

DEPARTMENT OF
**ENGINEERING
SCIENCE**



people
~~technology~~
It's the ~~economy~~, stupid

Energy services, flexibility and data

Part II

Energy Systems MSc – Energy Demand – MT2024

Phil Grunewald

energy-use.org/slides

Part I

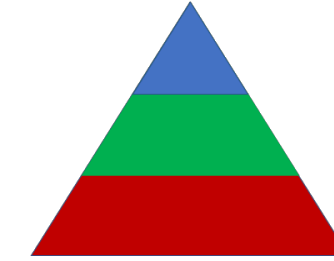
- System flexibility
- Energy needs and uses
- Feedback systems
- Causality

Part II

- Demand side flexibility
- Price elasticity
- Data and privacy
- Synthetic data

Recap

Energy service



Useful vs. used energy



Causes of energy use



Key activities driving demand



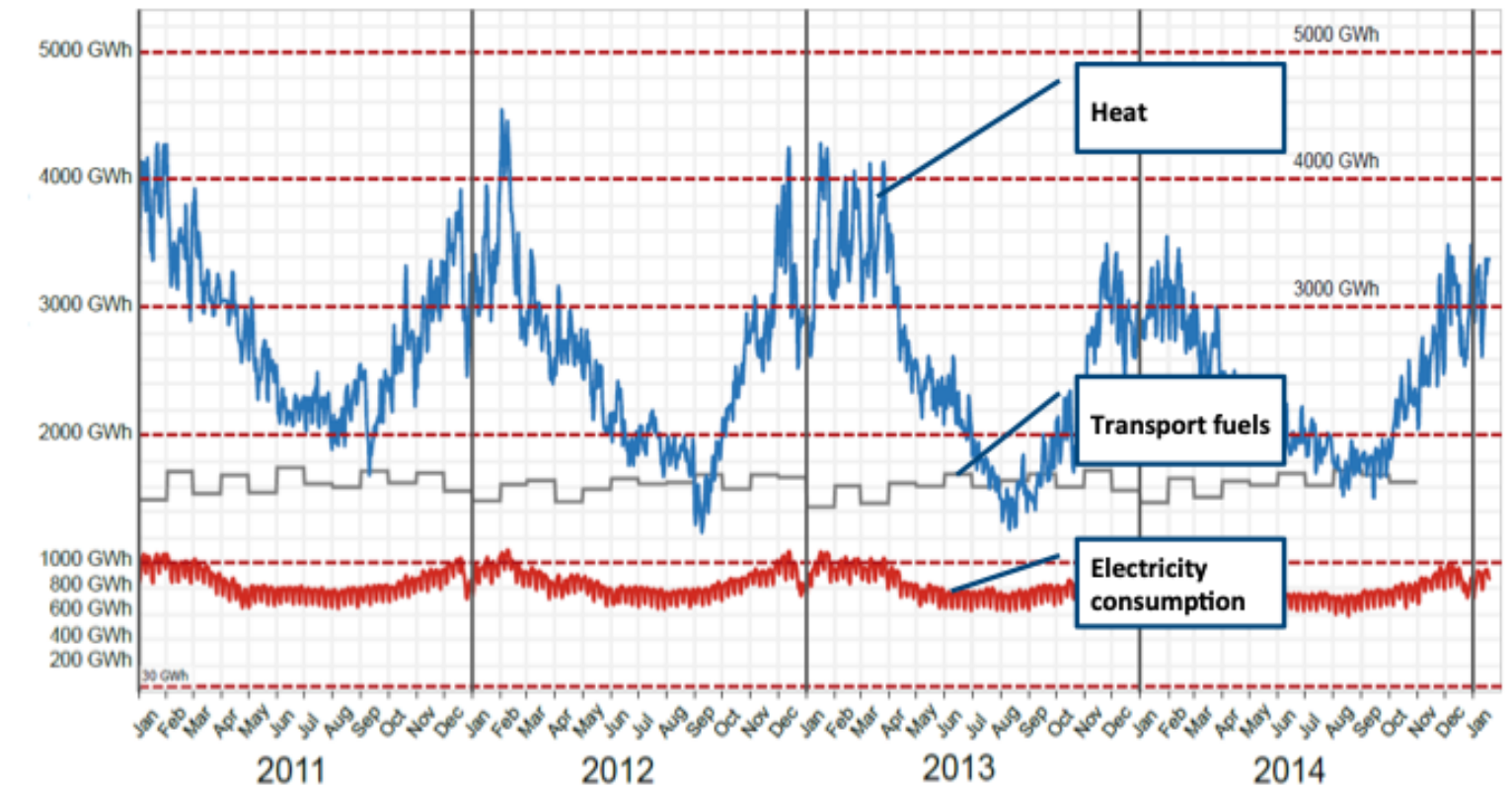
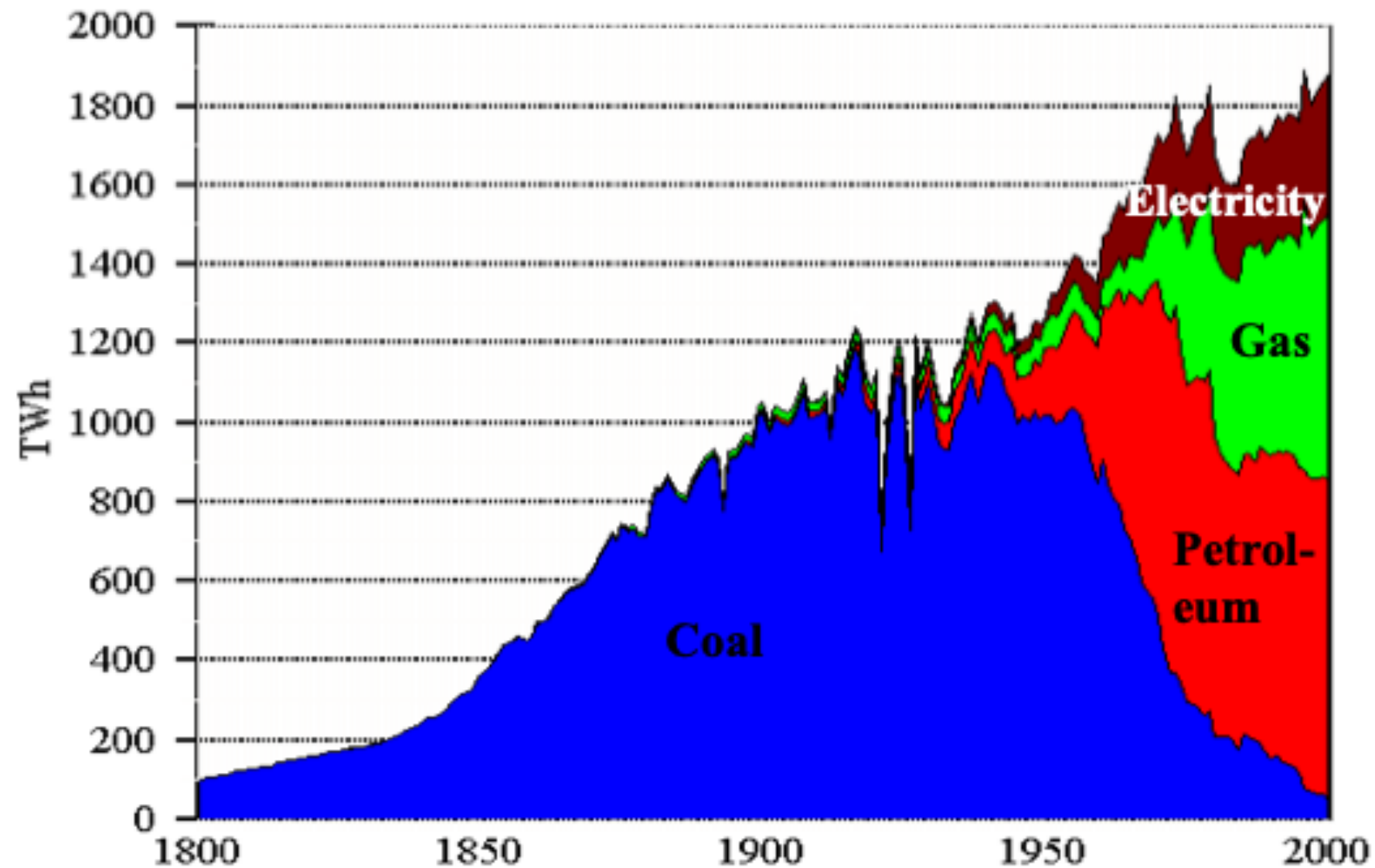
To understand causes we need (up to) three things

