Environmental *Change* Institute

Finding the balance
New System Flexibility with Storage and Demand

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28 Nov 2017

Efficiency was for fossil systems what

Flexibility will be for future systems

Efficiency

Flexibility

Storage

Flexible Demand

e^-

4kWh

$$\eta = \frac{Out}{In}$$

40%

10kWh

e^-

2kWh

$$\eta = \frac{Out}{In}$$

20%

10kWh

Does efficiency matter?

2 conditions:

$$\eta = \frac{Out}{In}$$

< valuable

< constrained

Does efficiency matter?

PV

e^-

20kWh

$$\eta = \frac{Out}{In}$$

Valuable?

Constrained?

100kWh

Sun – no

Space – maybe

Cost - yes

Does efficiency matter?

UK productivity

$$\eta = \frac{Out}{In}$$

GDP (valuable)

Time (constrained)

Does efficiency matter?

Demand

$$\eta = \frac{Out}{In} \quad \begin{matrix} \text{Service} \\ \text{Energy} \end{matrix}$$

Does efficiency matter?

Demand

$$\eta = \frac{Out}{In}$$

Service

Energy

Very valuable

Not constrained

Does efficiency matter?

Demand

$$\eta = \frac{Out}{In}$$

Service

Energy

constrained

valuable

Does efficiency matter?

Demand

$$\eta = \frac{Out}{In}$$

valuable

Service

Energy

Time

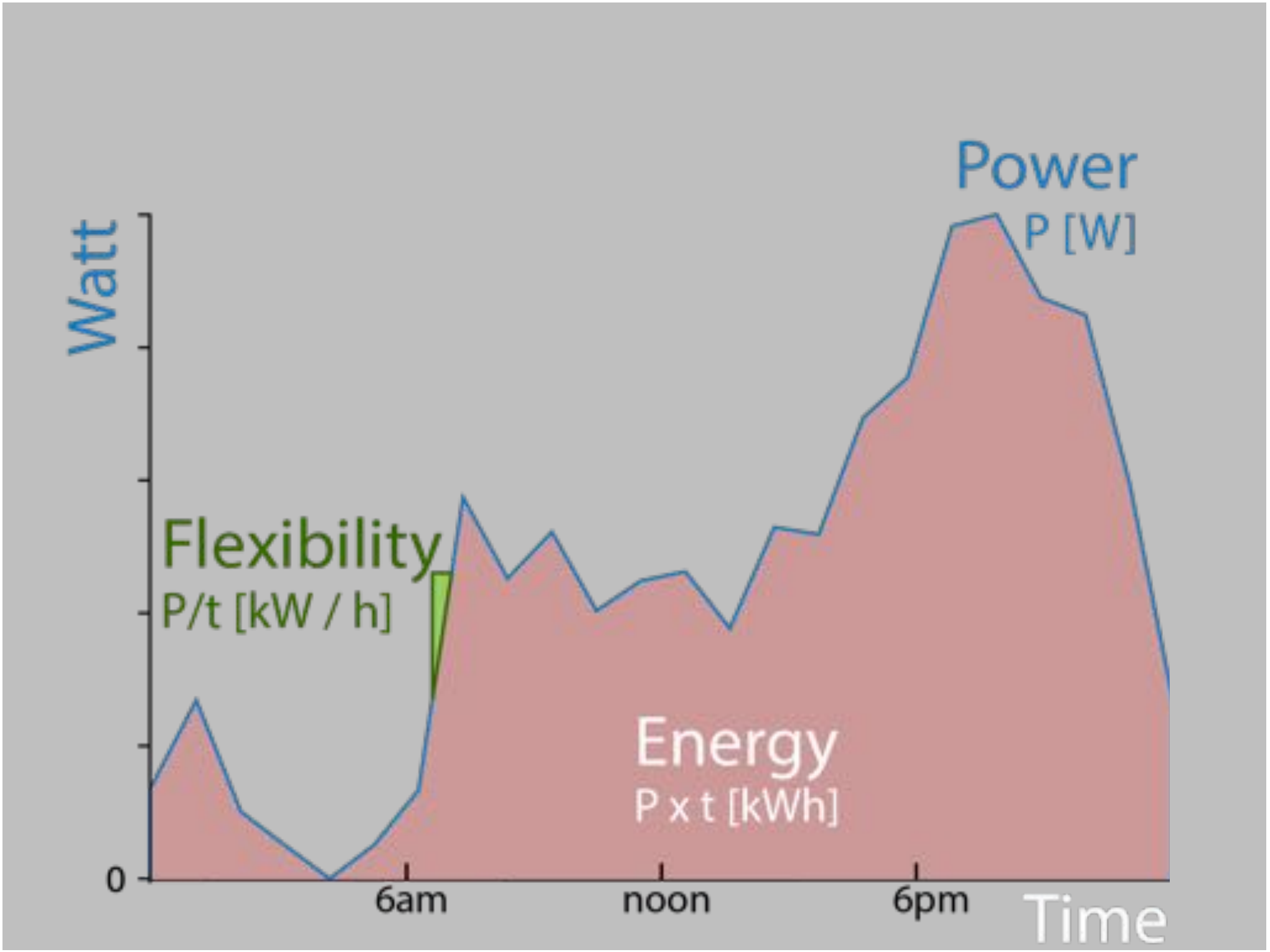
constrained

Efficiency

Flexibility

Storage

Flexible Demand


Power
P [W]
Watt
Flexibility
P/t [kW / h]
Energy
P x t [kWh]
0
6am
noon
6pm
Time

Synchronicity
(seconds - minutes)

Rhythm
(hours – seasons)

Change
(decades)

Synchronicity
(seconds - minutes)

Rhythm
(hours – seasons)

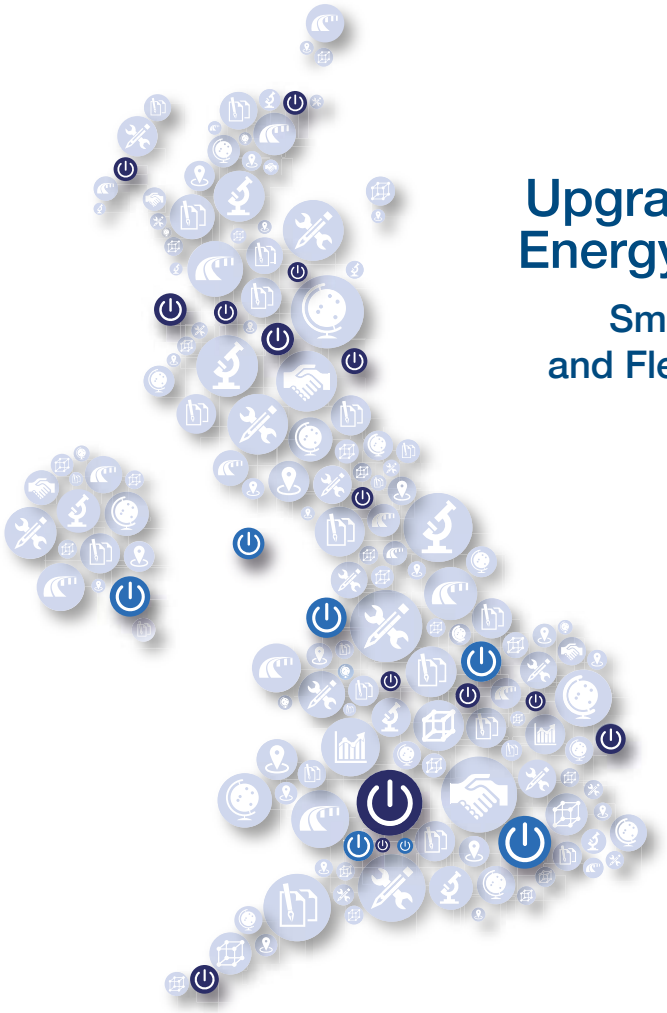
Change
(decades)

