CENTRE FOR RESEARCH INTO
ENERGY DEMAND SOLUTIONS

Research on demand-side flexibility: residential and non-residential sectors

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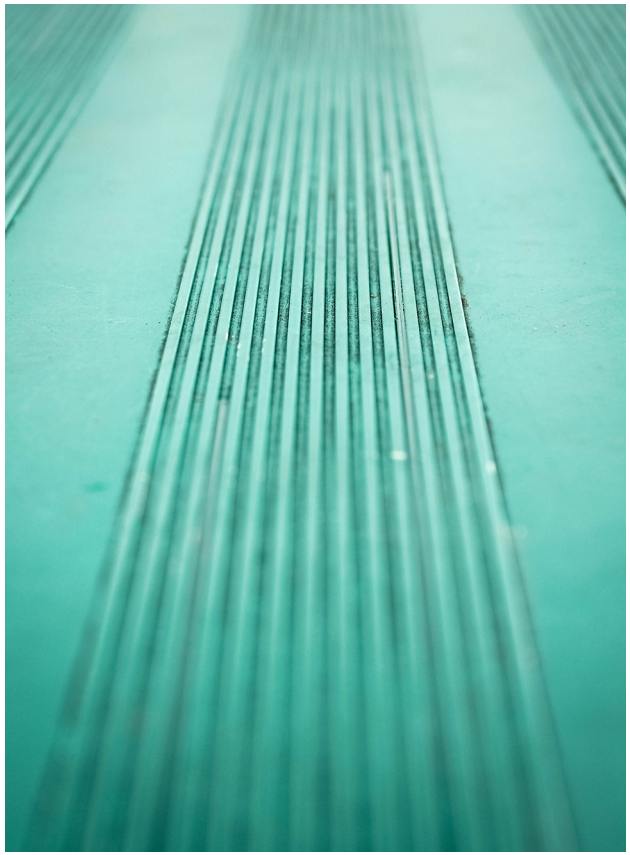
1 OCTOBER 2018

Outline

- Centre for Research into Energy Demand Solutions (CREDS)
- Research on flexibility in the residential sector:
  - Focus on people's activities
  - Clustering based on people's activities
  - Distributional effects of Time of Use tariffs
- Research on demand-side flexibility in the industrial and commercial sectors



The Centre for Research into Energy Demand Solutions (CREDS)

- A UKRI Energy Programme funded, from April 2018 to March 2023, with a budget of £19.5 million
- A distributed centre, involving 13 universities, with a core team based at the University of Oxford
- More information at: creds.ac.uk

Consortium institutions

University of Reading

UNIVERSITY OF OXFORD

Lancaster University

Loughborough University

LSE

UCL

THE UNIVERSITY of EDINBURGH

UNIVERSITY OF LEEDS

MANCHESTER 1824
The University of Manchester

University of Reading

UNIVERSITY OF SURREY

US
University of Sussex

UWE Bristol
University of the West of England

UNIVERSITY of York

CREDS Themes

Transport

Buildings

Materials

Flexibility

Digital

Policy

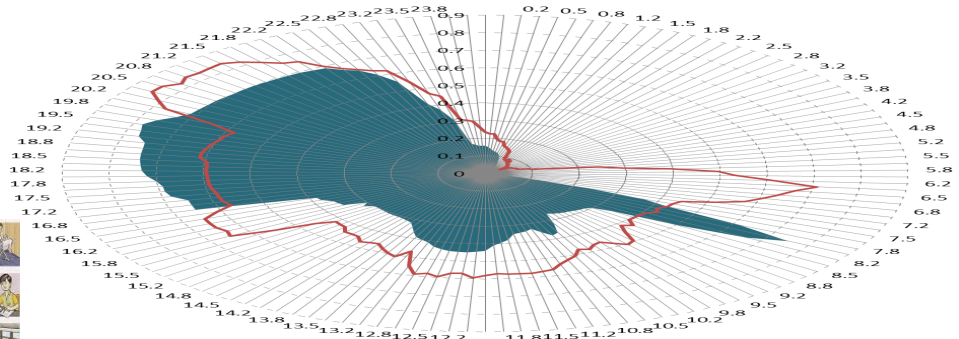
Research on demand-side flexibility: residential sector

- Weekday




- Weekend



Time use data

- Self-recorded diary
- 10 minute granularity

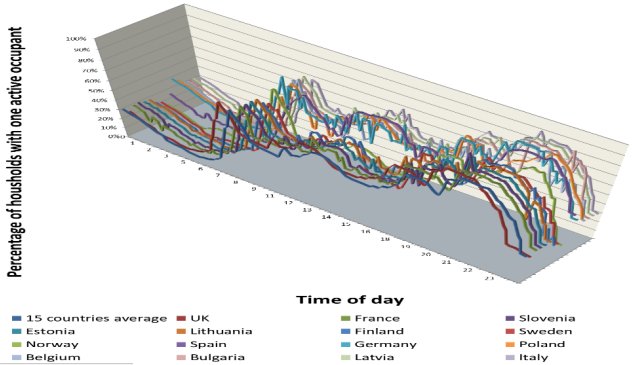
Diary/ person id	Starting Time	Ending Time	Main activity	Parallel activity	Who with:				Where/mode of tranport
					Alone	Spouse	Small child	Other pers.	
AA23	04:00	07:20	Sleep						At home
AA23	07:20	07:50	Shower						At home
AA23	7:50	08:30	Had breakfast	Read newspaper			Ch		At home
AA23	08:30	08:40	Walked to bus		A				By foot
AA23	08:40	09:00	Bus to job					OP	By bus

