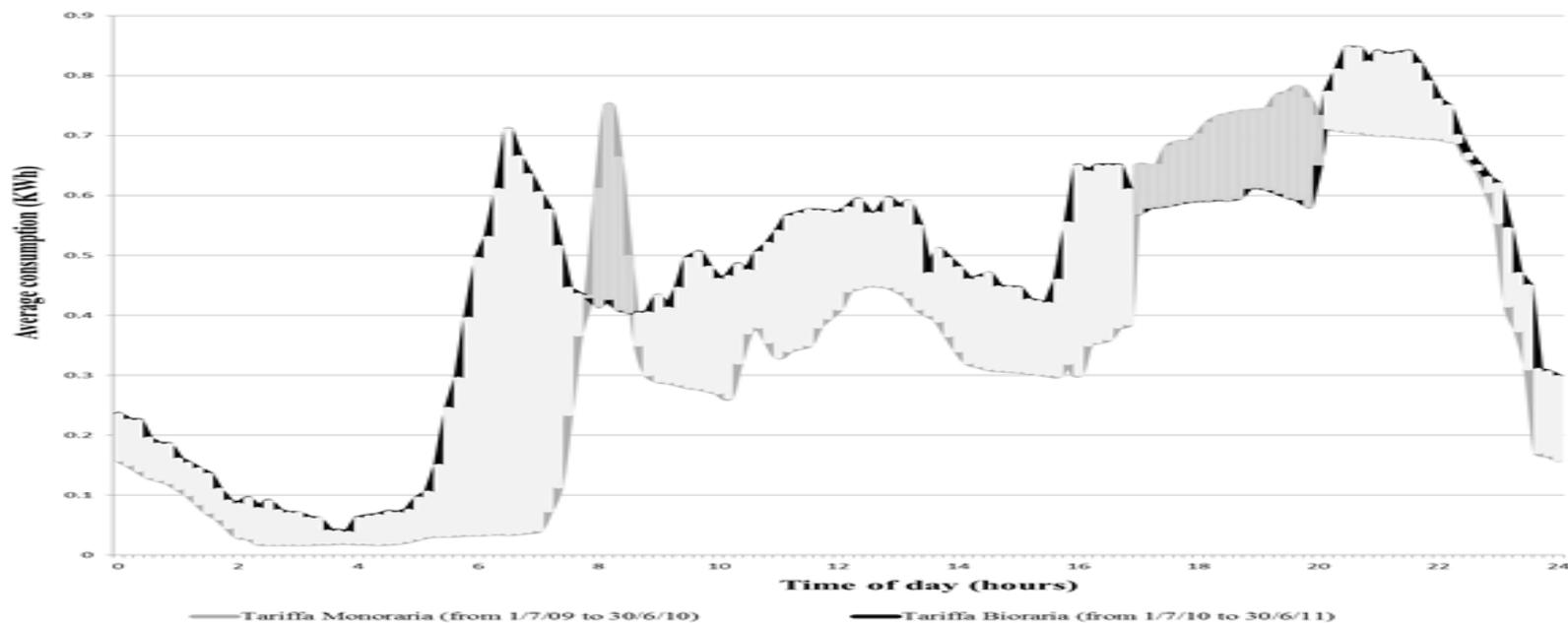


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# Shifting demand through price: Time of Use tariffs

- After TOU tariffs were introduced negative conservation effect (consumption increased by 13.7%)
- Consumers' electricity bills decreased by 2.2%
- Peak load shifting took place for morning peaks and created a split in two peaks for evening periods



# Shifting demand through understanding timing of activities: practices

- The timing of energy demand depends on activities / practices
- Simultaneity of practices / hot spots during the day are vital for peak demand issues
- DSR initiatives are aimed at making demand flexible

- Structure and social distribution
  - Spatial, temporal, and social distribution of different practices: who does what, where and when?
- Time pressure and peak demand
  - Peak demand and flexibility : how strong/hard is the temporal structure? What can be changed by (what?) intervention?
  - Societal synchronisation?
- Change over macro & micro time
  - Birth, life and death of practices : how do practices evolve, change shape, expand, spread..?