Everything changes

Market	Merit order	→ Zero SRM cost
Resilience	Physical inertia	→ Fast response
Storage	Fuel	→ Electricity
Responsiveness	Supply	→ Demand
Operation	Central	→ Distributed

HM Government

ofgem
Making a positive difference
for energy consumers



Upgrading Our Energy System

Smart Systems and Flexibility Plan

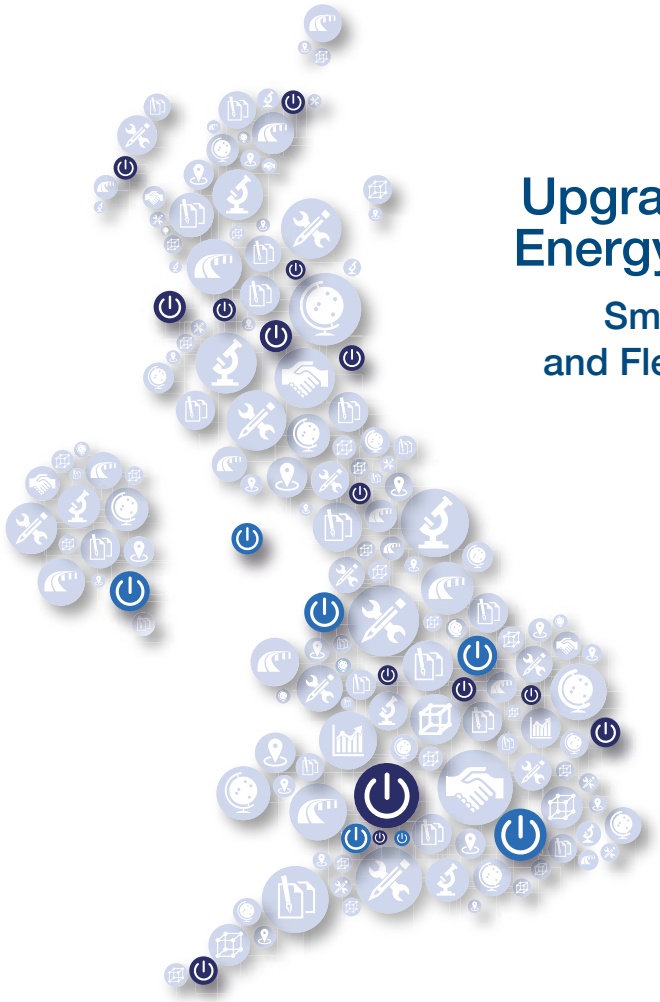
July 2017

Building our Industrial Strategy

(up to) £bn 40

HM Government

ofgem
Making a positive difference
for energy consumers



Upgrading Our Energy System

Smart Systems and Flexibility Plan

July 2017

Building our Industrial Strategy

in short:

1. Assume a costly counterfactual
2. Re-optimise with storage and (free!) DSR
3. Claim all savings are passed to consumers (p.4: “£40bn off their energy bills”)
4. Rely on “markets and competition”
5. “Expect consumers want high levels of automation”
6. Trust in technology to do good