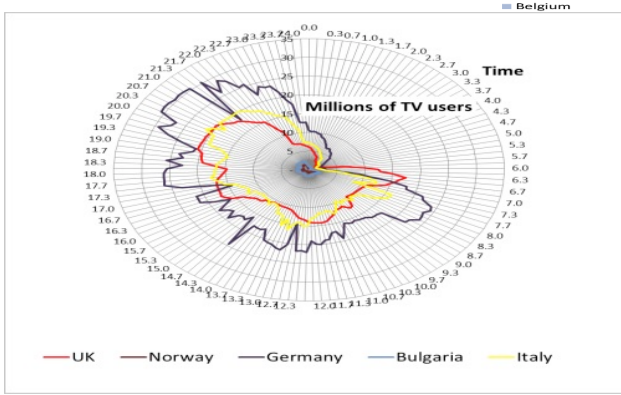
Country	StartTime	Work and study	Travel to/from work/study	Household work	Sleep and other personal care	Eating	Freetime	TV and video	Unspecified time
Belgium	04:00	1.04	0.07	0.16	97.16	0.15	1.01	0.17	0.24
Belgium	04:10	1.09	0.09	0.28	97.14	0.18	0.85	0.14	0.23
Belgium	04:20	1.09	0.15	0.18	96.94	0.4	0.81	0.17	0.25
Belgium	04:30	1.13	0.35	0.23	96.51	0.27	1.09	0.17	0.27
Belgium	04:40	1.23	0.34	0.36	96.46	0.2	0.97	0.15	0.29
Belgium	04:50	1.26	0.35	0.44	95.81	0.49	1.16	0.18	0.31
Belgium	05:00	1.53	0.34	0.61	94.76	0.49	1.78	0.21	0.27
Belgium	05:10	1.6	0.47	0.68	94.82	0.61	1.34	0.21	0.27
Belgium	05:20	1.71	0.64	0.61	94.54	0.65	1.25	0.24	0.36
Belgium	05:30	1.83	0.95	0.7	93.31	0.77	1.84	0.22	0.37
Belgium	05:40	1.94	1.26	0.99	92.77	0.74	1.74	0.24	0.3
Belgium	05:50	2.31	1.22	1.08	91.76	0.98	2.09	0.21	0.36
Belgium	06:00	3.08	1.06	1.39	88.08	1	4.81	0.23	0.34

Deriving occupancy for 15 European countries

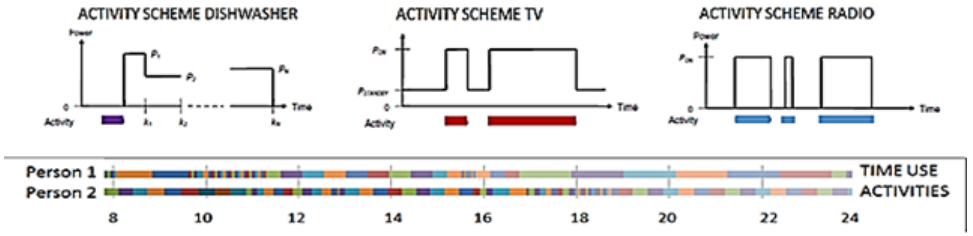
-Harmonised European Time Use Survey (HETUS) database consists of 220,464 residential users across 15 countries

-Active occupancy: how much occupancy varies within peak periods

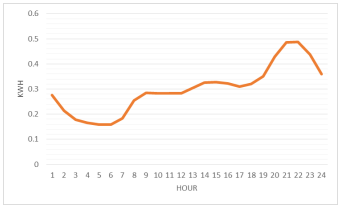




Time use data and load profiles



Activity schemes can enable to link time use activities with appliance and electricity use