Causal model

Observation

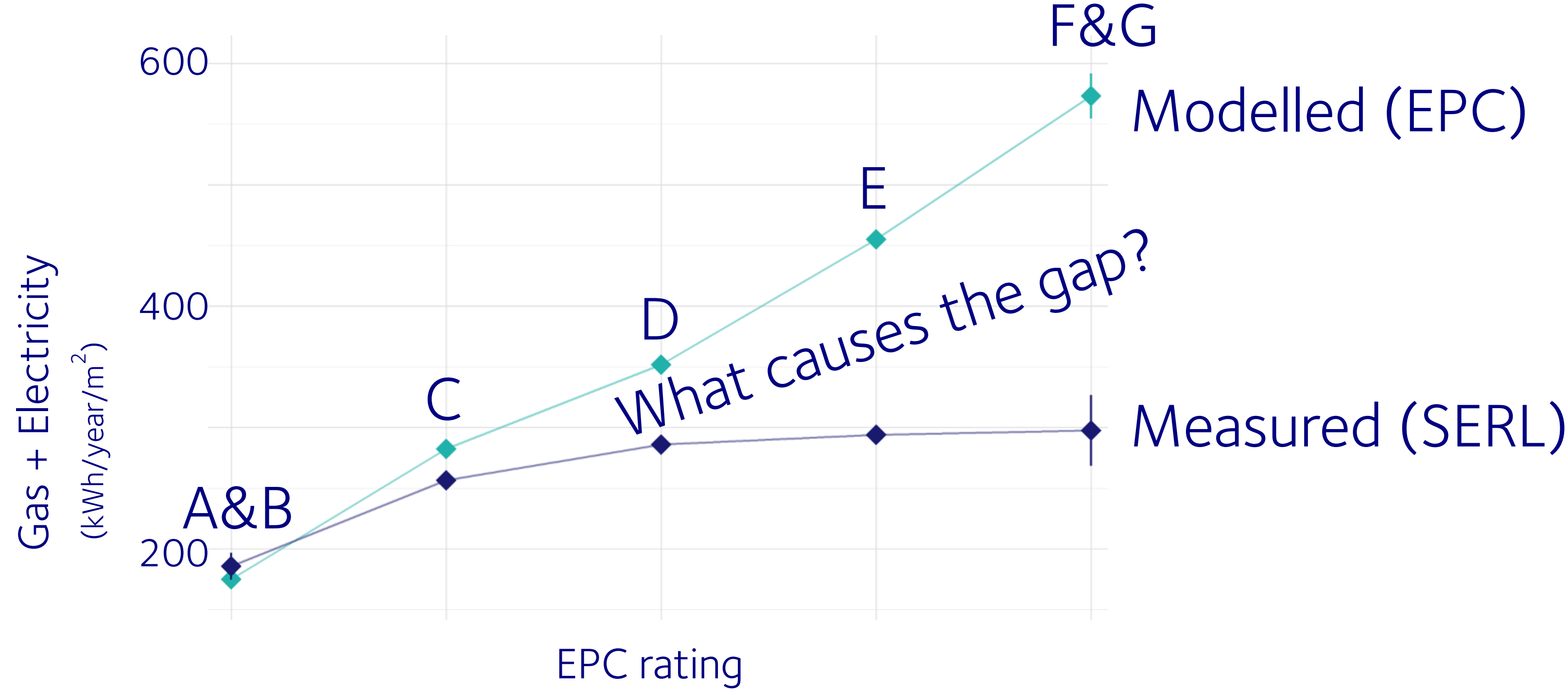
Do something

Heat – the elephant in the room

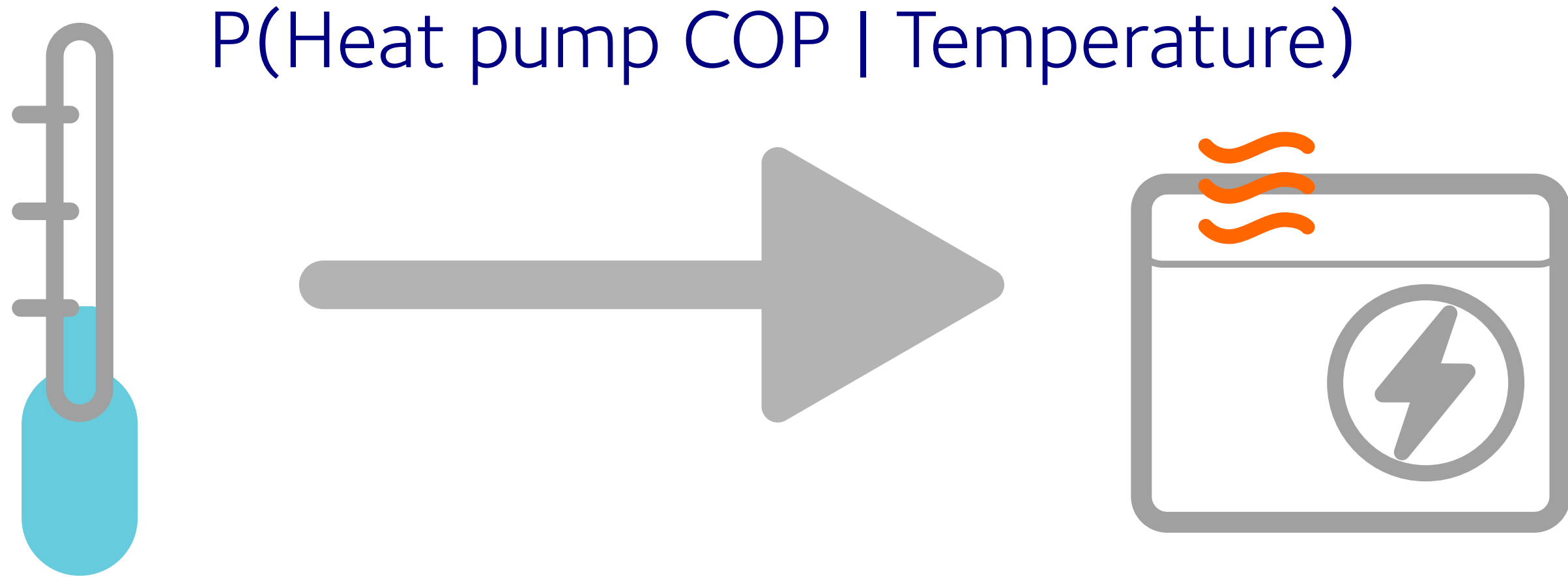


Source: University of Sheffield

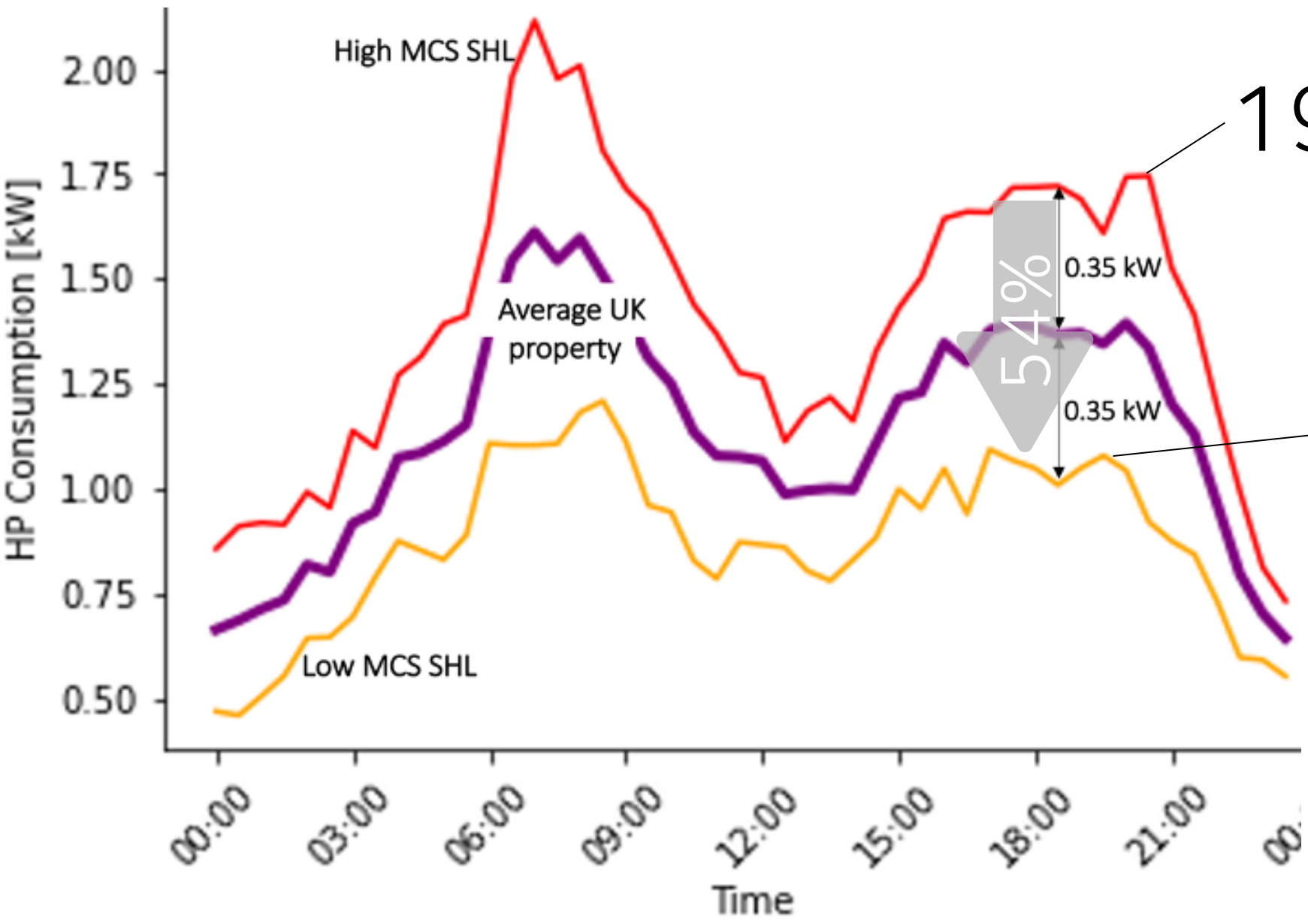
Model vs Reality: EPCs are poor predictors of demand



No data: I think... heat pumps don't work on cold days



Some data: heat pumps work on cold days and even better in efficient homes



19.3°C

Sofia Perelli-Rocco
Energy Systems MSc (2022/23)