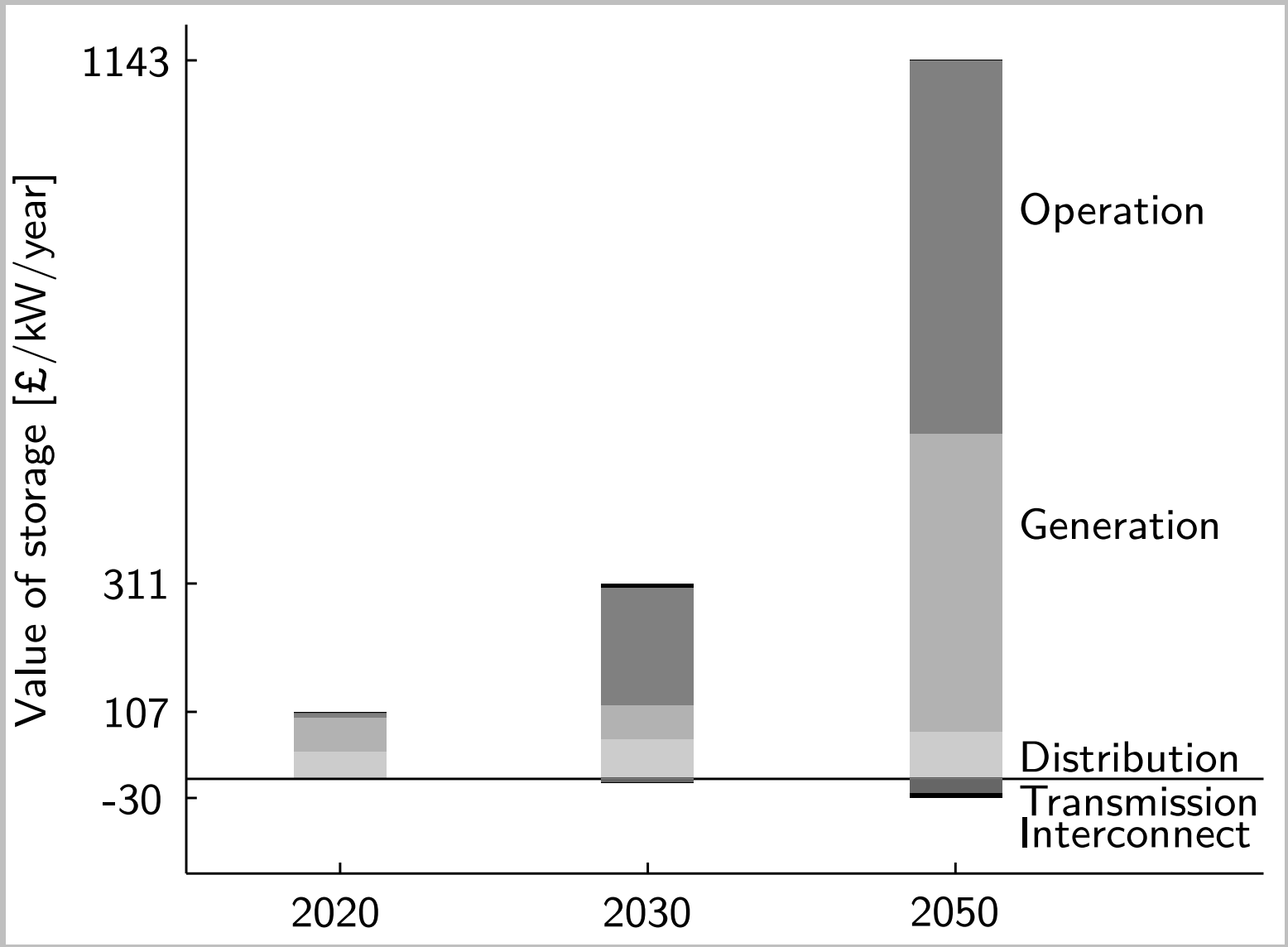
Efficiency

Flexibility

Storage

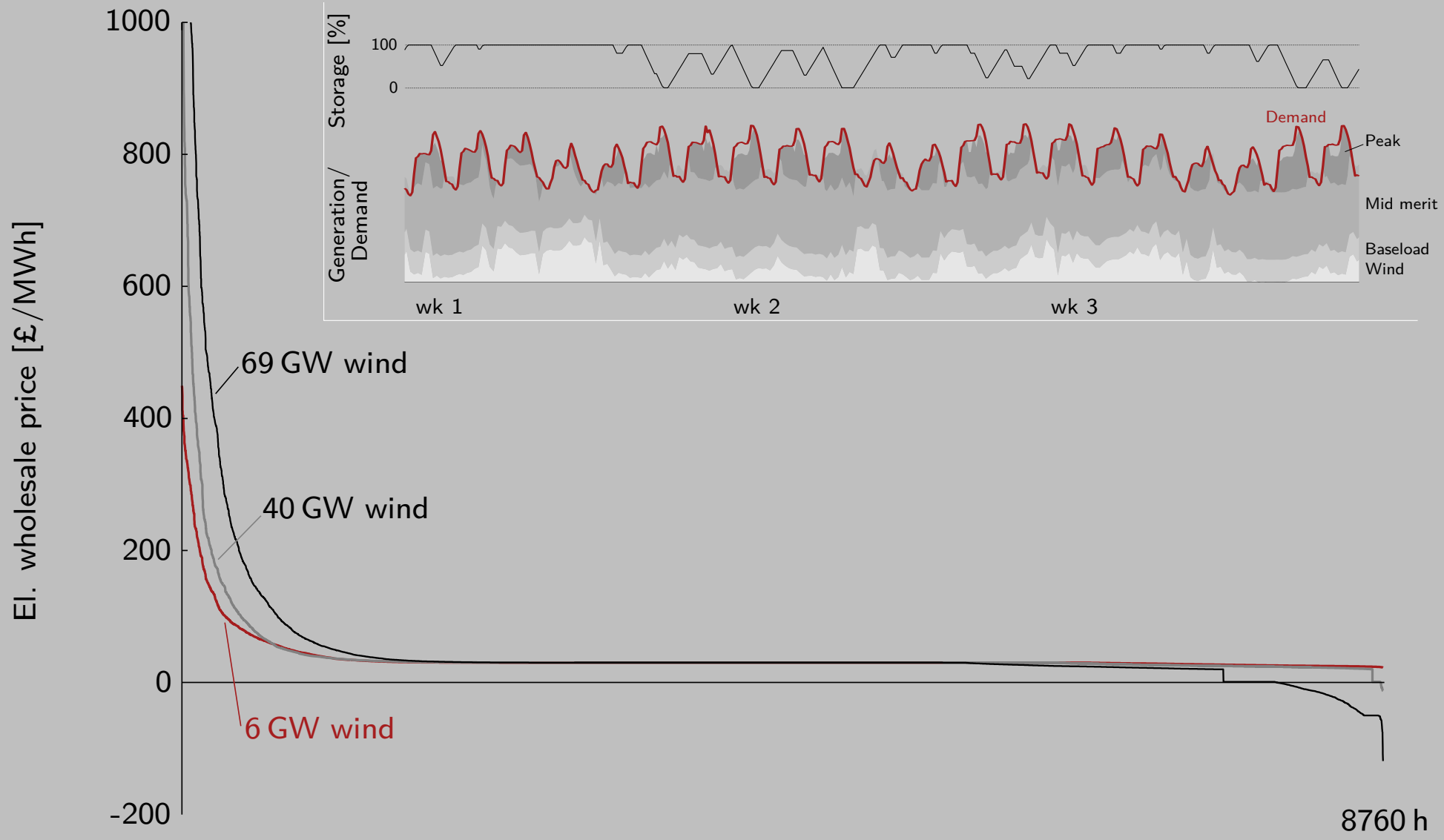
Flexible Demand

Storage value



System values: Strbac et al., Strategic Assessment of the Role and Value of Energy Storage Systems in the UK Low Carbon Energy Future. The Carbon Trust

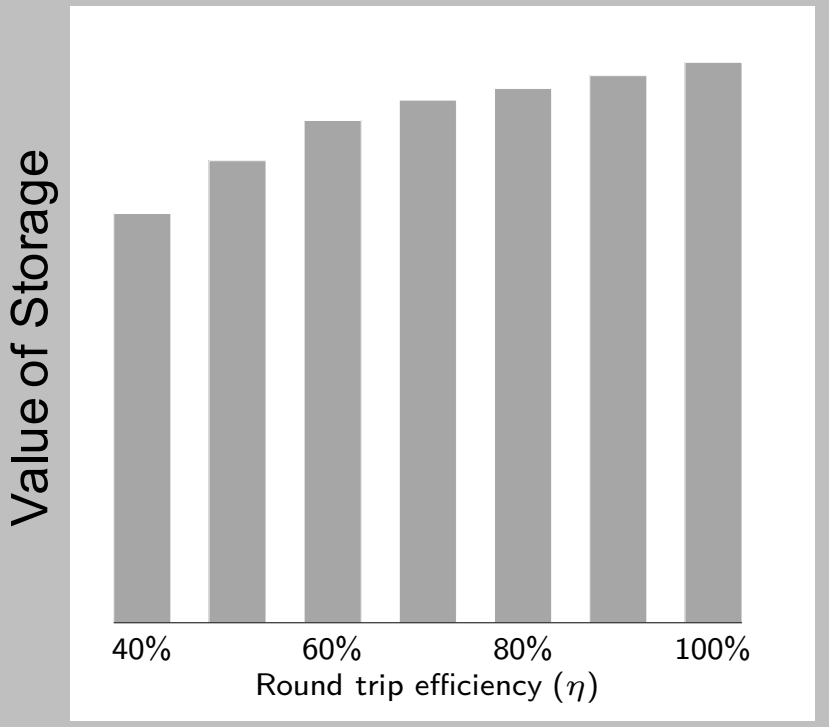
Price volatility



Does efficiency matter?

Large scale storage

$$\eta = \frac{Out}{In}$$



Importance

Low Medium High

Cost	Lifetime	Energy	Power	Size	Weight	Efficiency
Lack of alternatives	High device turnover	Daily charging accepted	Steady load modest peaks	Miniaturisa-tion	Handheld devices	Avoid overheating
Early adopter willing to pay	High device turnover	Range anxiety	Fast charging Accelerate	Space is precious	Moving mass	Economics and range
Competitors: gas, diesel…	Reliability required	Hours, days (and longer?)	Relative to energy	Esp. if on remote sites	Not an issue	Less important with high RES

Performance

Low Medium High

	Cost $/kWh	Lifetime yrs	Energy /Power	Power MW	Size m^3	Weight t	Efficiency %
Li-Ion	500 (150)	3-10	2	0.001-10	1 – 1000	0.03 300	>90
Flow battery	500	10	5+	0.1 – 100	10 – 10k	20 – 20k	80
Pumped hydro	150	60	4-30	200 – 2000	10m	10m+	73
Compressed air	80 – 250	40	2-26	100 – 300	100k – 500k	?	45 – 70
Thermal	5 – 300	10 – 30	10	0.001 – 100	0.1 – 10k	0.1 – 10k	40 – 80
Power to gas	4 – 50	10 +	10 ++	0.01 – 100	100 – 500k	?	35