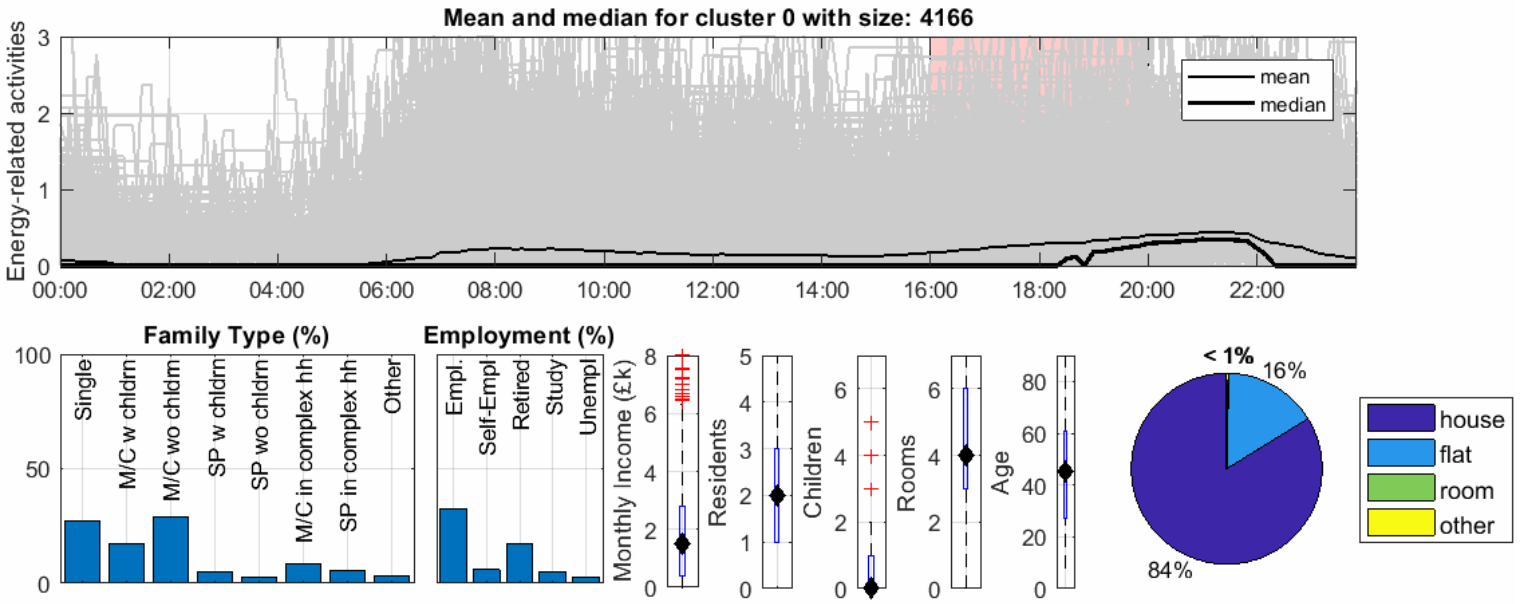


Role of household activities in peak electricity demand and distributional effects of Time-of-Use tariffs

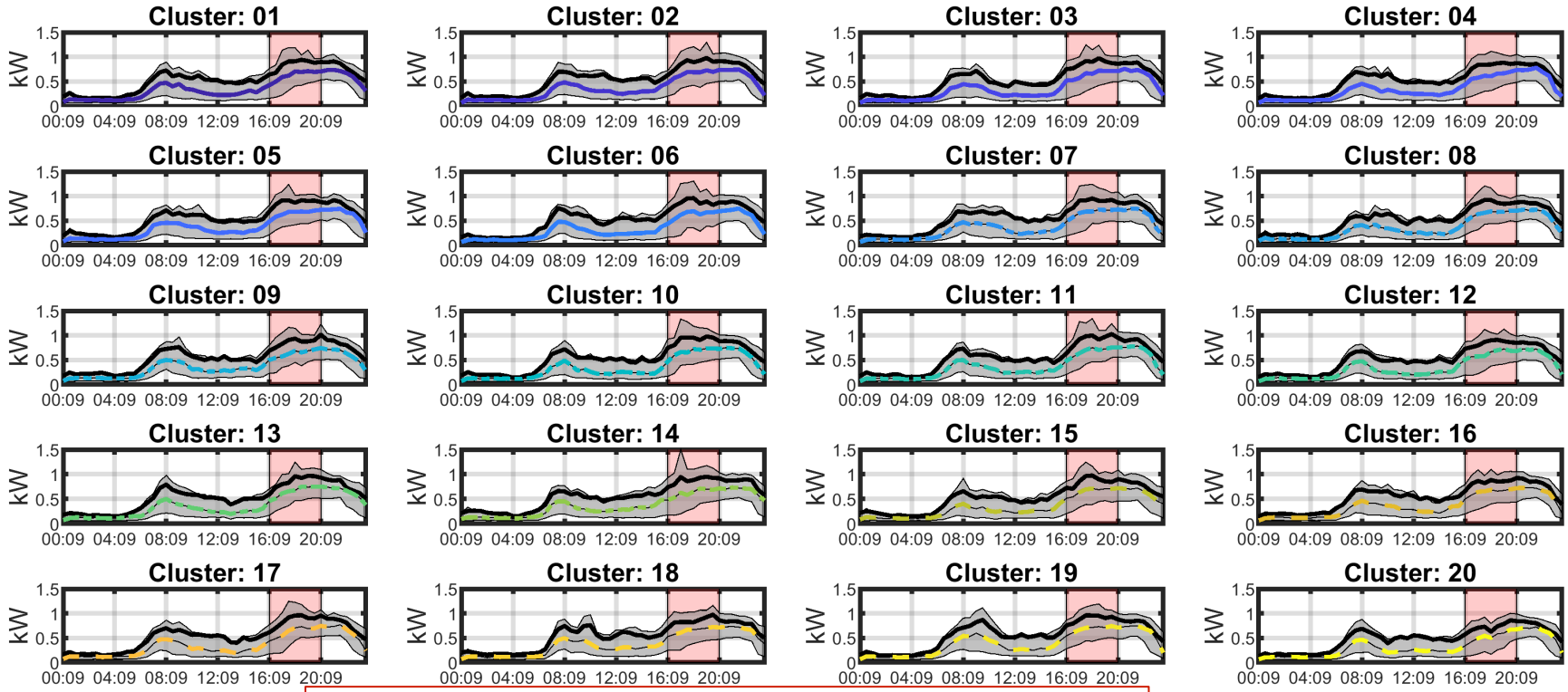
Investigating the distributional impact of Time of Use tariffs by analysing UK Time Use data