### 5 years funding

£4,808,648	EPSRC/ESRC (RCUK Energy Programme)
£1,643,000	Additional and in-kind funding (EDF, TFL, IEA, SCI/TESCO)
£658,592	Institutional support (from across partner universities)
£7,110,200	<i>Total Research Resource</i>

### EDF R&D European Centre and Laboratories for Energy Efficiency Research

- Part of core team, co-produced research programme
- 3 funded PhD studentships at Lancaster, 2 in Paris
- comparative and parallel programme of work in France by EDF researchers

### Multidisciplinary research team

- 14 Co-Is from 9 Universities
- 15 Post doc Researchers
- 13 PhDs

# Timing of residential demand and active occupancy

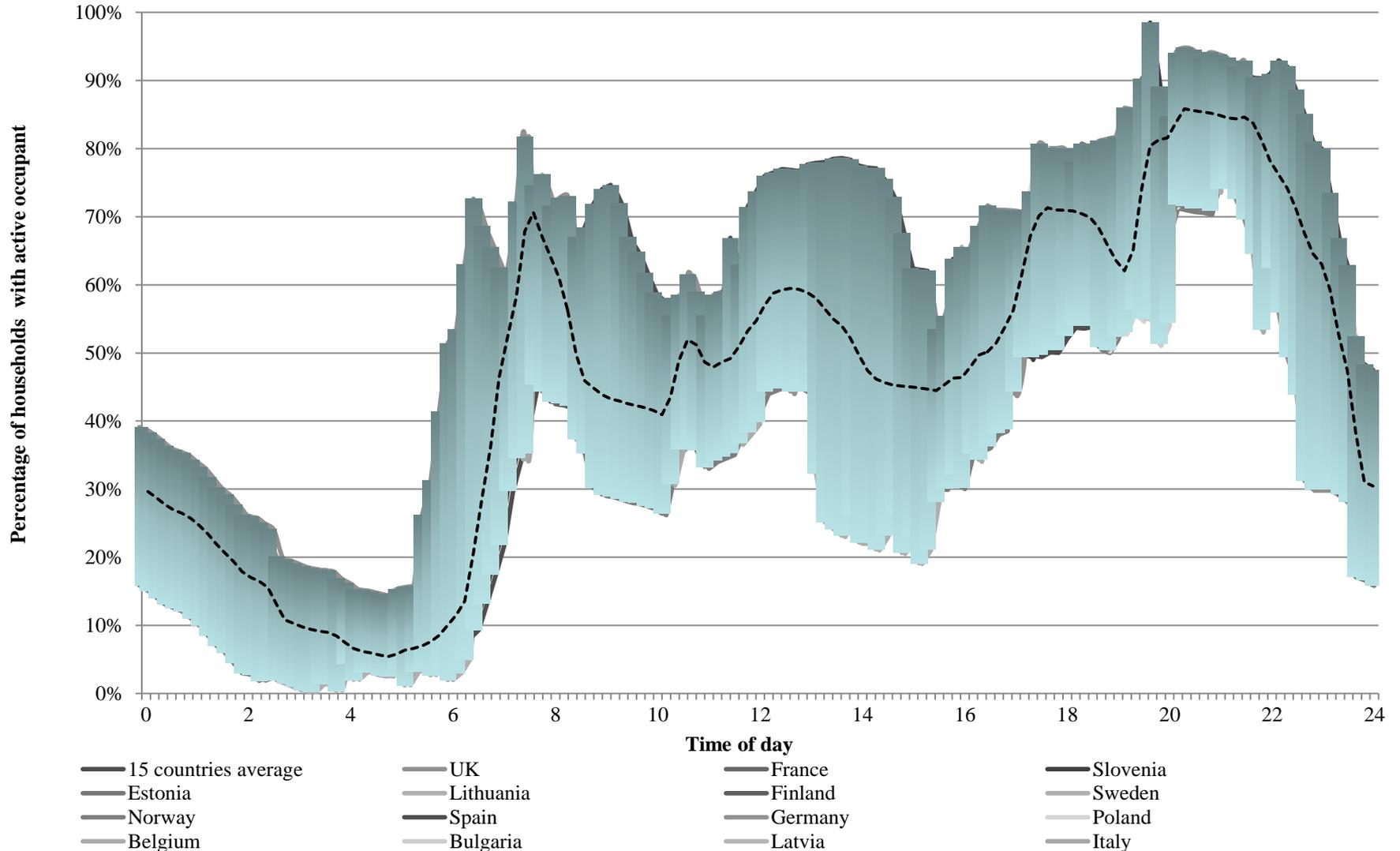
- Large amounts of data available on timing of generation, transmission, distribution and supply (European Commission, 2010; International Energy Agency, 2010)
- But limited information about timing of consumption of residential users
- Two possible approaches:
  - advanced metering technologies
  - deriving time-related demand for electricity from available occupancy data