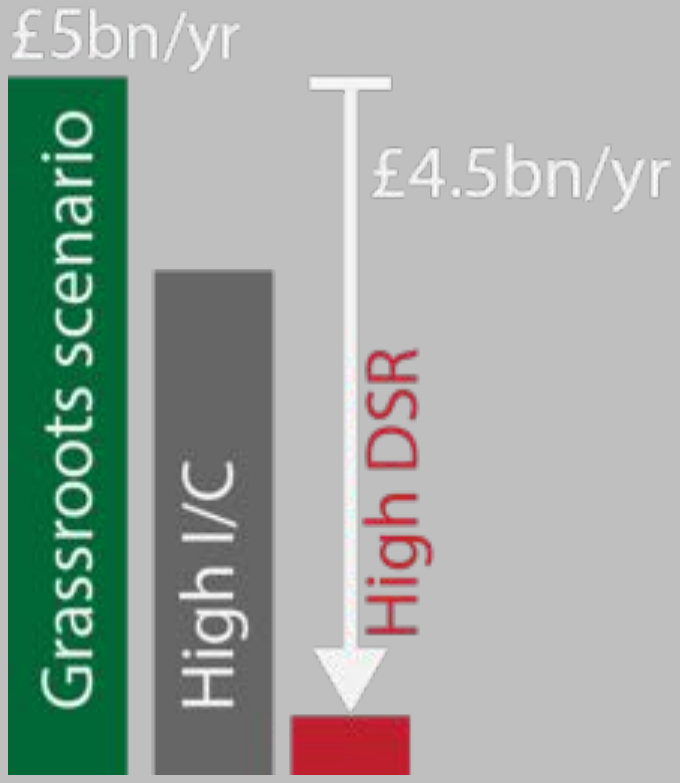
Efficiency

Flexibility

Storage

Flexible Demand

Value of Storage



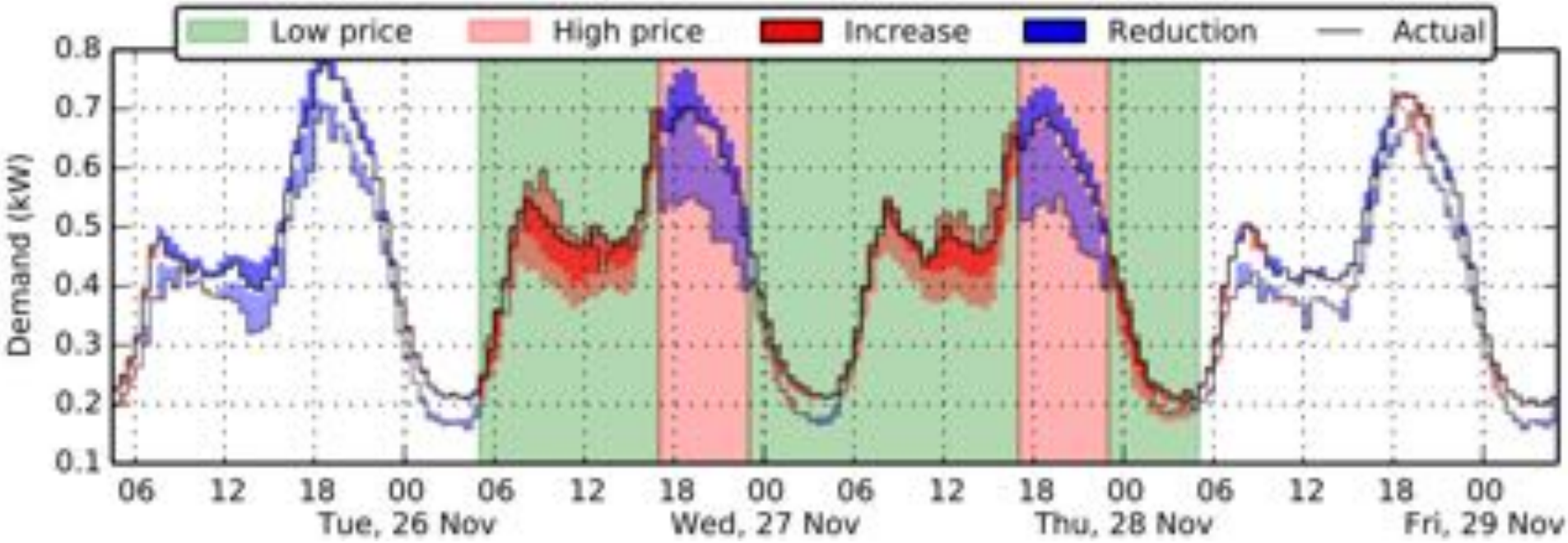
Very similar for the system

Very different in terms of motivation, cost, reliability

based on Strbac 2012


DEMAND RESPONSE
EVENT ACTIVE
ON
OFF
DISABLE
DEMAND RESPONSE

Price signal flexibility



Responsiveness
to time-varying pricing

Low Carbon London Learning Lab


OPINEL
SAVOIE FRANCE
Carbone

Two types of **agency**

Storage based

Appliances

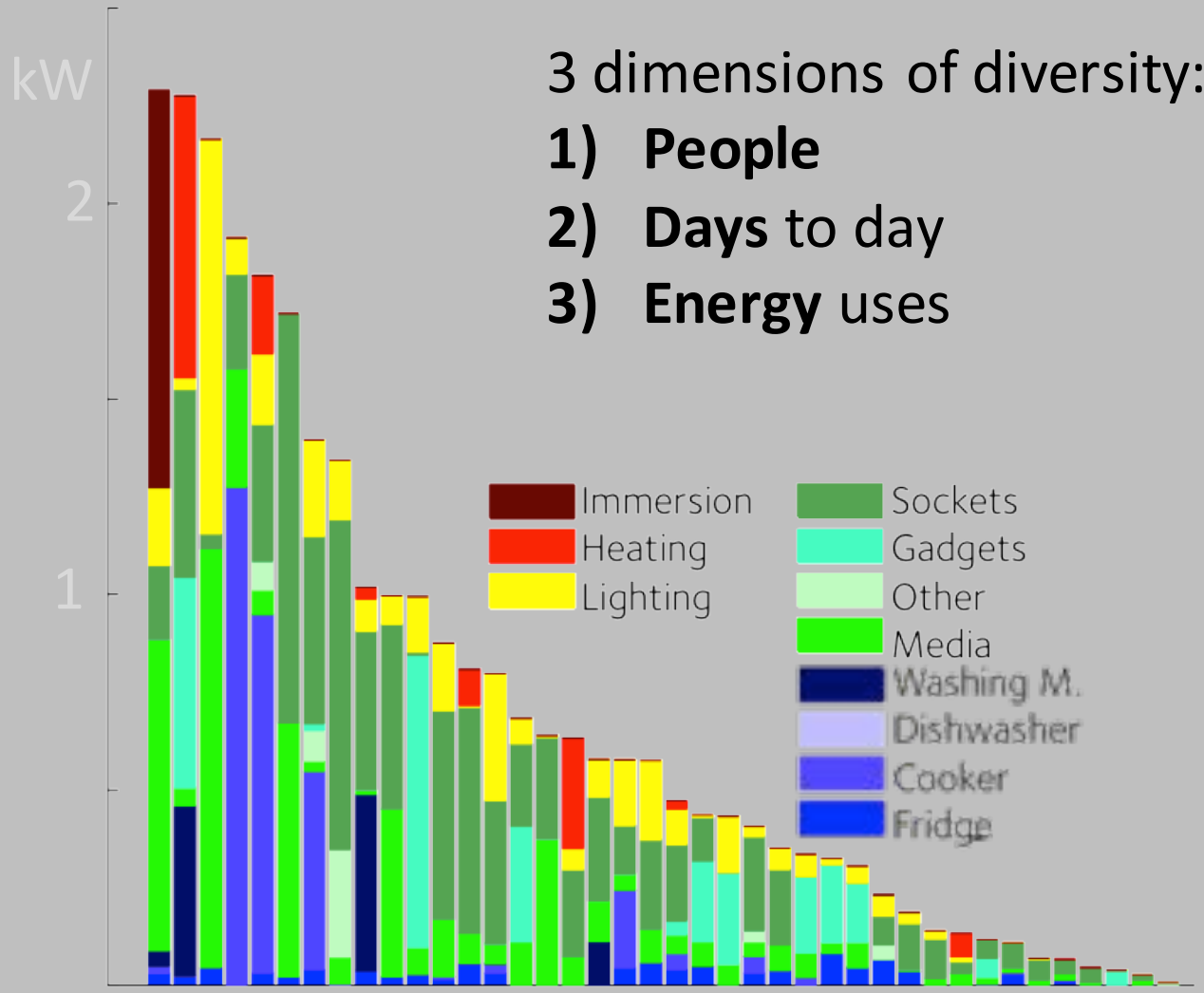
- Battery
- Storage heater
- Dishwasher
- Washing machine