CREDS FLEXIBILITY University of Reading Energy www.creds.ac.uk

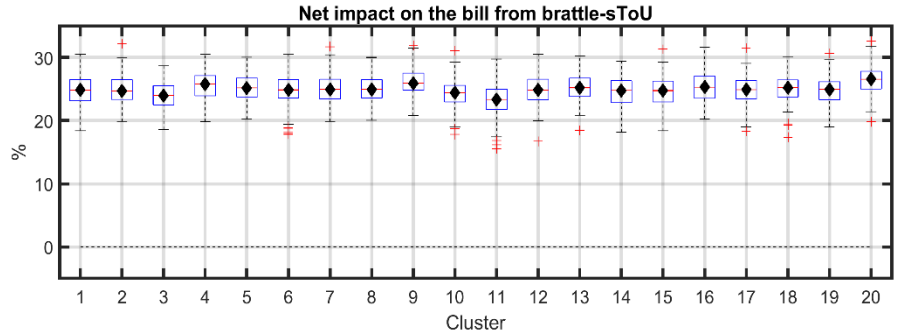
Results: clusters

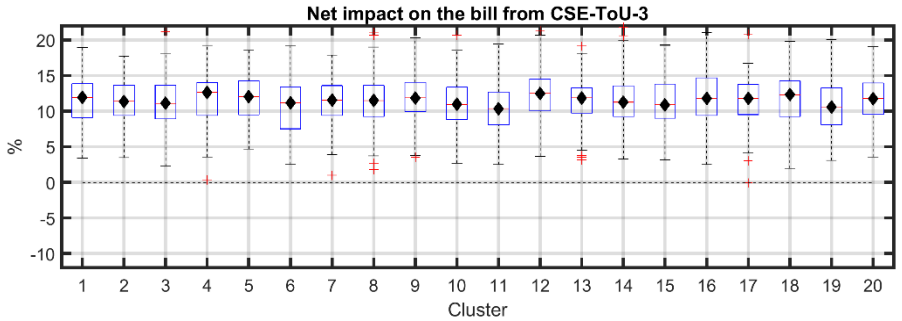


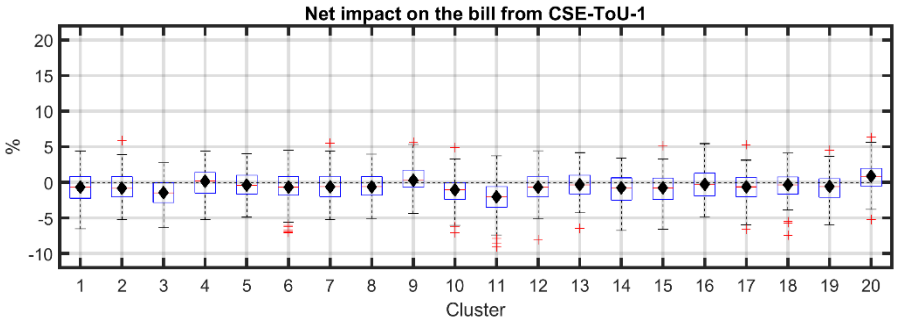
Results: demand profiles

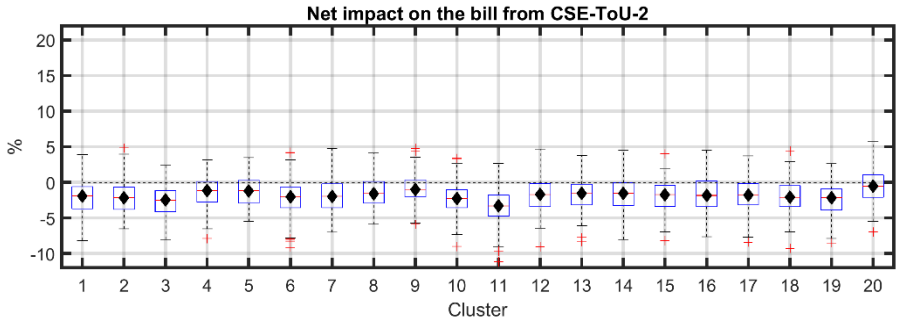


Results: impact of ToU tariffs

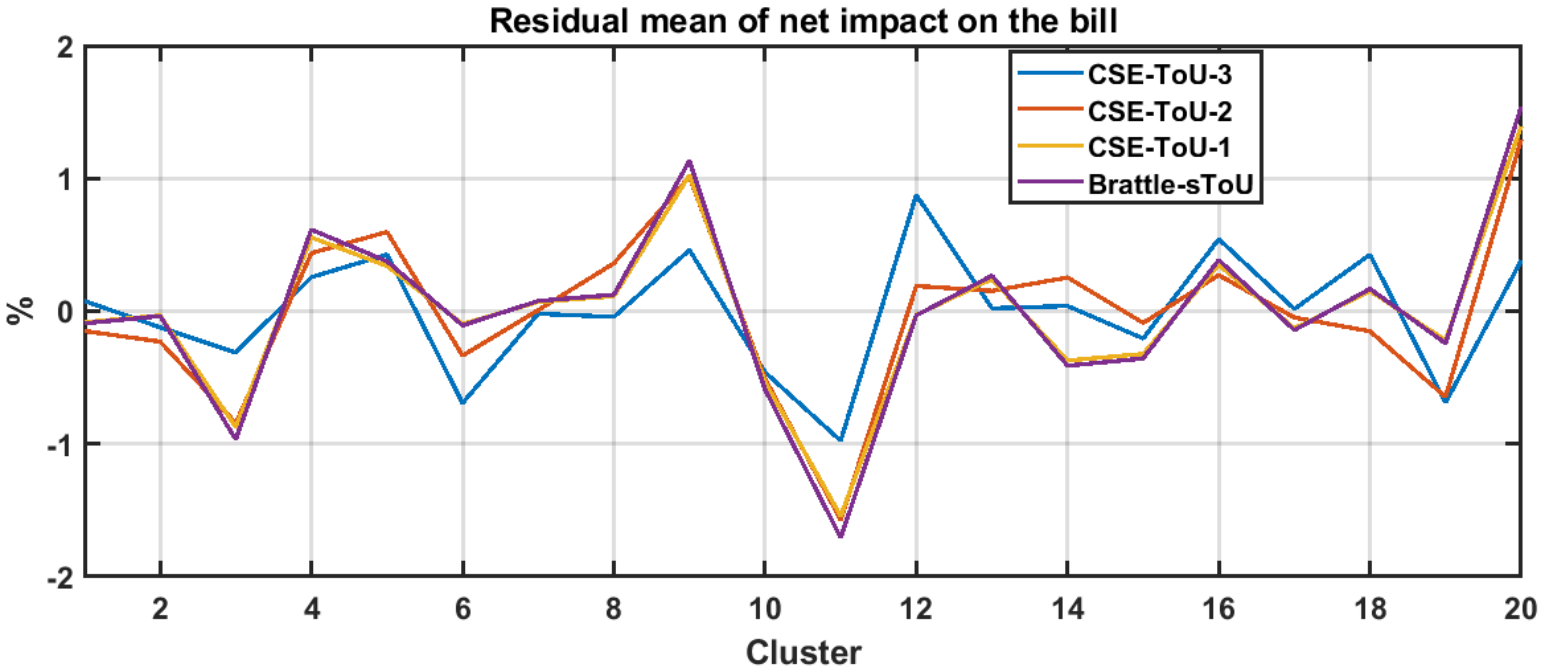


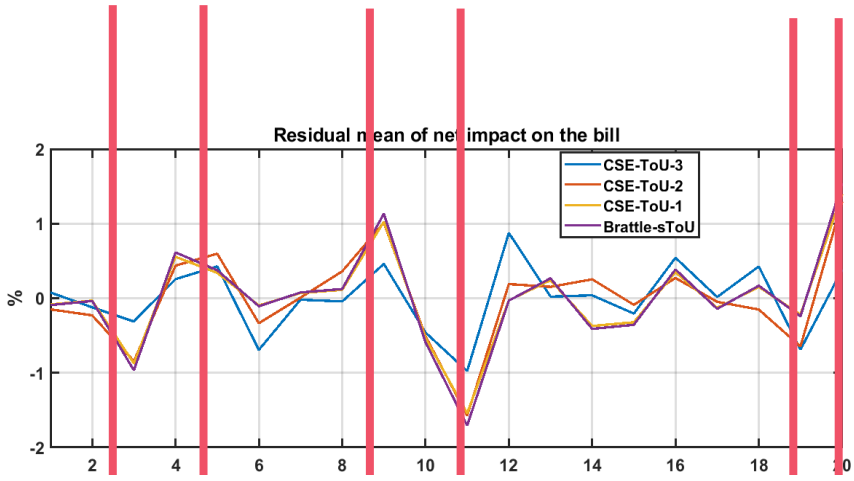




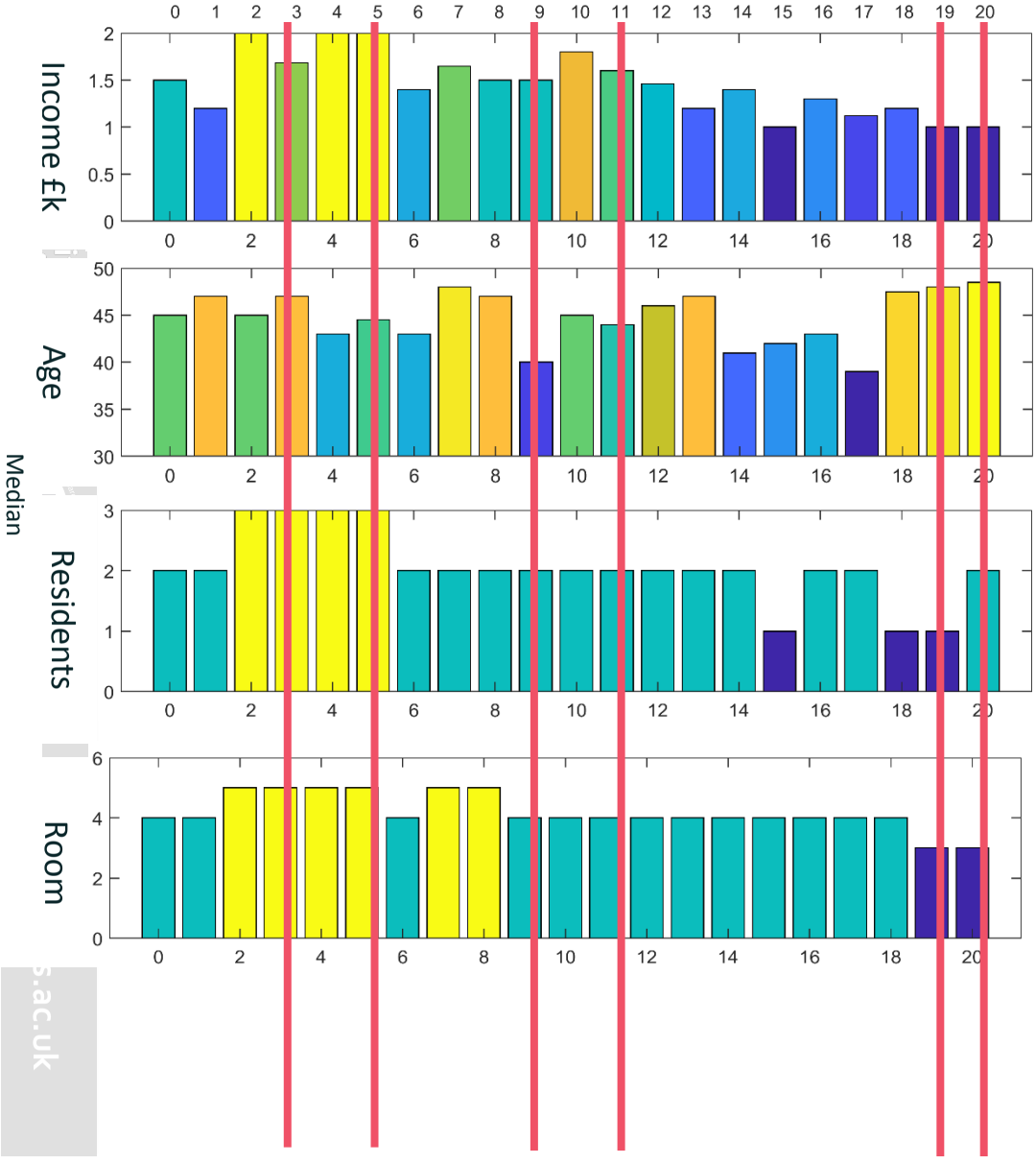


Results: impact of ToU tariffs

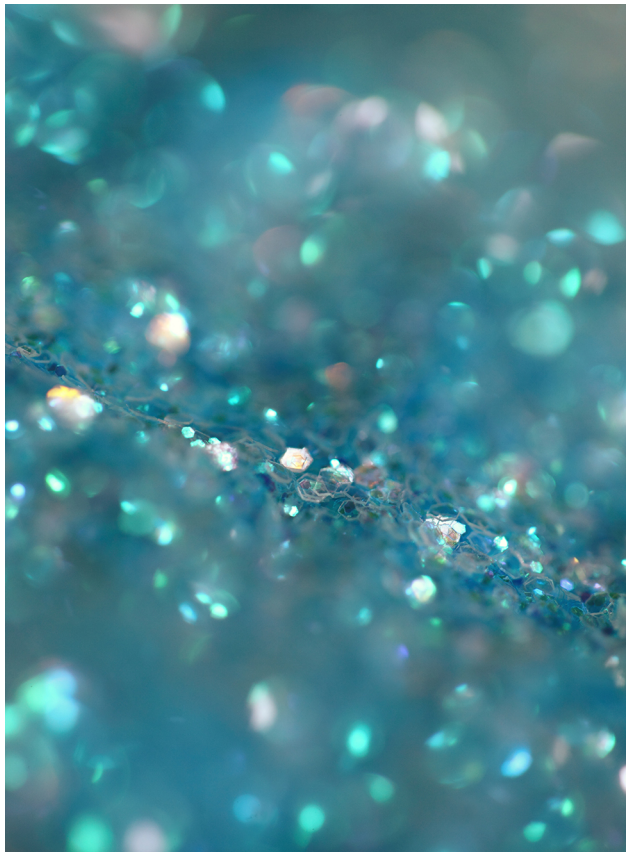




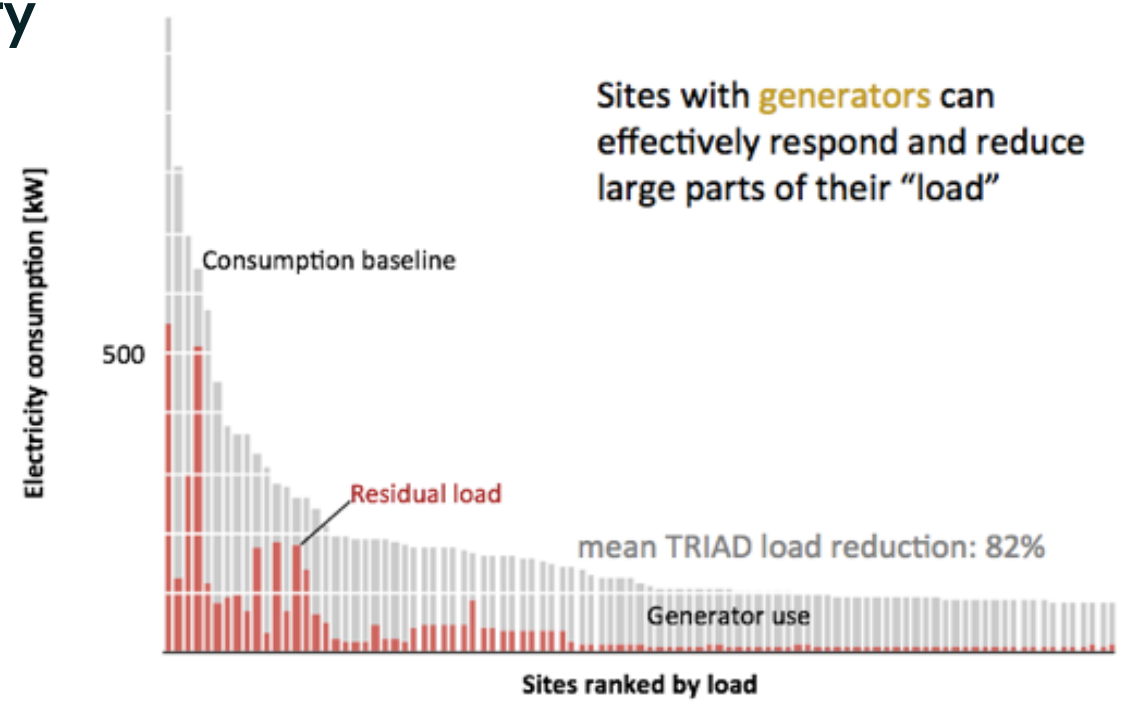