# Time use data

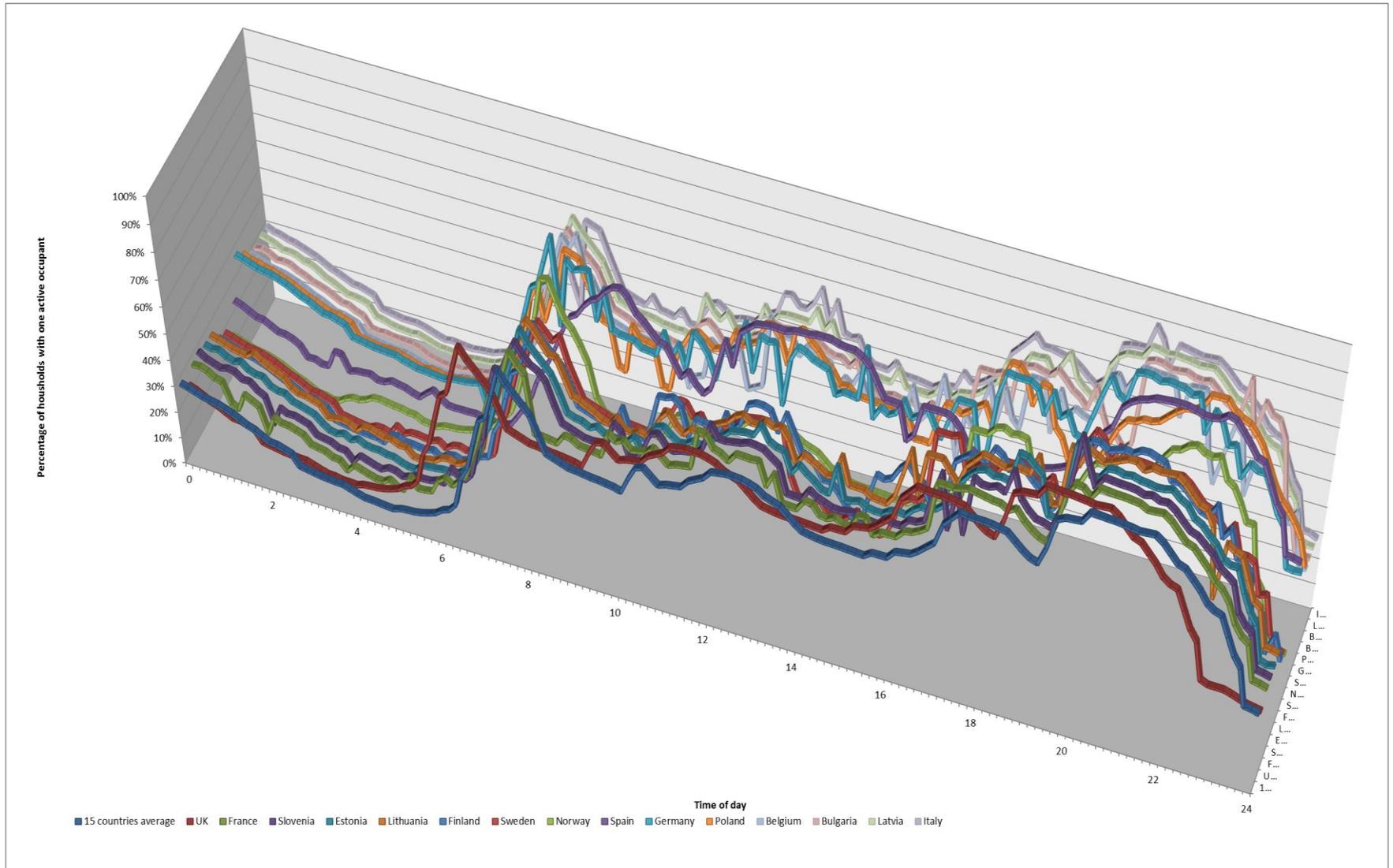
- The Harmonised European Time Use Survey (HETUS) database consists of 220,464 residential users across 15 countries
- Focus on single households