19.7°C



HOW BUILDING CHARACTERISTICS AFFECT
HEAT PUMP CONSUMPTION – A UNITED
KINGDOM CASE STUDY

University of Oxford, Department of Engineering Science

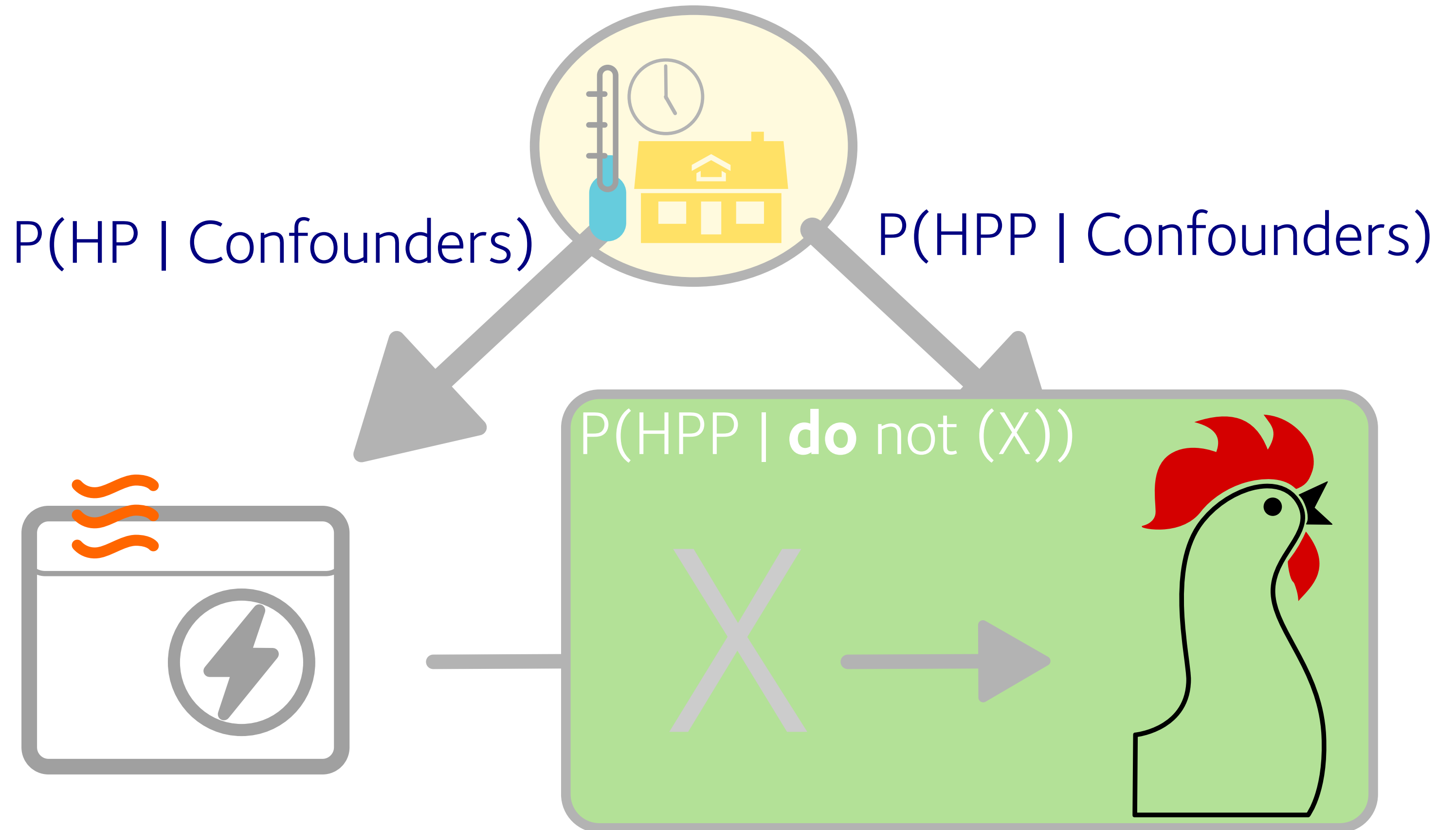
Keble College

Academic year 2022/2023

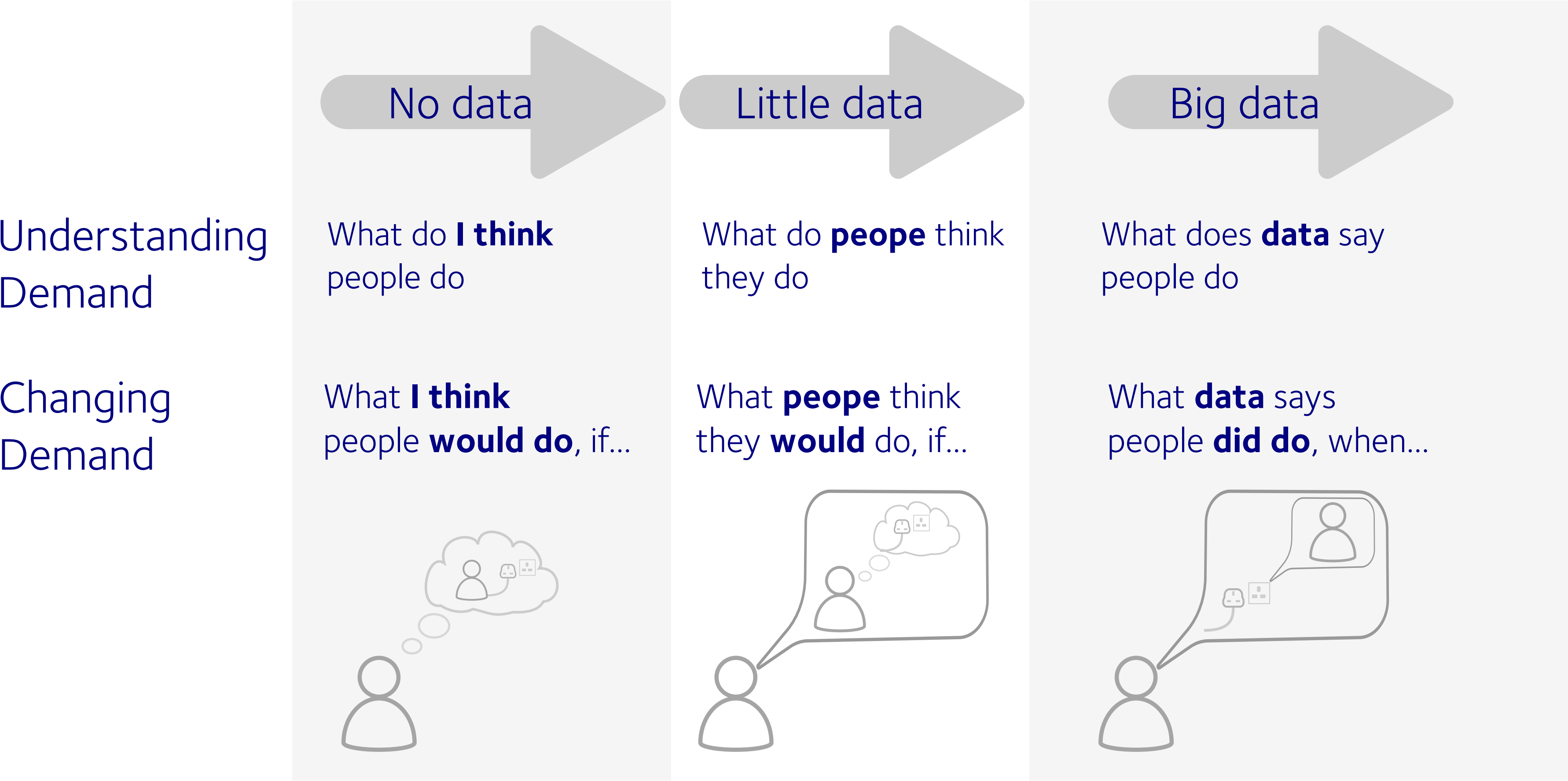
MSc in Energy Systems

Dissertation by Sofia Perelli-Rocco

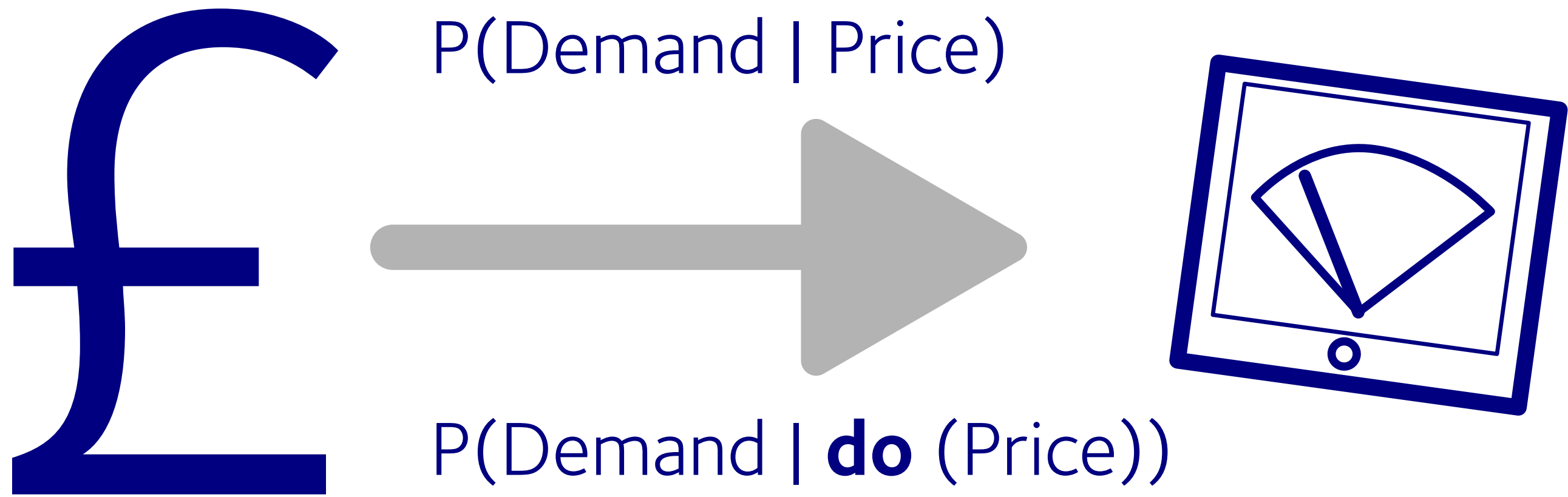
Big data: What improves heat pump performance?



Observation is not enough – make a change

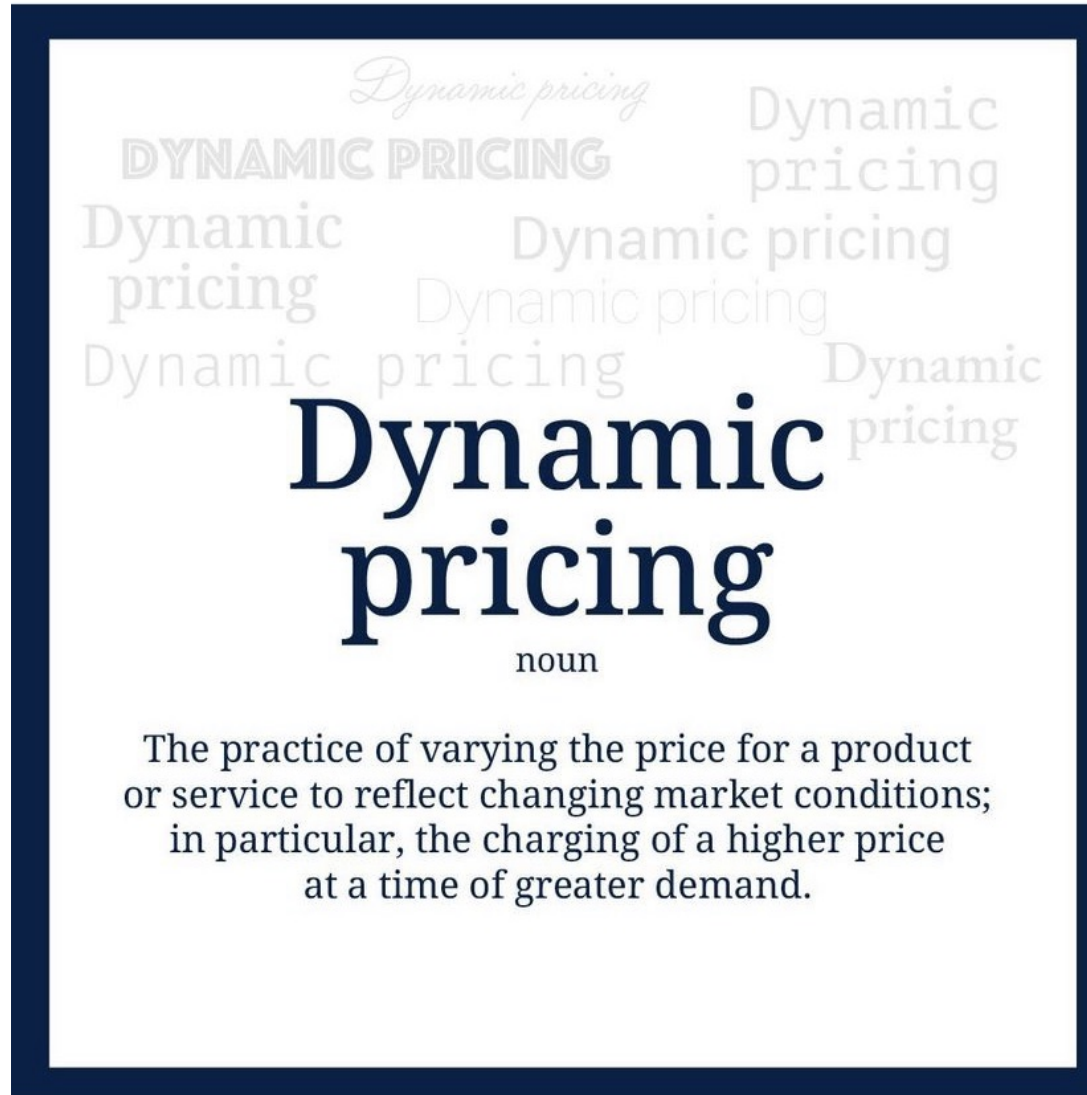


No data: I think... demand falls when prices rise






oxford_uni



♡ 14.5K 💬 127 ▼ 1,287 📌

oxford_uni NEW: Oxford University
Press announce shortlist for... [more](#)