Single	27.29	26.25	28.46	30.21	28.99	25.09	29.88	30.69	21.16	31.46	29.21	26.85	22.79	25	16.81	27.72	34.02	30.53	21.69	22.22	30.51
M/C w chldrn	17.46	16.23	19.78	17.52	18.89	16.97	20.32	13.86	15.34	16.29	16.29	19.46	13.24	13.71	24.37	15.84	17.53	22.11	16.87	19.05	20.34
M/C wo chldrn	29.24	30.87	30.08	29.61	28.66	25.46	25.1	27.23	32.28	25.84	29.78	27.52	38.24	33.87	32.77	23.76	23.71	21.05	37.35	34.92	25.42
SP w chldrn	4.877	4.354	4.336	3.625	4.235	3.69	5.179	5.446	5.82	4.494	6.18	5.369	4.412	5.645	4.202	8.911	5.155	7.368	7.229	1.587	10.17
SP wo chldrn	2.857	3.562	3.252	2.417	2.932	2.214	3.984	1.485	2.646	3.933	2.809	3.356	4.412	2.419	1.681	2.97	1.031	1.053	2.41	1.587	0
M/C in complex hh	8.645	9.103	6.775	6.647	8.469	12.55	8.367	9.901	9.524	10.67	7.865	8.725	7.353	5.645	10.08	6.931	10.31	7.368	4.819	15.87	5.085
SP in complex hh	5.616	5.145	3.794	4.532	4.886	8.487	3.984	6.436	7.407	3.371	6.18	6.711	7.353	10.48	5.042	8.911	4.124	7.368	3.614	1.587	8.475
Other	2.98	3.166	2.71	4.23	2.606	3.69	1.992	2.97	4.762	3.371	0.5618	1.342	2.206	1.613	5.042	4.95	3.093	1.053	4.819	3.175	0