Service based

People

- Activities
- Practitioners
- Provisions
- Norms

Average users are rare



3 dimensions of diversity:

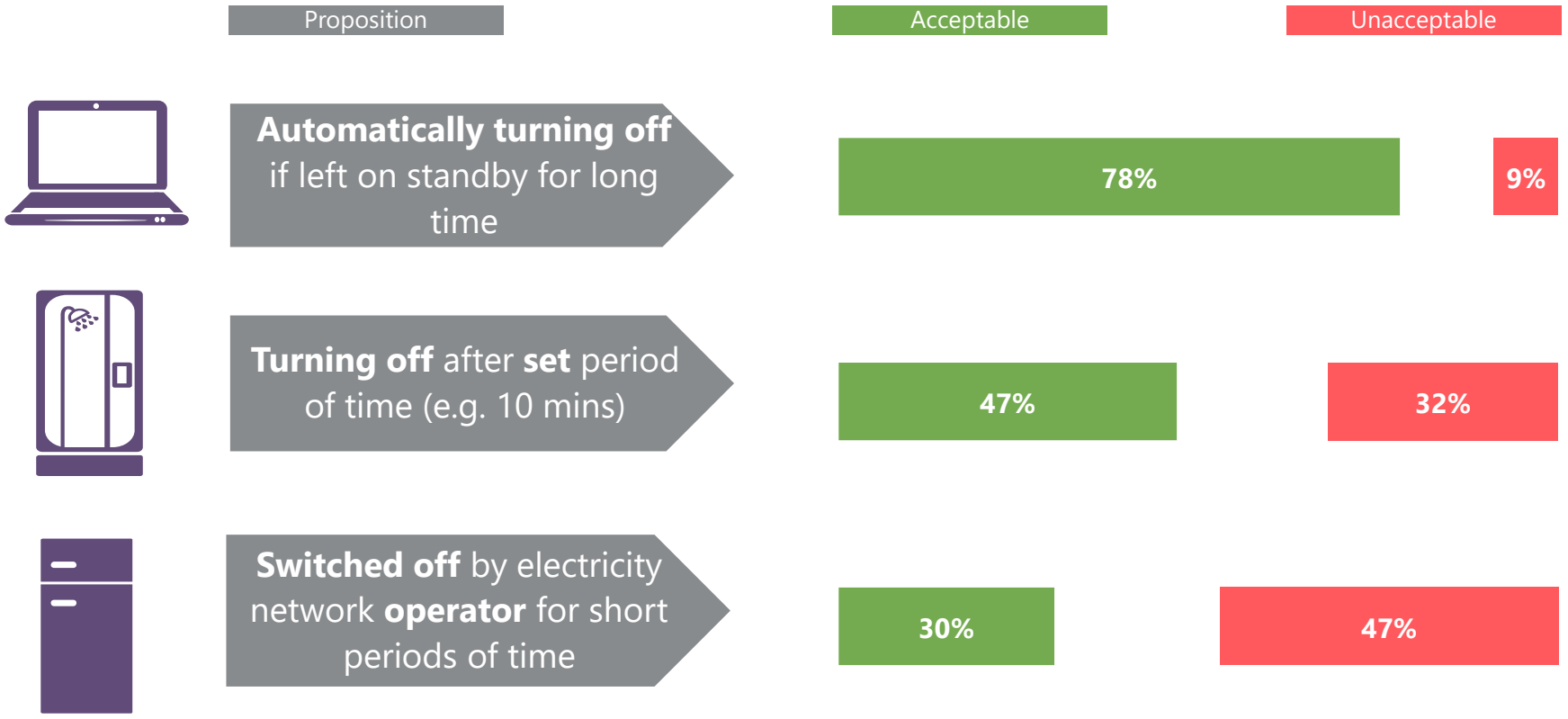
1) **People**
2) **Days** to day
3) **Energy** uses

42 Households at 5:30pm

based on HES data

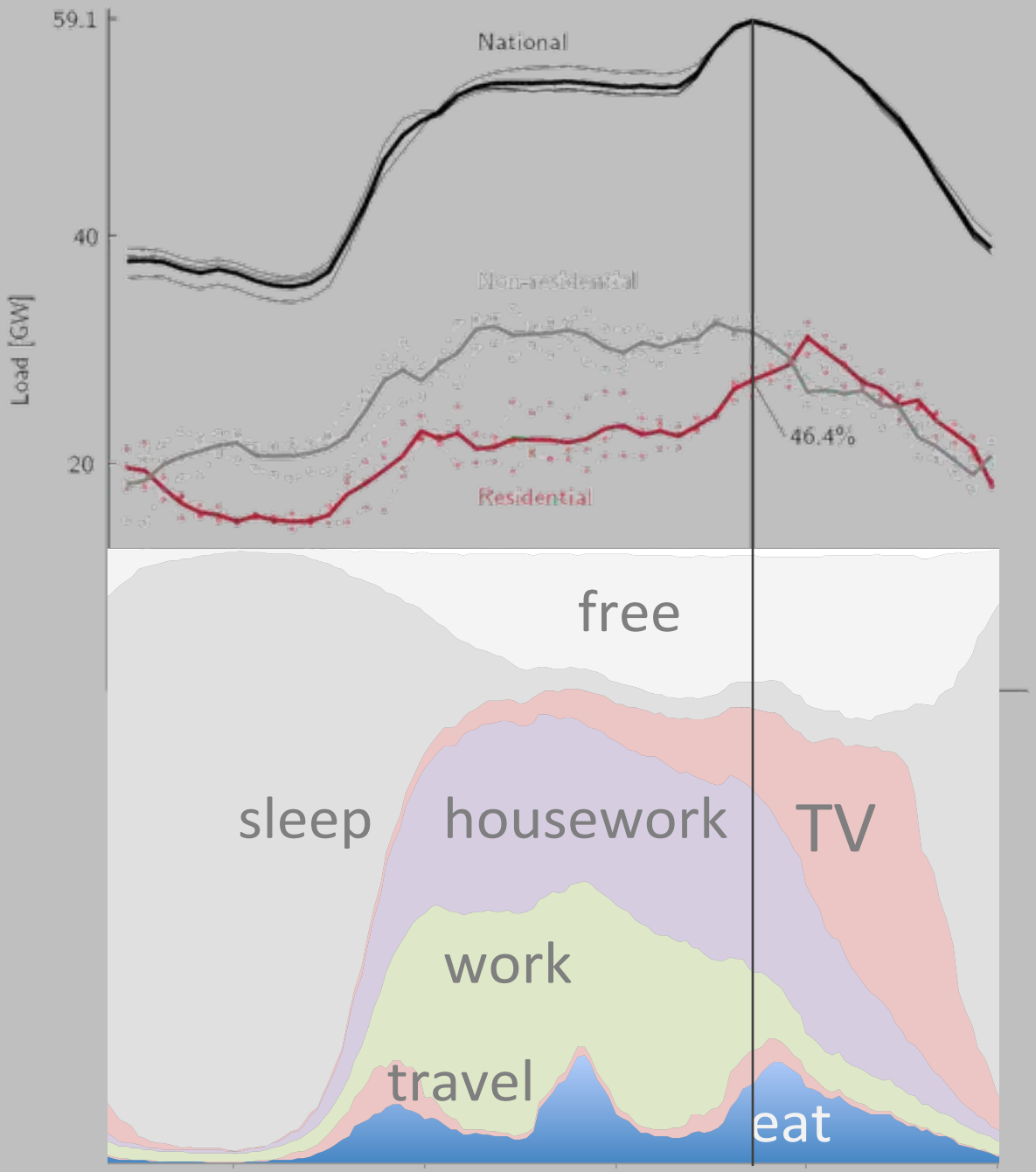
Do we understand what's asked of us?