 **PRIVATE EYE**
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13 September –
26 Sept 2024
£2.99

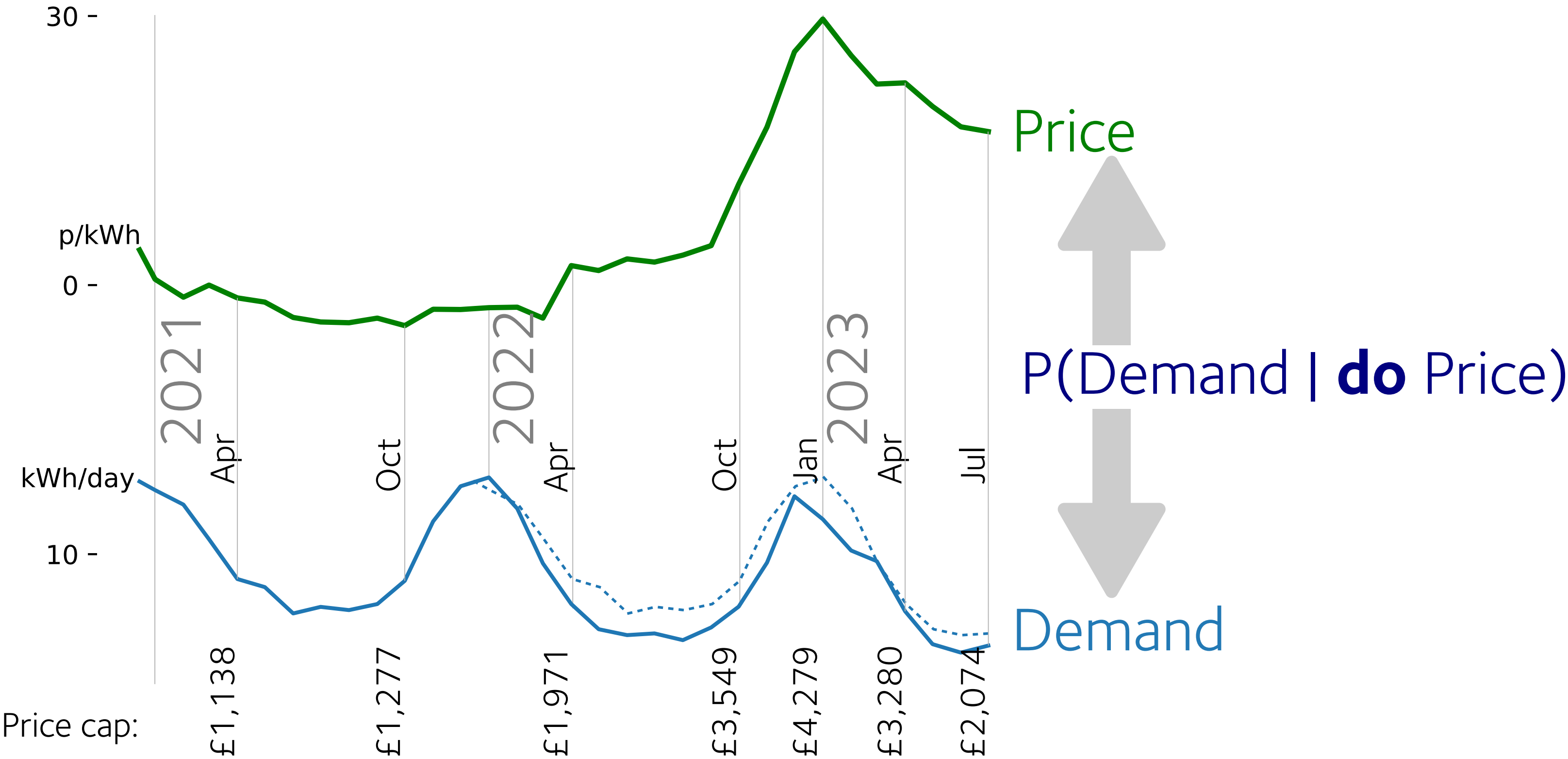
**SPECIAL OASIS
DYNAMIC
PRICING ISSUE**

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Purchase within the
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price will go up to
£299,000.**