Diary/ person id	Starting Time	Ending time	Main activity	Parallel activity	Who with:				Where/mode of transport
					Alone	Spouse	Small child	Other pers.	
a	04:00	07:20	Sleep						At home
a	07:20	07:50	Shower						At home
a	7:50	08:30	Had breakfast	Read newspaper			Ch		At home
a	08:30	08:40	Walked to bus		A				By foot
a	08:40	09:00	Bus to job					OP	By bus

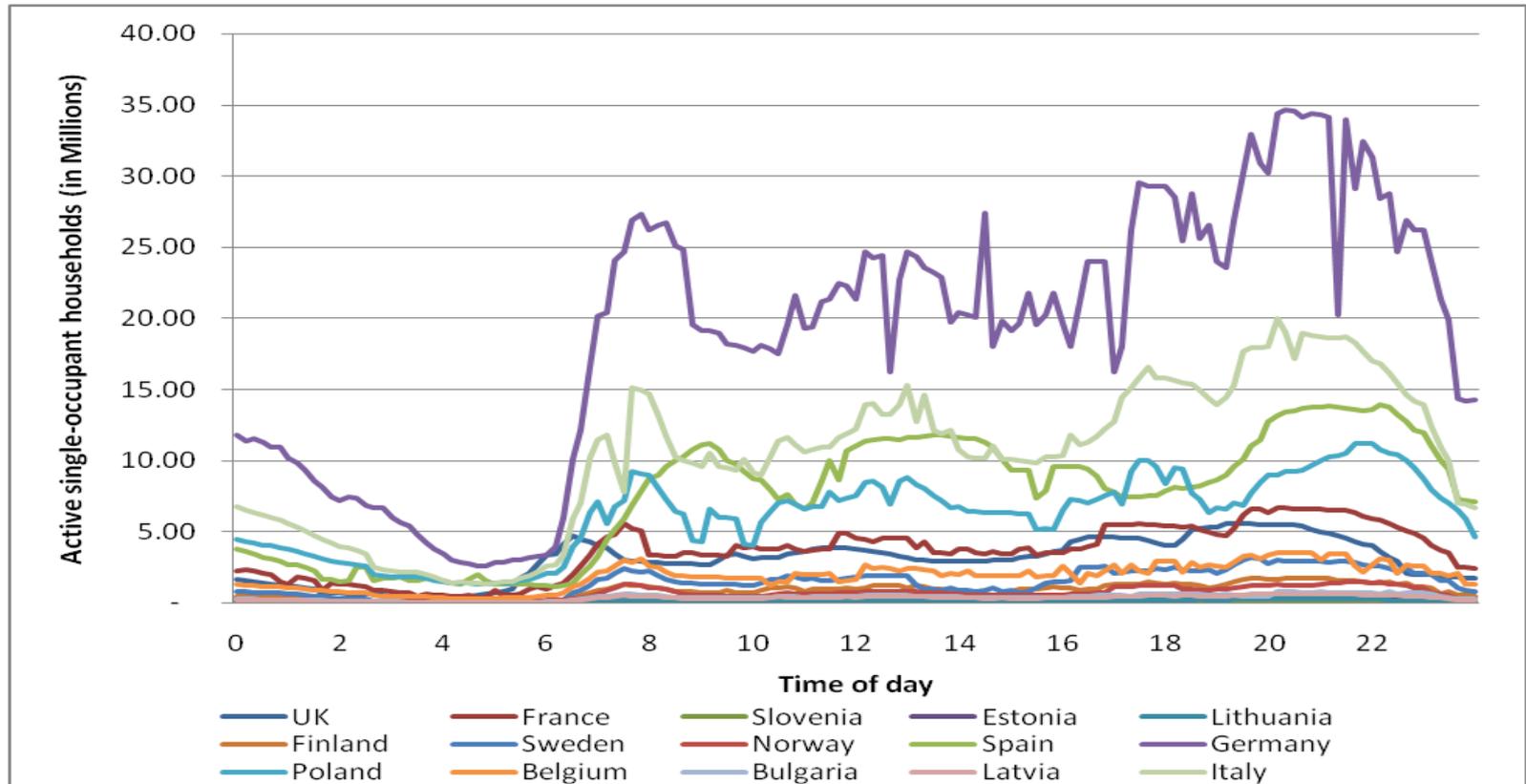
# Relative occupancy curves of single households in 15 European countries (1)