But how "smart" should we go?



Ipsos MORI
Social Research Institute

Base: 2,441 British adults aged 15 and over, 2nd-12th August 2012- Source – Cardiff University/ Ipsos MORI



METER

Energy-use.org

Partners

nationalgrid

UKERC
UK Energy Research Centre

DEMAND
DYNAMICS OF ENERGY, MOBILITY AND DEMAND

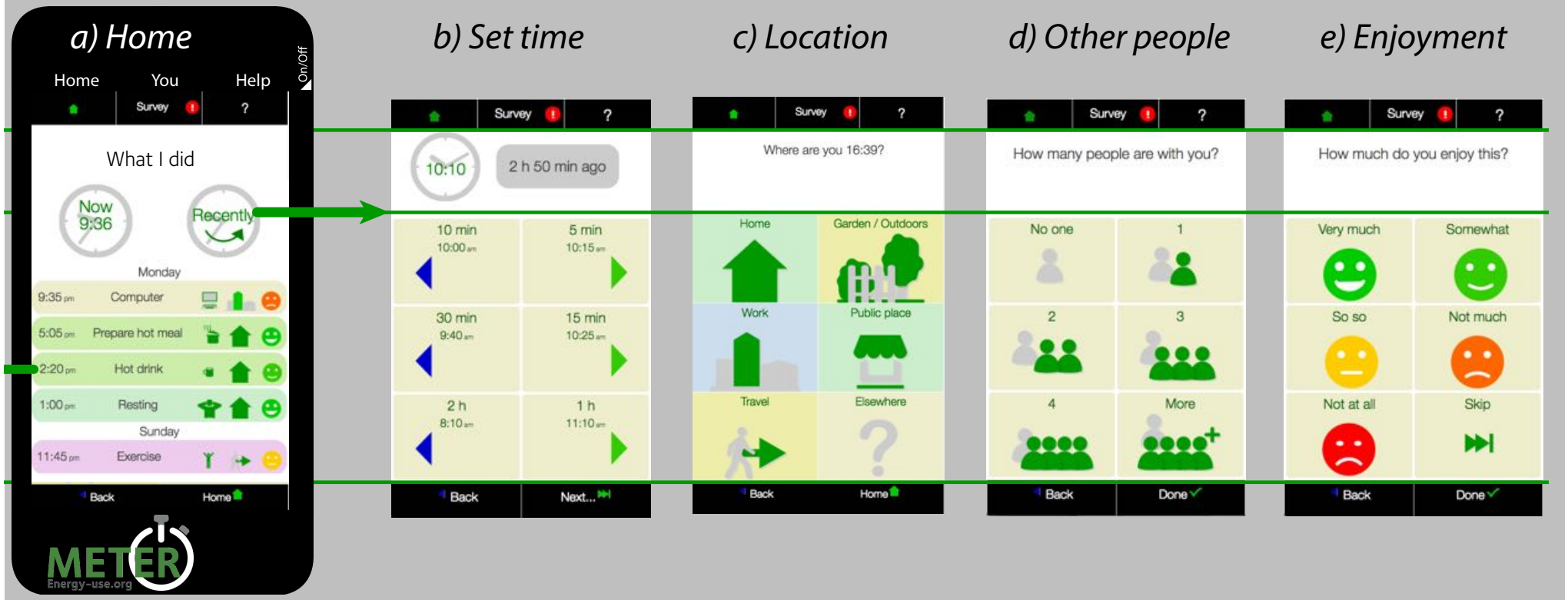
Bioregional

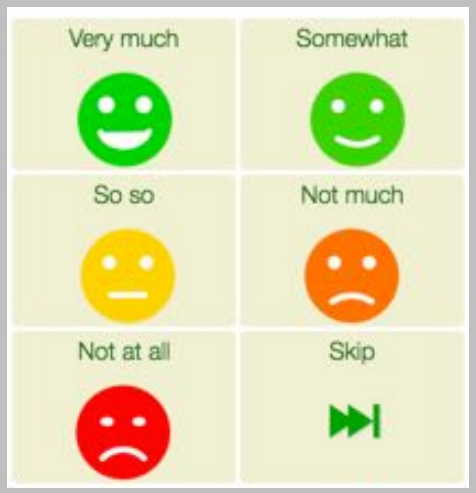
Pilio

moixa energy

Linköping University

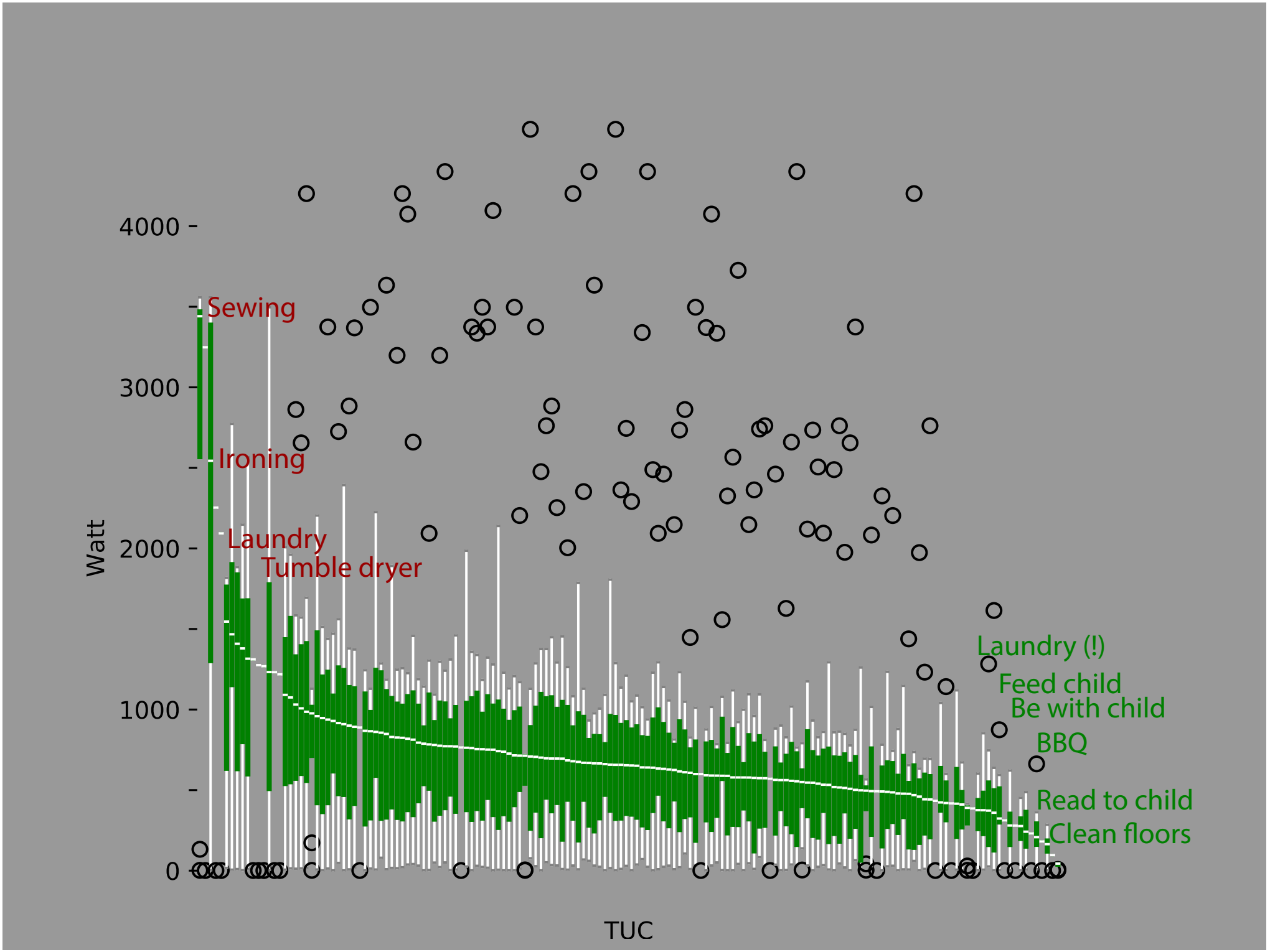

METER
1
Attach me to your electricity meter. Put the clip on the right-most cable.
2
Leave me there. While you record activities, I take electricity readings.
3
Return me and your activity booklet(s) in the pre-paid envelope.
If you are unsure, please contact philipp.grunewald@ouce.ox.ac.uk before approaching your meter.
Property of
OXFORD
Home
You
Help
On/Off
?
Where are you 10:08?
Home
Garden / Outdoors
Work
Public place
Travel
Back
Home
METER


a) Home
Home
You
Help
Survey
?
On/Off
What I did