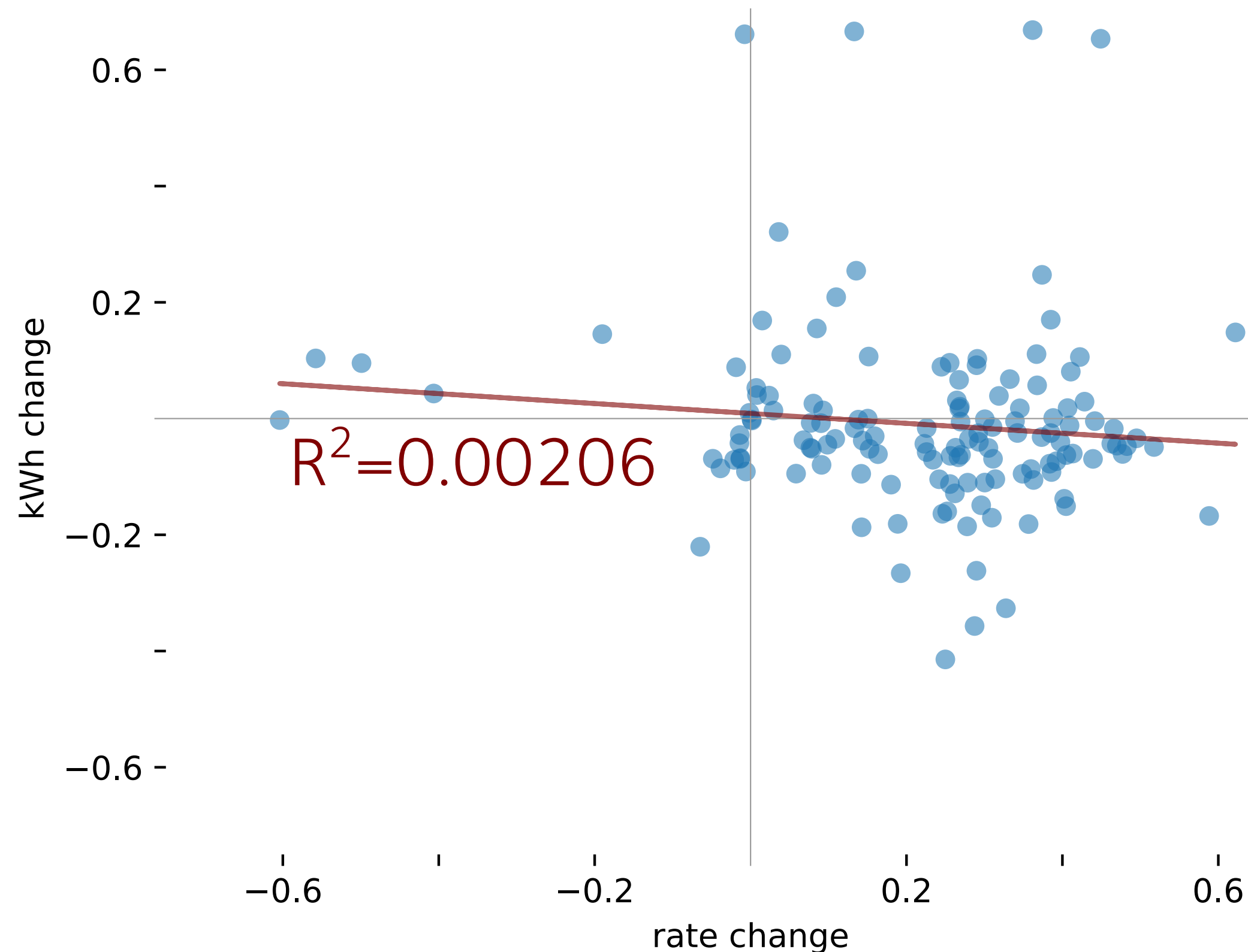


(c) Matt

Little data: demand falls when prices rise



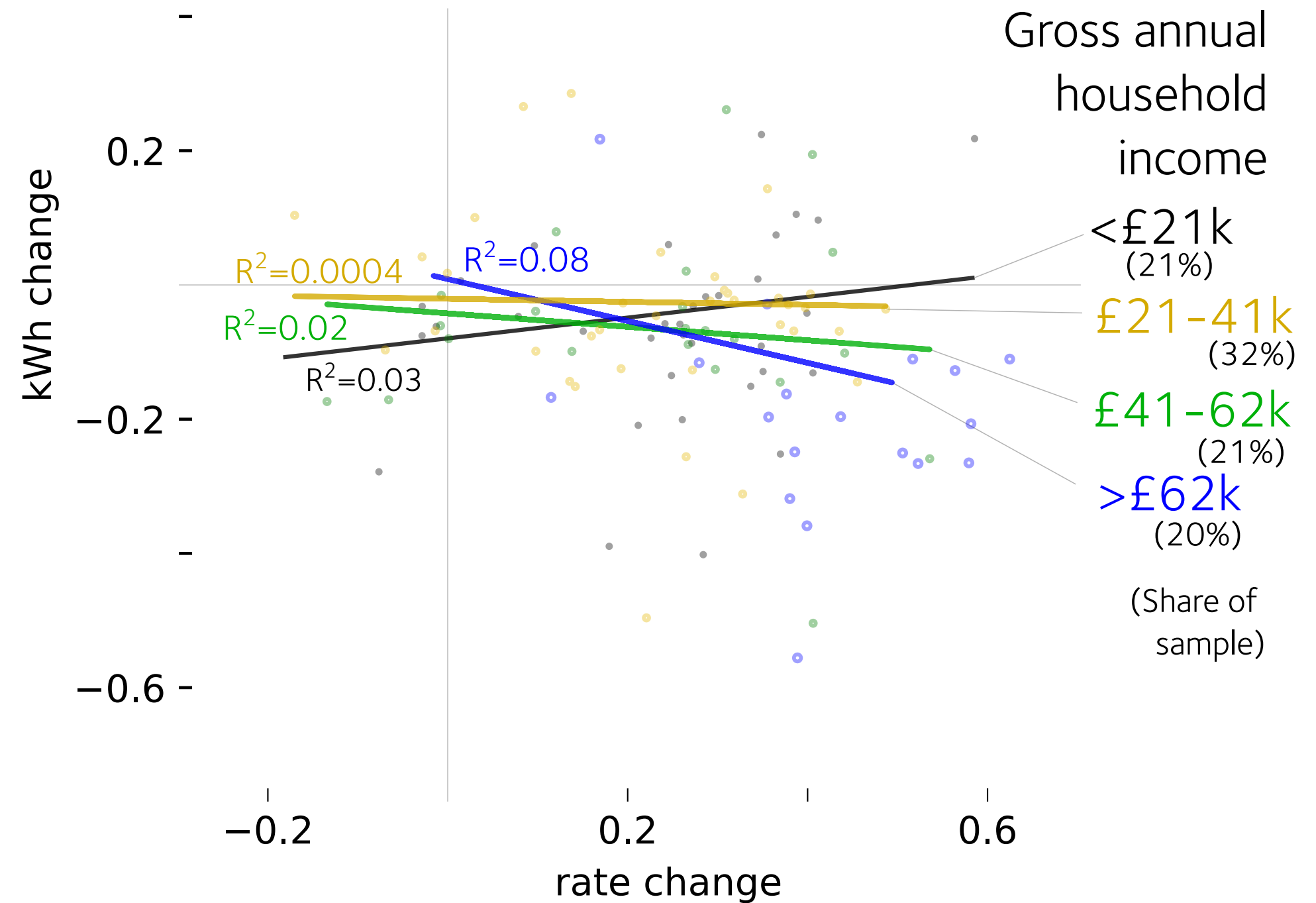
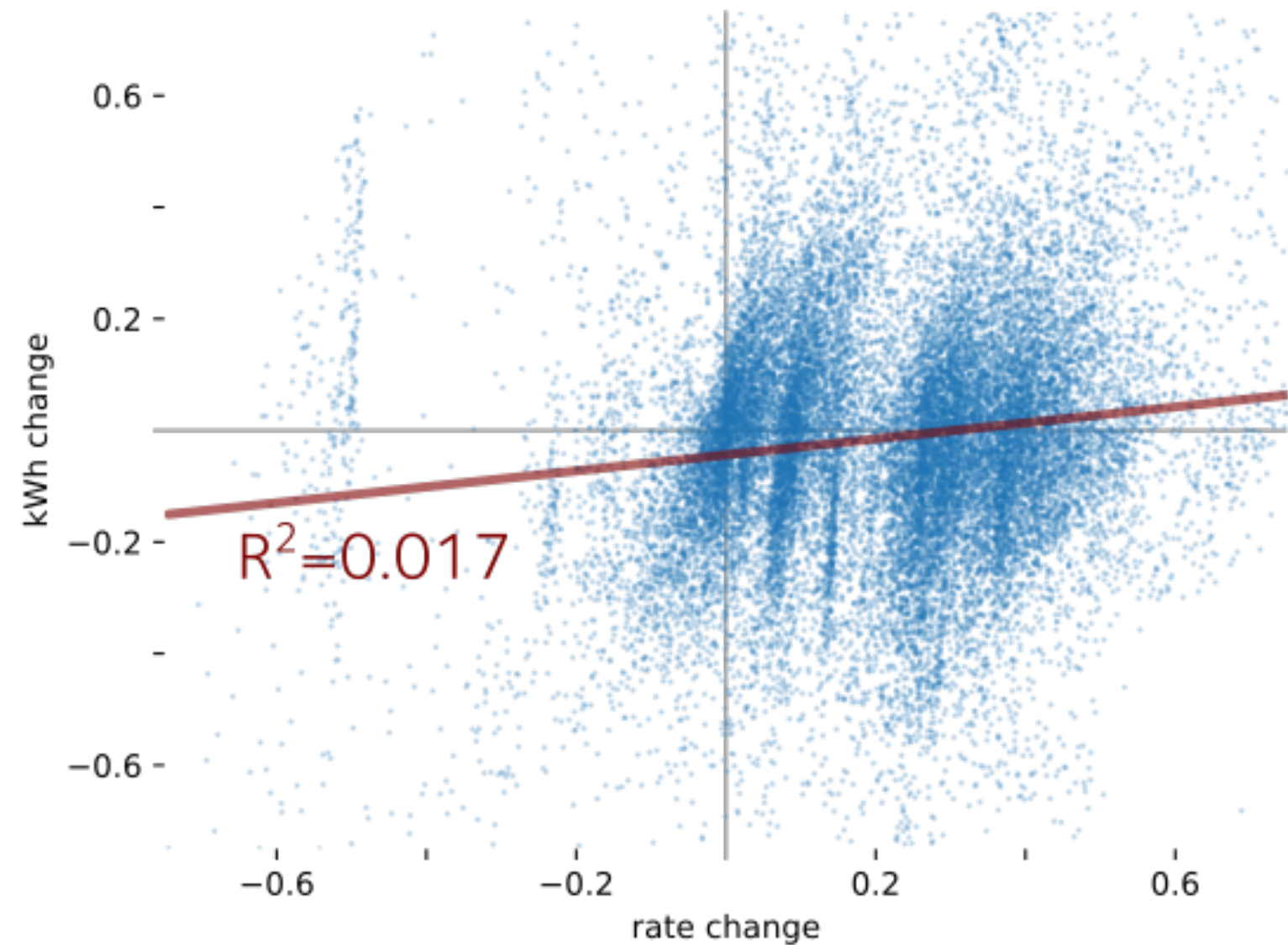
Medium data: negative price elasticity?



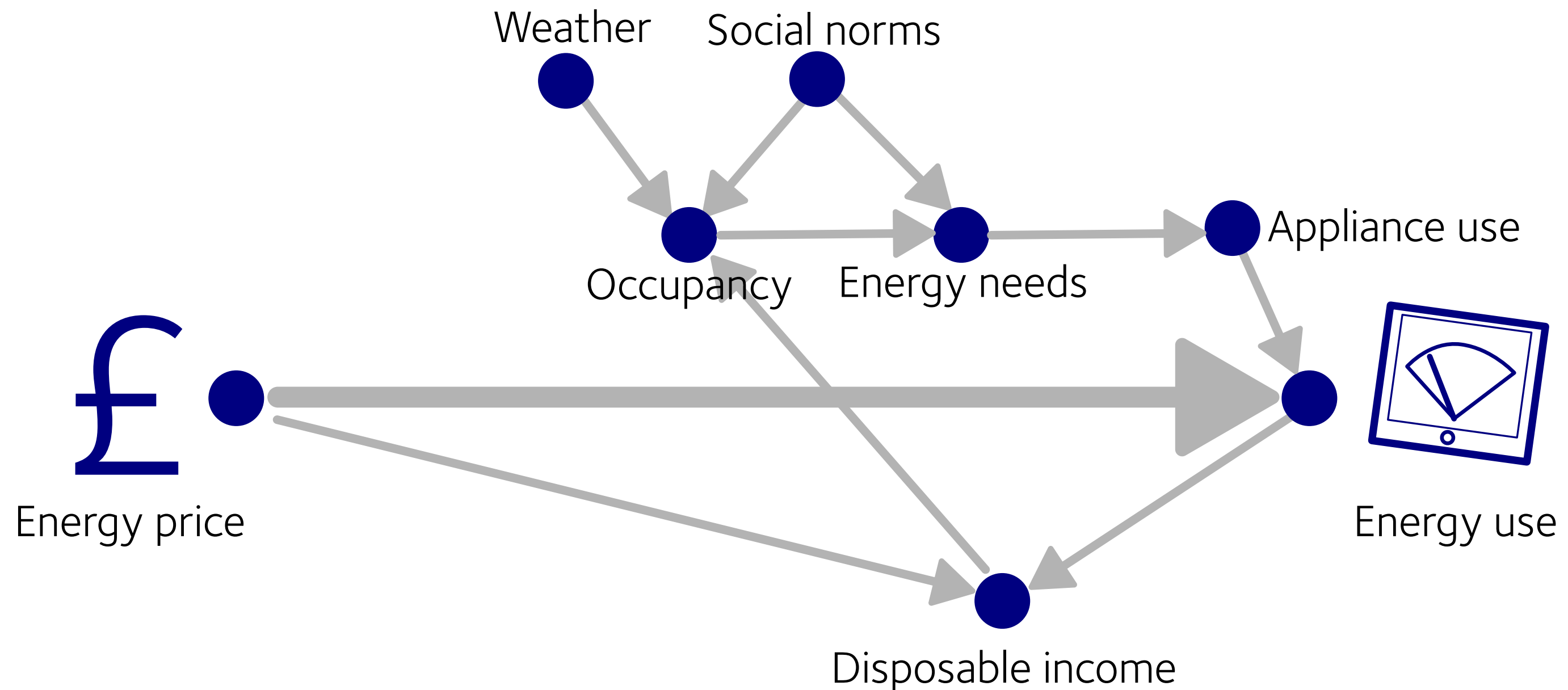
Jan 2022
vs.
Jan 2023

Big data: ... it depends

Price elasticity is weak and depends on circumstances



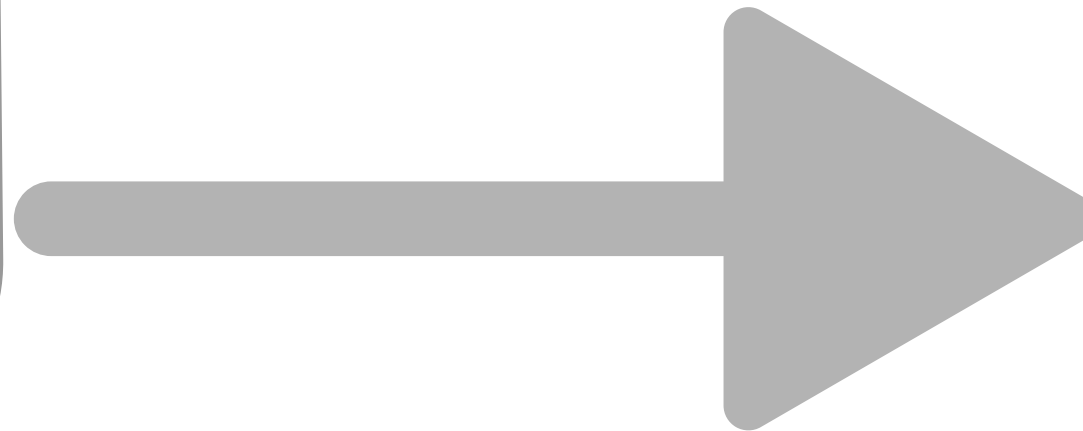
Causal model: What causes energy demand to change?