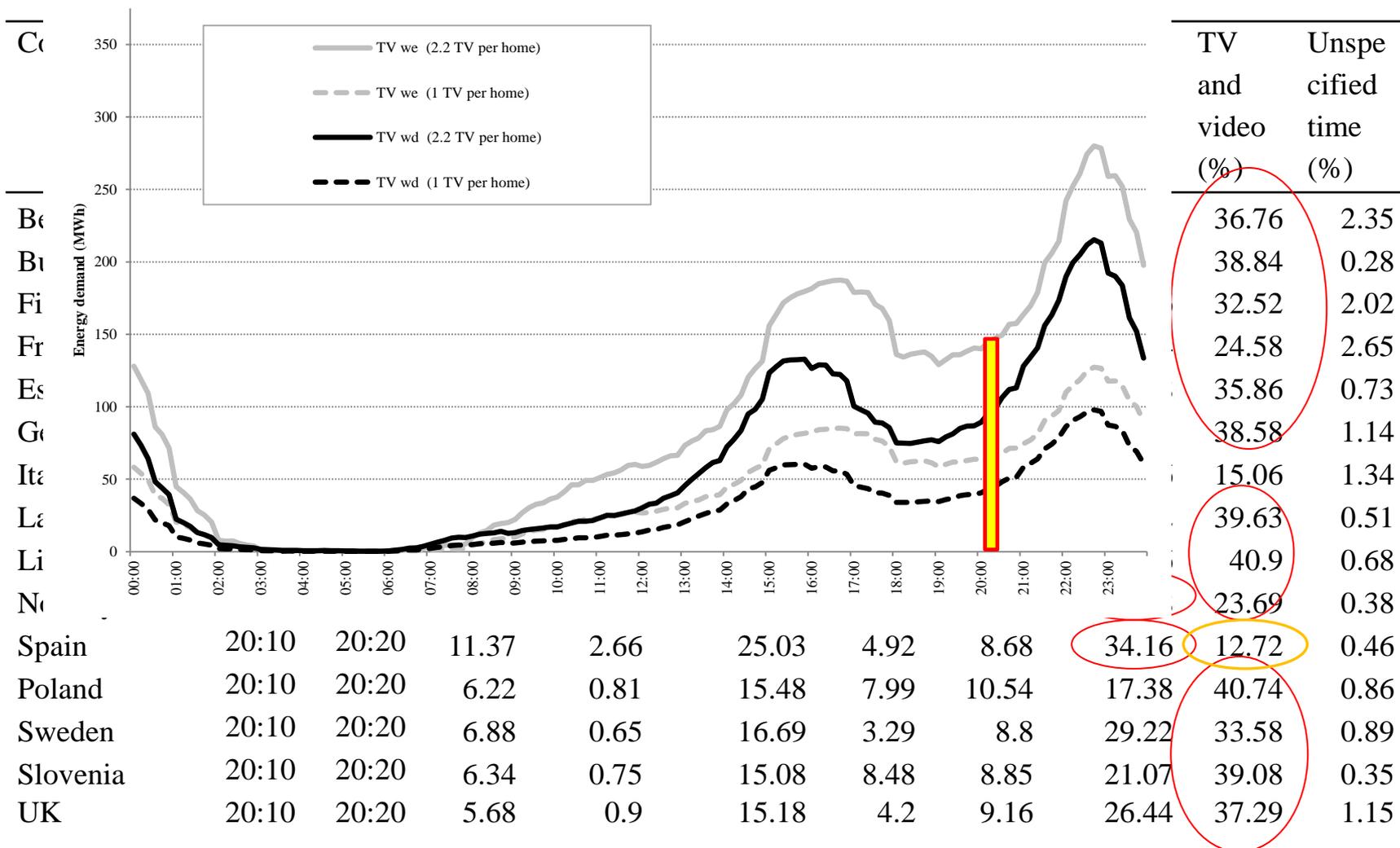
# Relative occupancy curves of single households in 15 European countries (2)