Now 9:36
Recently
Monday
9:35 pm Computer
5:05 pm Prepare hot meal
2:20 pm Hot drink
1:00 pm Resting
Sunday
11:45 pm Exercise
Back
Home
METER
Energy-use.org
b) Set time
Survey
?
10:10
2 h 50 min ago
10 min
10:00 am
5 min
10:15 am
30 min
9:40 am
15 min
10:25 am
2 h
8:10 am
1 h
11:10 am
Back
Next...
c) Location
Survey
?
Where are you 16:39?
Home
Garden / Outdoors
Work
Public place
Travel
Elsewhere
Back
Home
d) Other people
Survey
?
How many people are with you?
No one
1
2
3
4
More
Back
Done
e) Enjoyment
Survey
?
How much do you enjoy this?
Very much
Somewhat
So so
Not much
Not at all
Skip
Back
Done

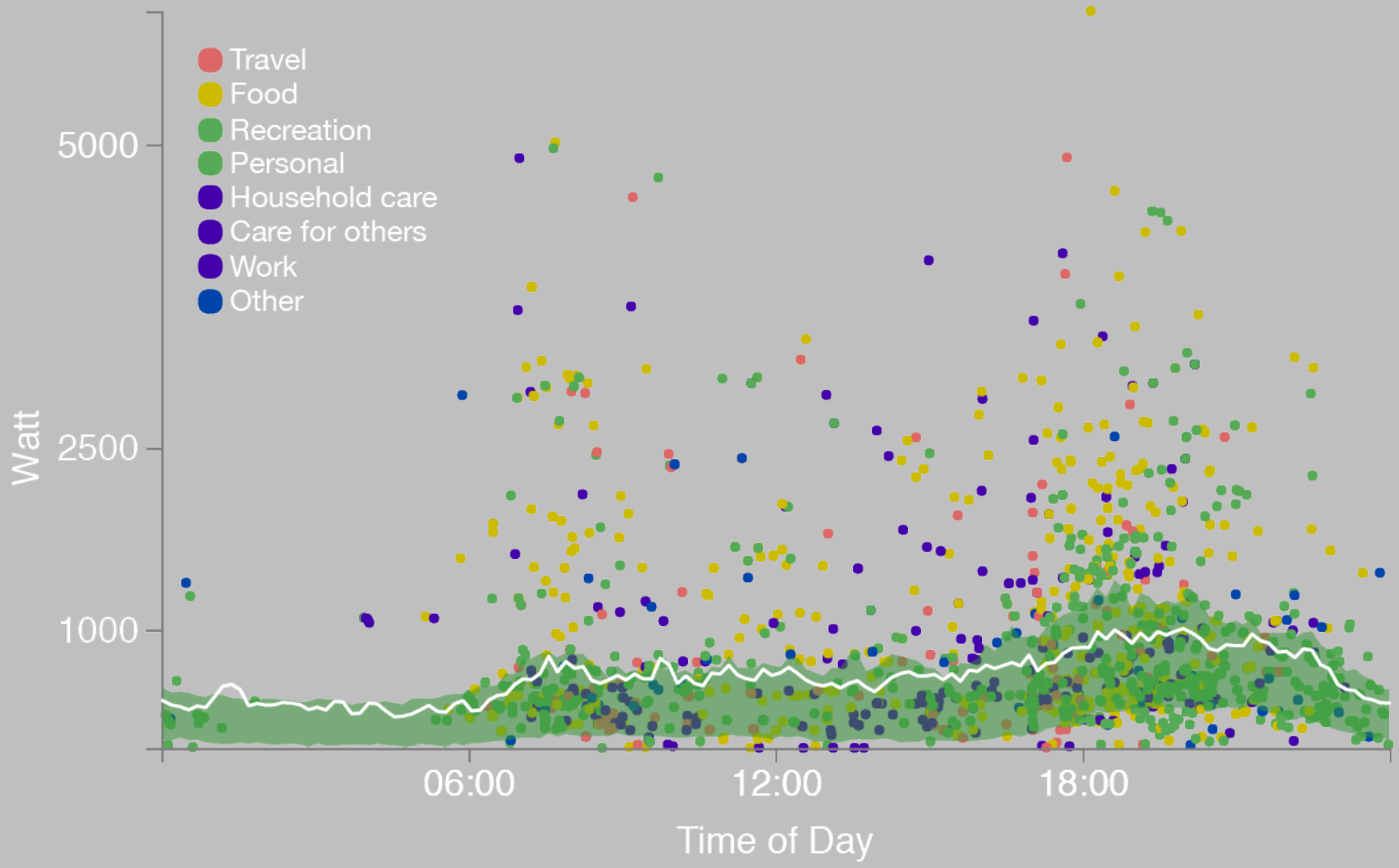


Location	Activity			Other people	Enjoyment
Home	Personal	Next...	Cold meal	Next...	No one	Very much
Outdoors	Joint	Prepare	Hot meal	Oven	1	Somewhat
Work	Work	Lay of clear	Baking	Hob	2	So so
Public Place	Food	Eat	Lay table	Microwave	3	Not much
Travel	Appliances	Snack		Kettle	4	Not at all
Elsewhere	Customise	Hot drink	Next...	Toaster	More	Skip