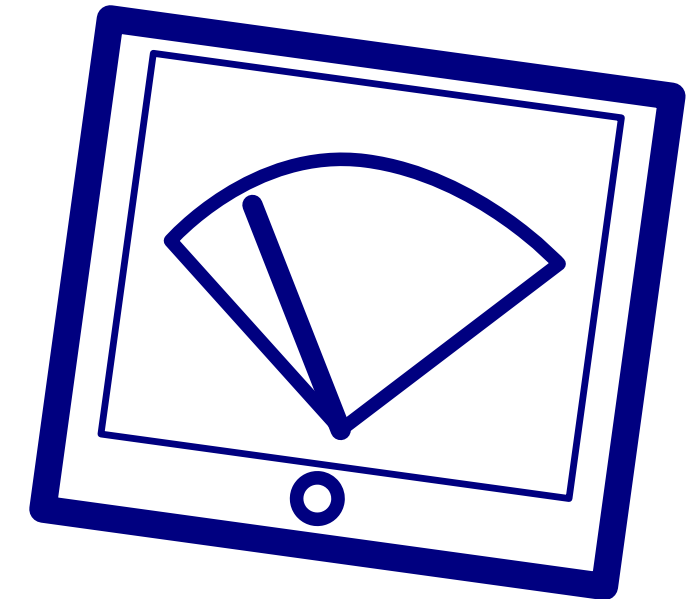
No data: I think... people will never give up dinner for DSR

Please,
1) Keep a diary
2) Reduce demand
5pm to 7pm

$P(E \mid \text{Life})$

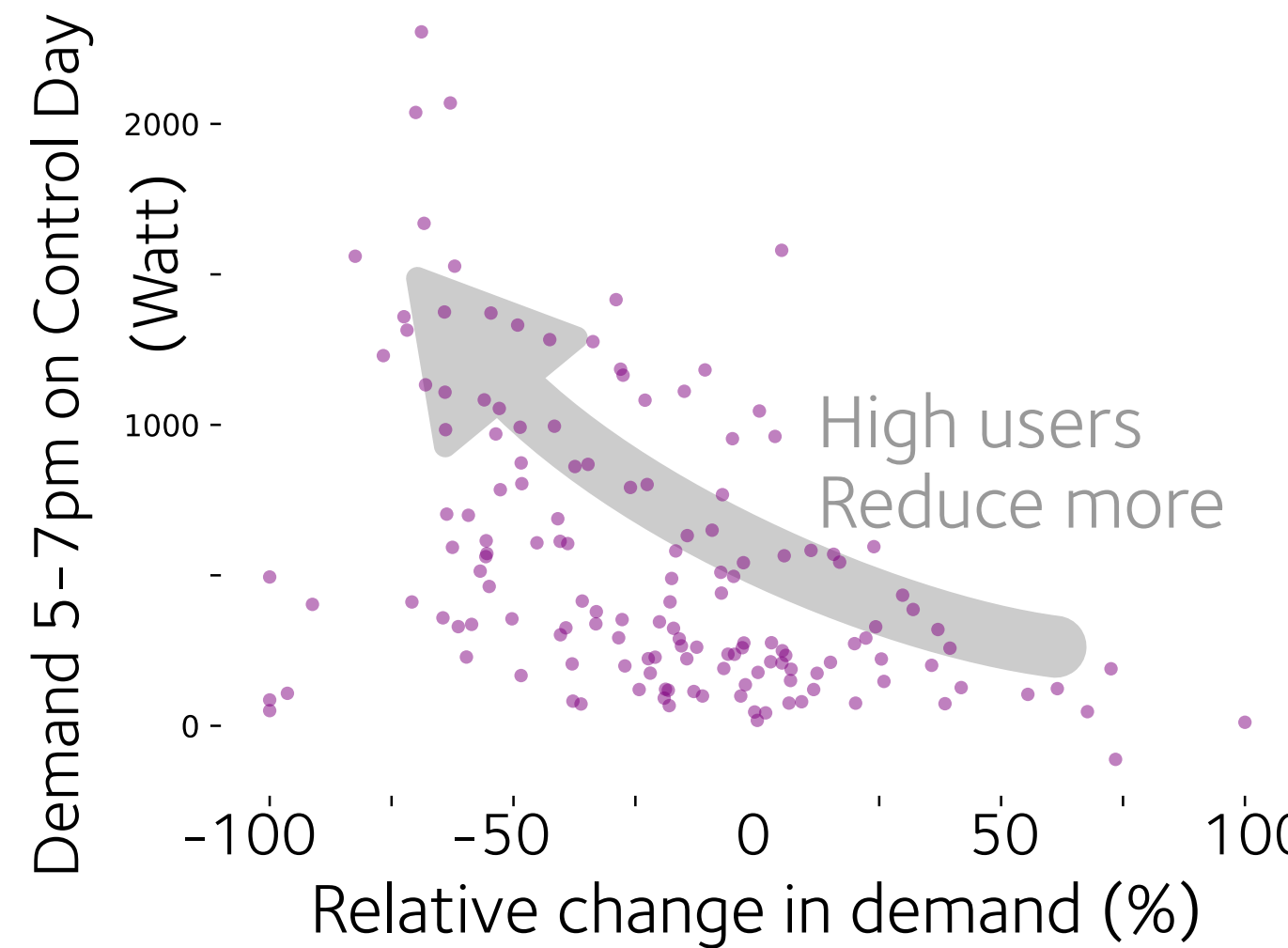
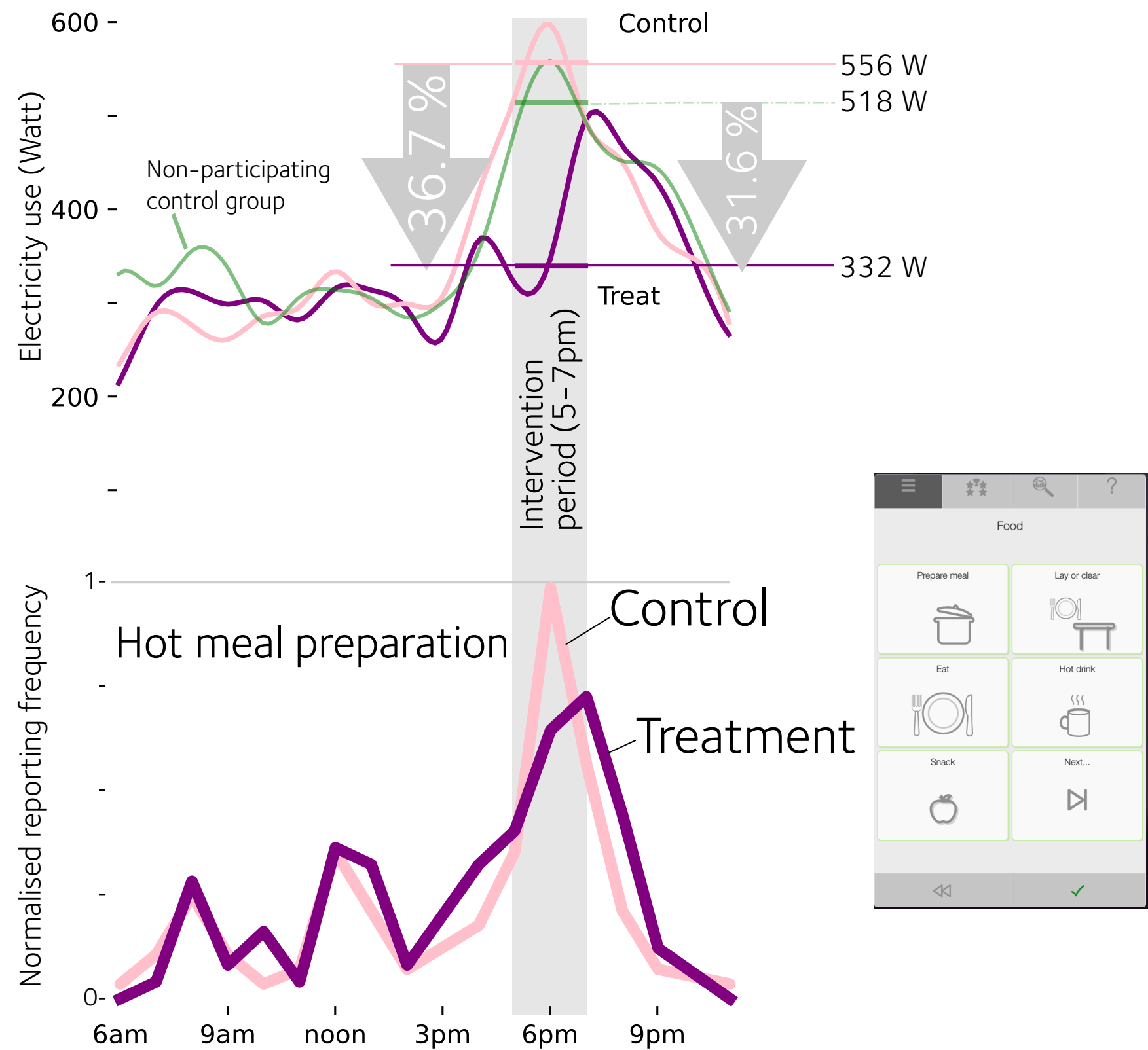