Research on demand-side flexibility: Demand Side Response (DSR) in the non-residential sector

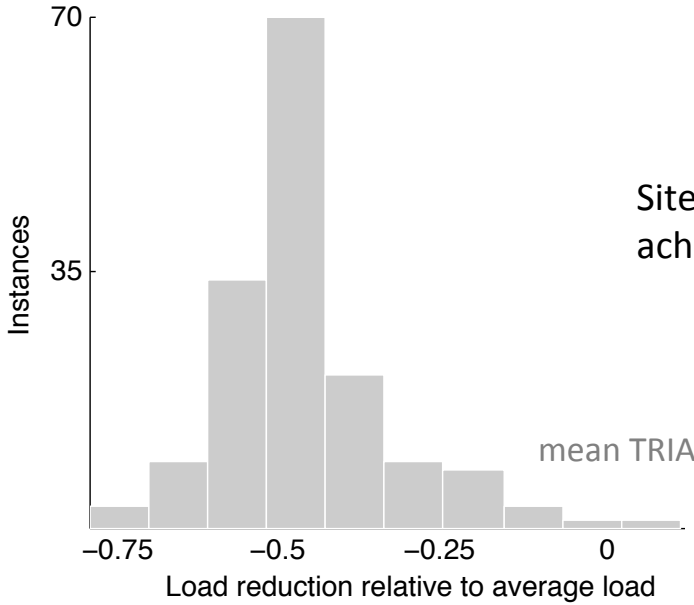


Load response of generation sites in the telecommunications industry



Virtual load reduction in the telecoms sector where generators are present

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



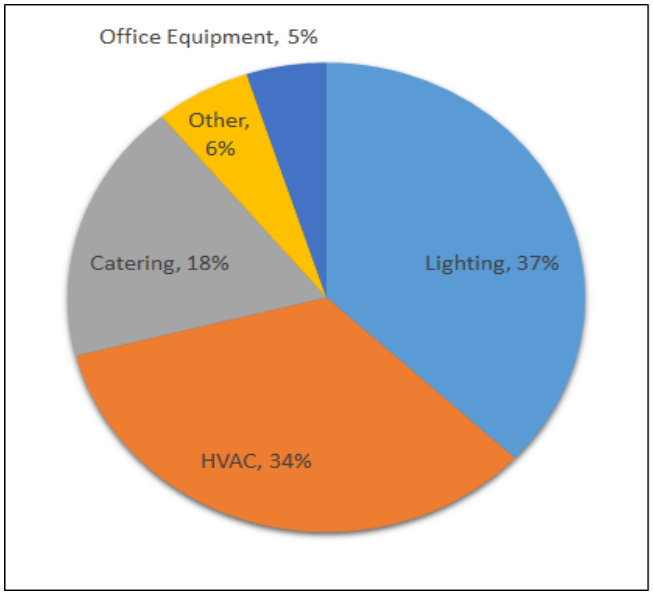
Sites without generators can also achieve significant reductions.

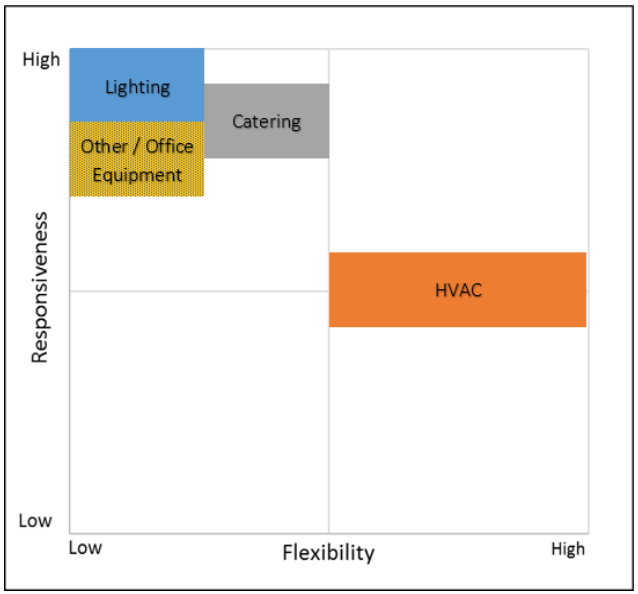
"Real" load reduction in the hotel sector based on TRIAD response of 98 hotels