# Absolute occupancy curves of single households in 15 European countries



# Activities at home of single households between 20h20 and 20h30



# Occupancy variance

- Baseline occupancy variance
- Peak occupancy variance

- High peak variance  $\rightarrow$  *smart appliances*
- Low peak variance  $\rightarrow$  *manual and incentive-based DSR programmes*
- Low non-peak variance  $\rightarrow$  *DDSC*
- High baseline variance  $\rightarrow$  *ToU*

Country	$\beta$	$\mu_{MP}$ $\mu_{EP}$	$(\beta - \mu_{MP})$ $(\beta - \mu_{EP})$
Belgium	0.193 (0.027)	0.051 0.034	0.142 0.159
Bulgaria	0.194 (0.071)	0.048 0.011	0.146 0.183
Finland	0.130 (0.056)	0.024 0.010	0.106 0.120
Estonia	0.127 (0.028)	0.008 0.021	0.119 0.106
Germany	0.113 (0.015)	0.043 0.022	0.070 0.091
Italy	0.124 (0.023)	0.049 0.024	0.075 0.100
Latvia	0.128 (0.027)	0.011 0.024	0.117 0.104
Lithuania	0.131 (0.025)	0.009 0.018	0.122 0.113
Norway	0.130 (0.026)	0.057 0.012	0.073 0.118
Spain	0.192 (0.031)	0.064 0.057	0.128 0.135
Poland	0.101 (0.019)	0.051 0.012	0.060 0.089
Sweden	0.126 (0.025)	0.054 0.014	0.072 0.112
Slovenia	0.144 (0.023)	0.041 0.025	0.103 0.119
United Kingdom	0.165 (0.023)	0.091 0.020	0.074 0.145

# Final remarks

- Current “demand side” arrangements favour generation rather than DSR
- The factors which slowed down DSR in the past are likely to change in the future
- Different regulatory arrangements (e.g. under capacity mechanisms) would favour potential increase of DSR
- Following timing of activities is key to understand the potential of DSR in the residential sector

# References

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# Thanks

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