$P(E \mid \text{Life} + \mathbf{do}(\text{Ask}))$

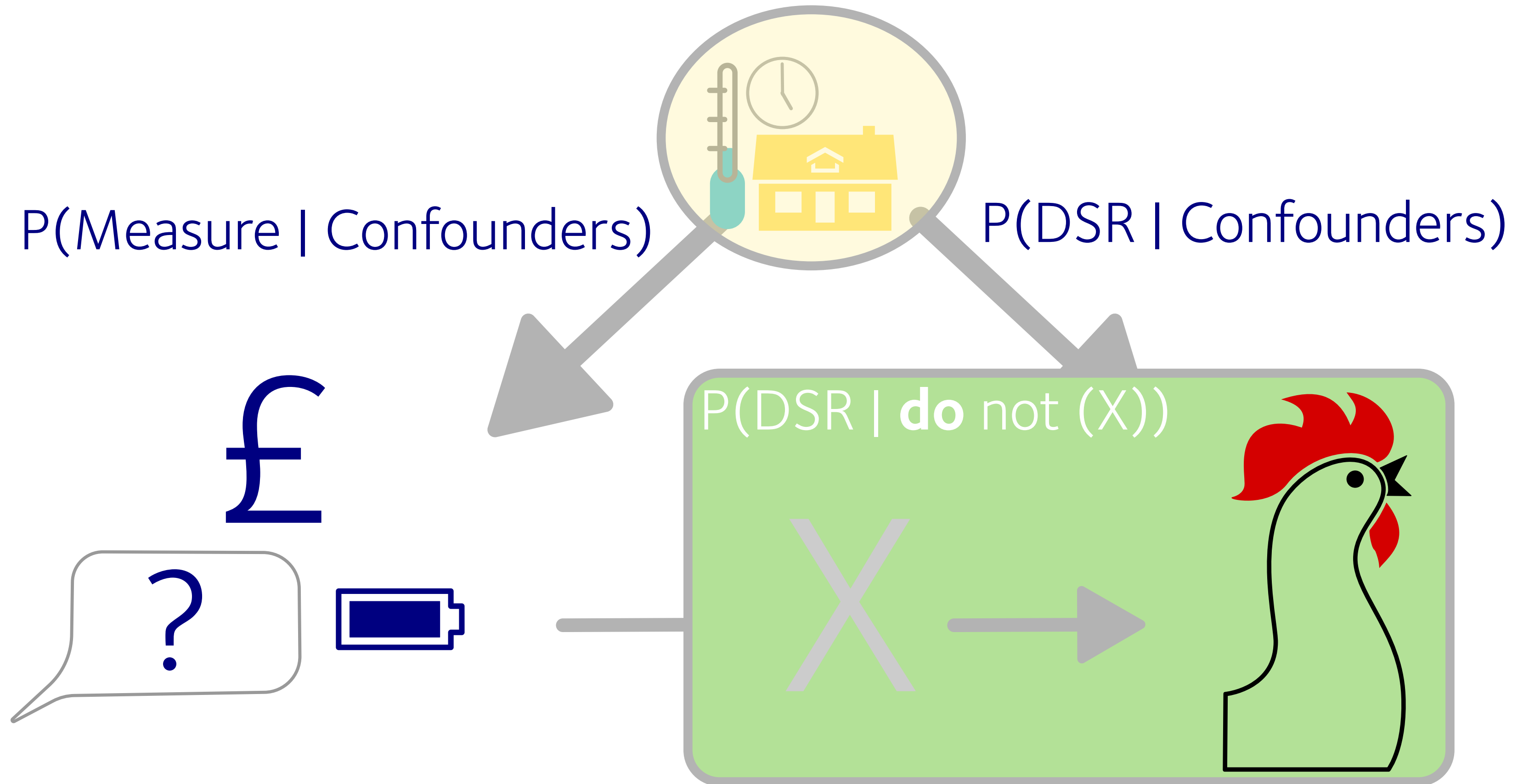


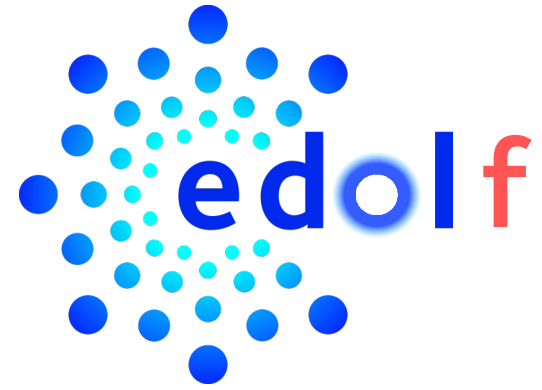
Little Data: Control and intervention:

Responses are significant, repeatable and effective



Big data: Who/what delivers demand side responses?

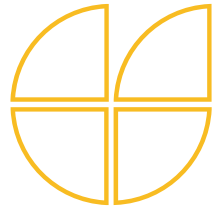




Energy Demand Observatory and Laboratory and Forensics



Engineering and
Physical Sciences
Research Council



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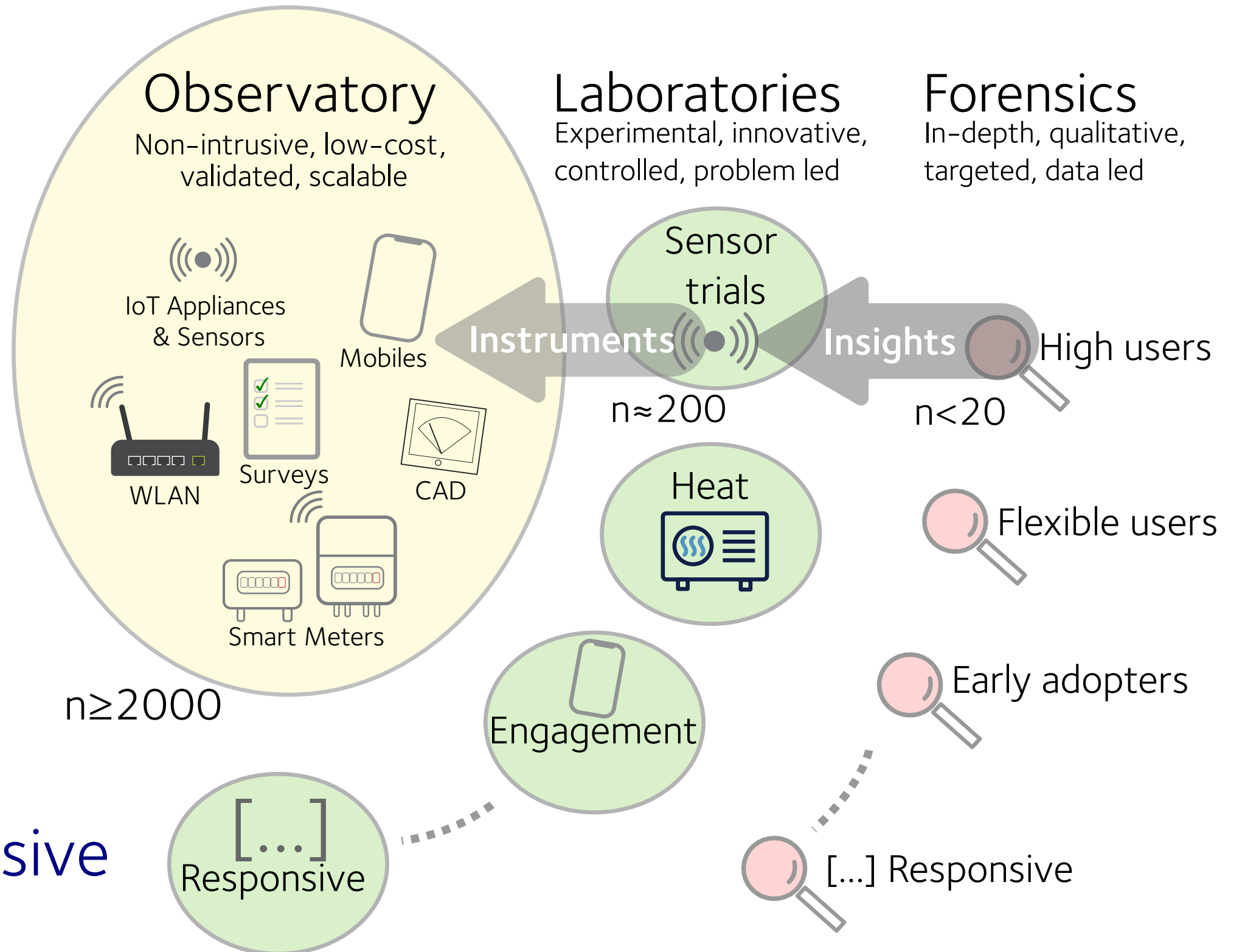


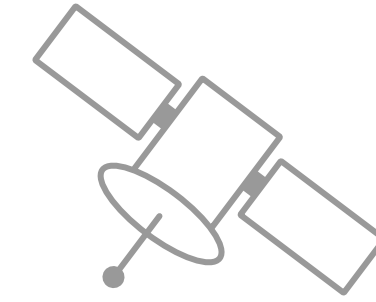
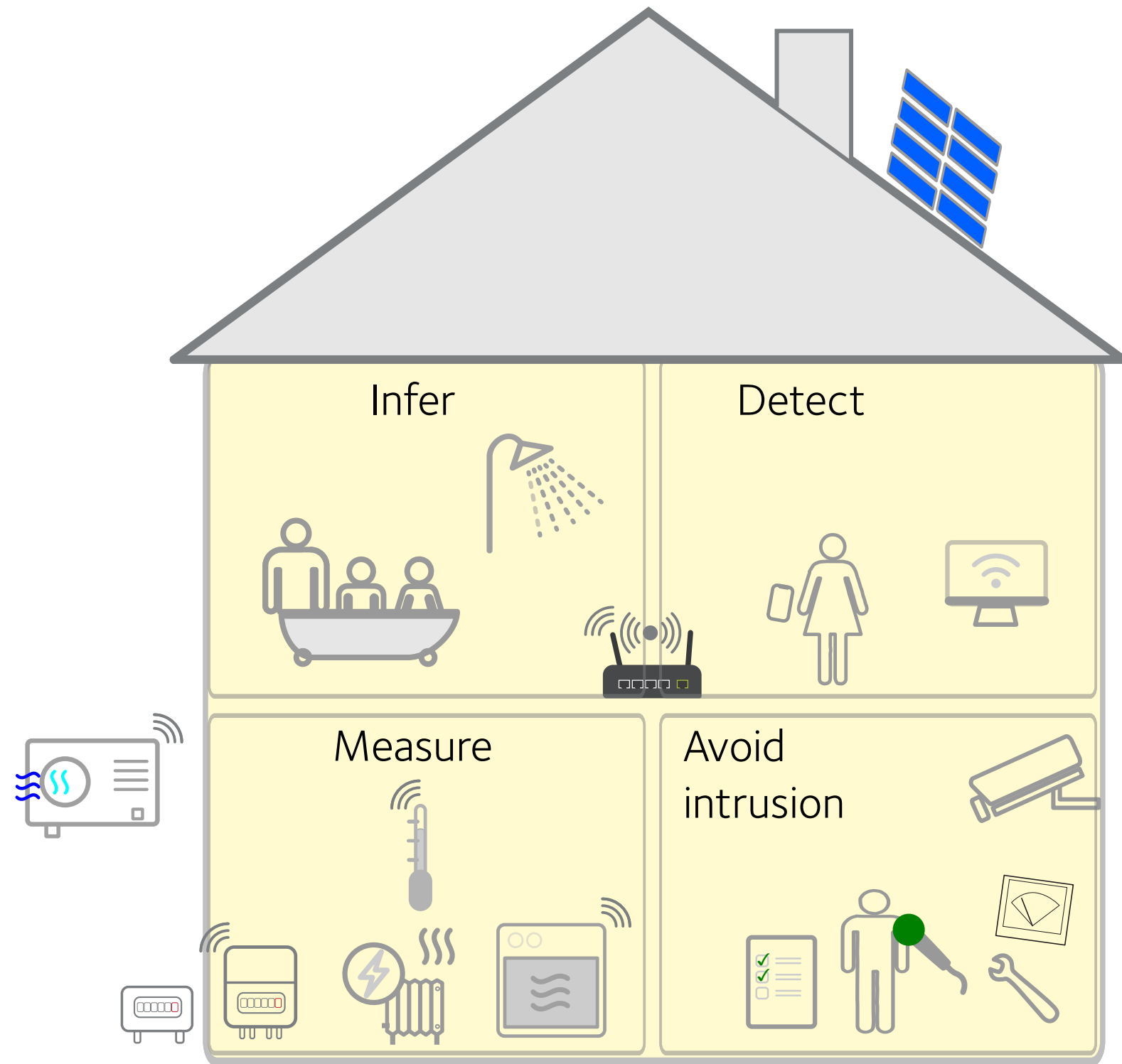
UNIVERSITY OF
OXFORD