Hotel electricity consumption: flexibility and responsiveness

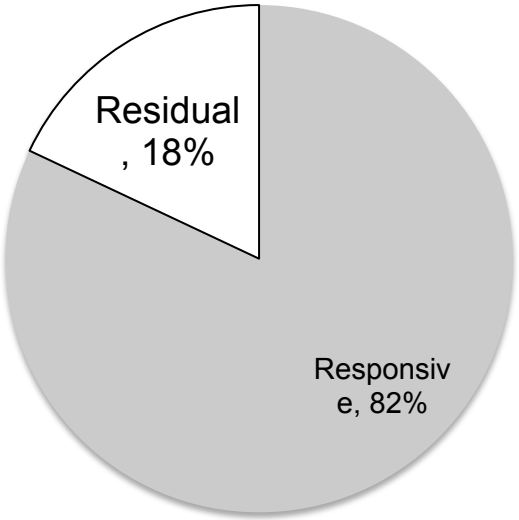
Flexibility: by how much

Responsiveness: how quickly

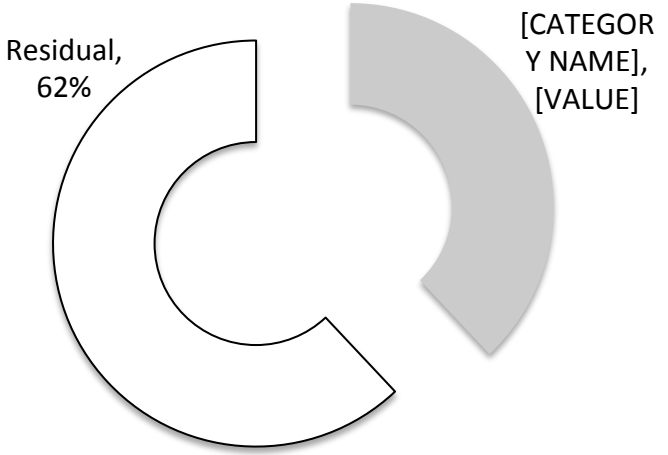




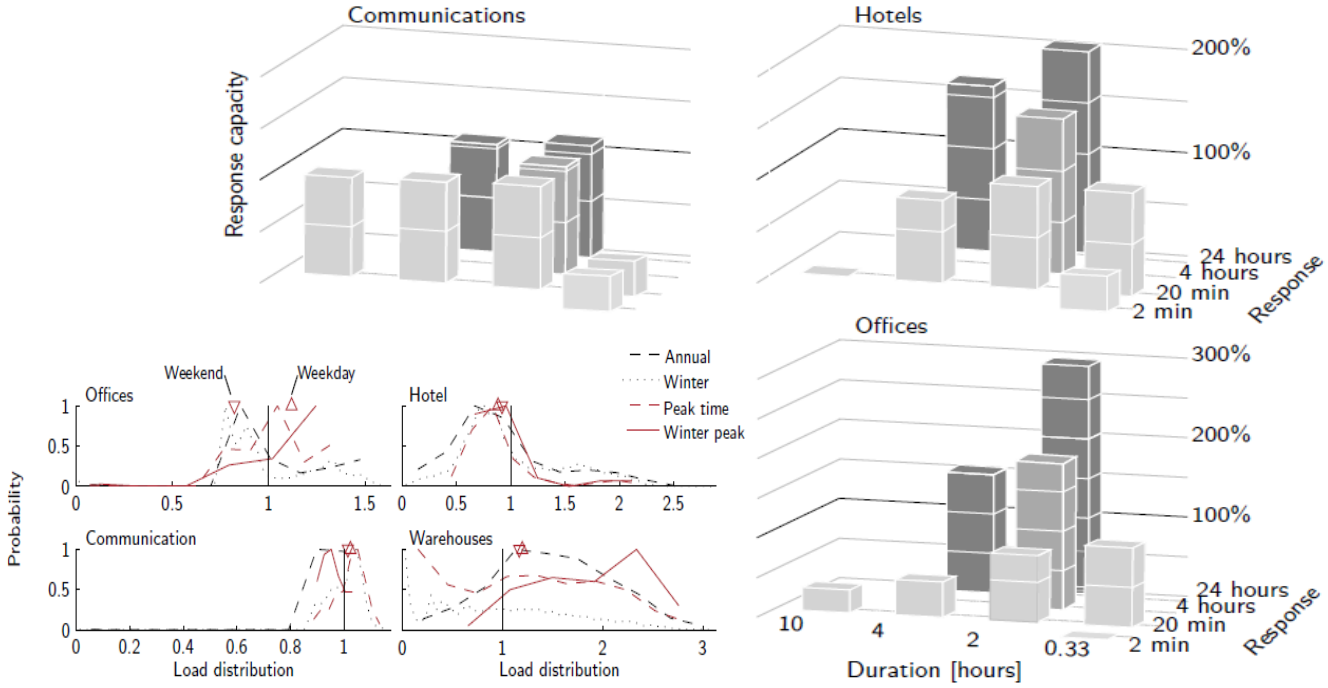
Sites with back-up generation



Sites without back-up generation (turn down only)



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



References

- Torriti, J. (2012) Demand side management for the European Supergrid: occupancy variances of European single-person households. Energy Policy, 44. pp. 199-206
- Torriti, J. (2016) Peak energy demand and demand side response. Routledge Explorations in Environmental Studies. Routledge
- Curtis, M., Torriti, J. and Smith, S. T. (2018) A comparative analysis of building energy estimation methods in the context of demand response. Energy and Buildings, 174. pp. 13-25

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