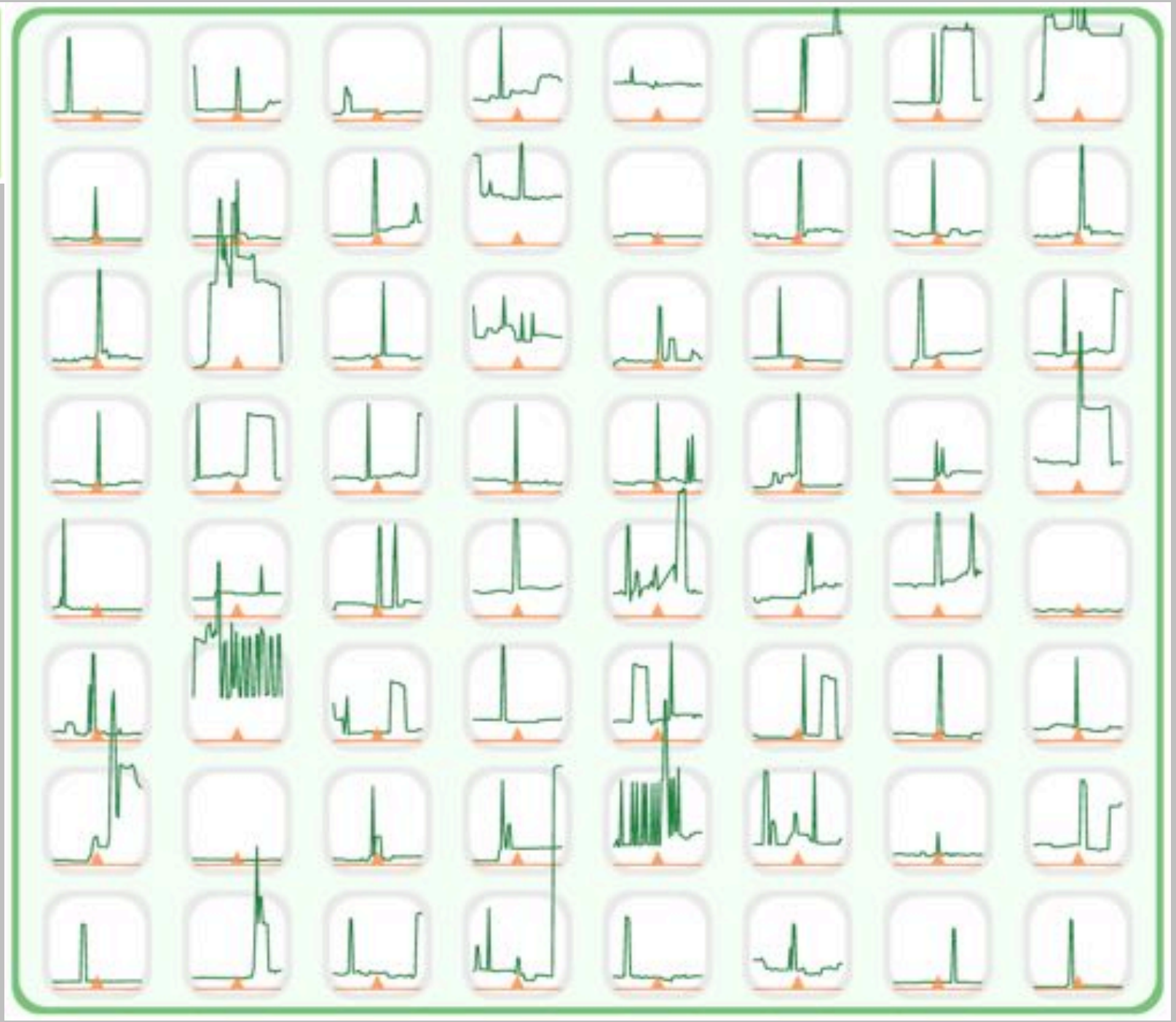
3 selections → discriminate 216 options (...1,296...)


4000
3000
2000
1000
0
Watt
TUC
Sewing
Ironing
Laundry
Tumble dryer
Laundry (!)
Feed child
Be with child
BBQ
Read to child
Clean floors

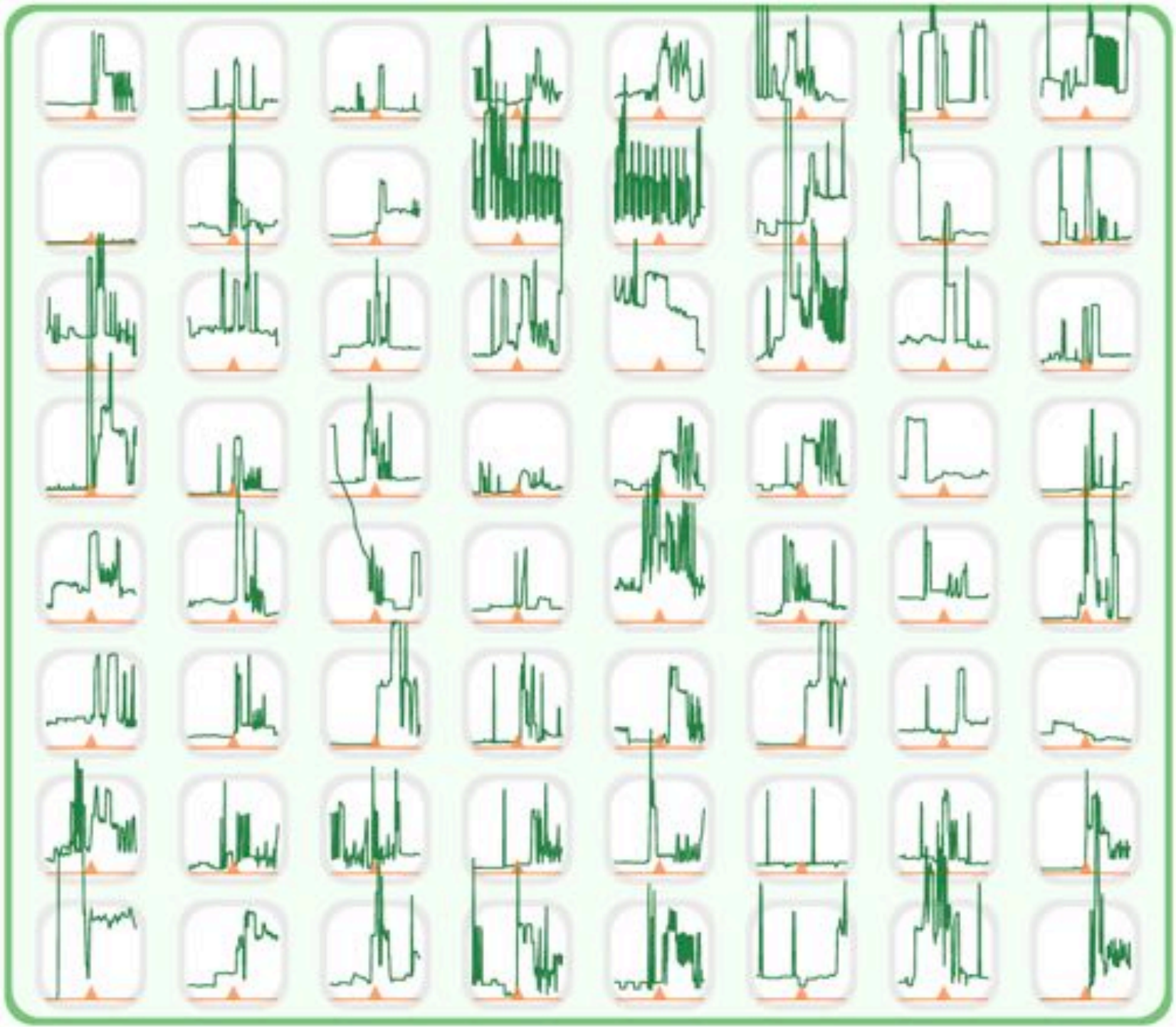
Life is busy


Travel
Food
Recreation
Personal
Household care
Care for others
Work
Other
5000
2500
1000
Watt
06:00
12:00
18:00
Time of Day

Hot drink



Washing machine




money /
reward
smartness /
technology
Exploring flexibility
circumstances
information /
nudge

Efficiency

- It matters
  if IN constrained and OUT valuable

Flexibility

- Lost in physical inertia, fuel stores and central control
- To be replaced with storage, DSR and decentralised control

Storage

- Significant (split) system value
- Short term P, long term E

Flexible Demand

- Not all about energy and money
- We change what we do all the time

Thank you