THE BARTLETT

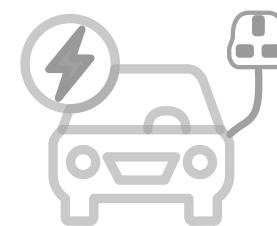
- Large scale
- Longitudinal
- Un-intrusive and low cost
- (after being) intrusive and expensive



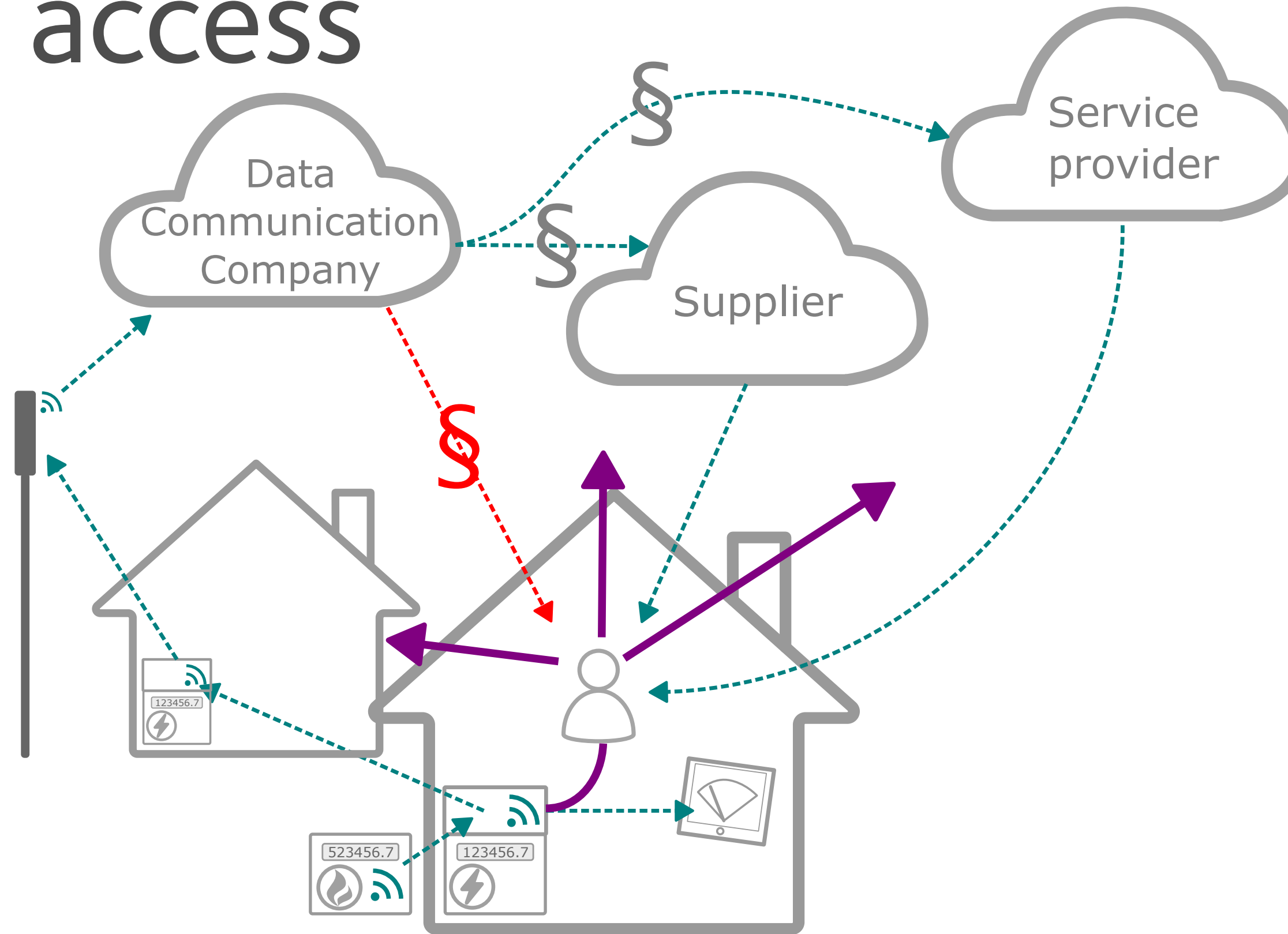


Key development steps

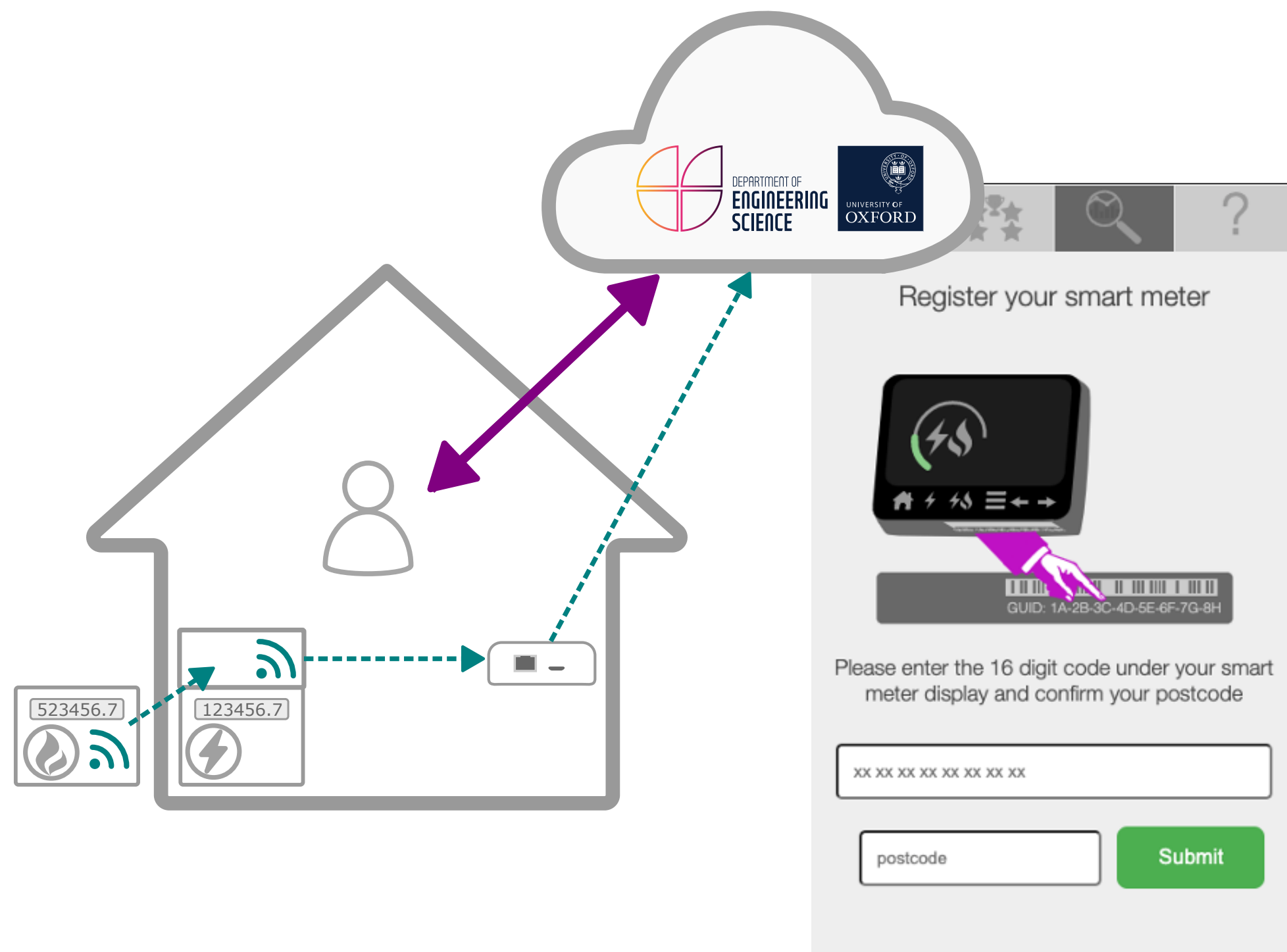
- 1) Identify and validate technology options
- 2) Minimise the need for hardware and intrusion
- 3) Use accessible sources of data



Data access



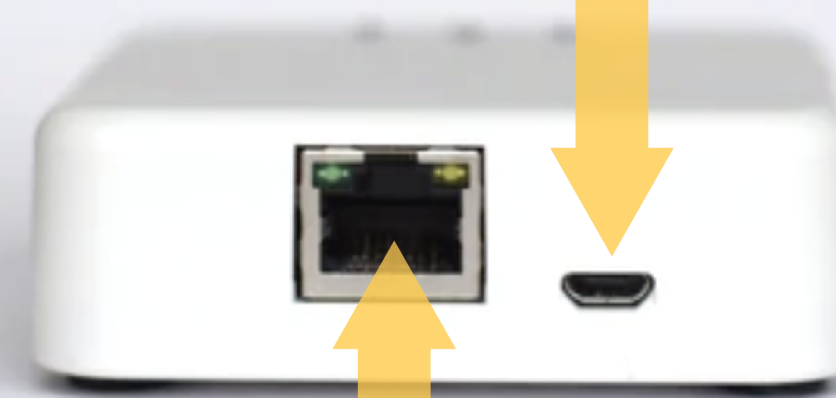
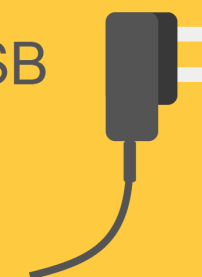
Data access



Your Smart Meter Access Device

1

Connect the USB cable to power



2

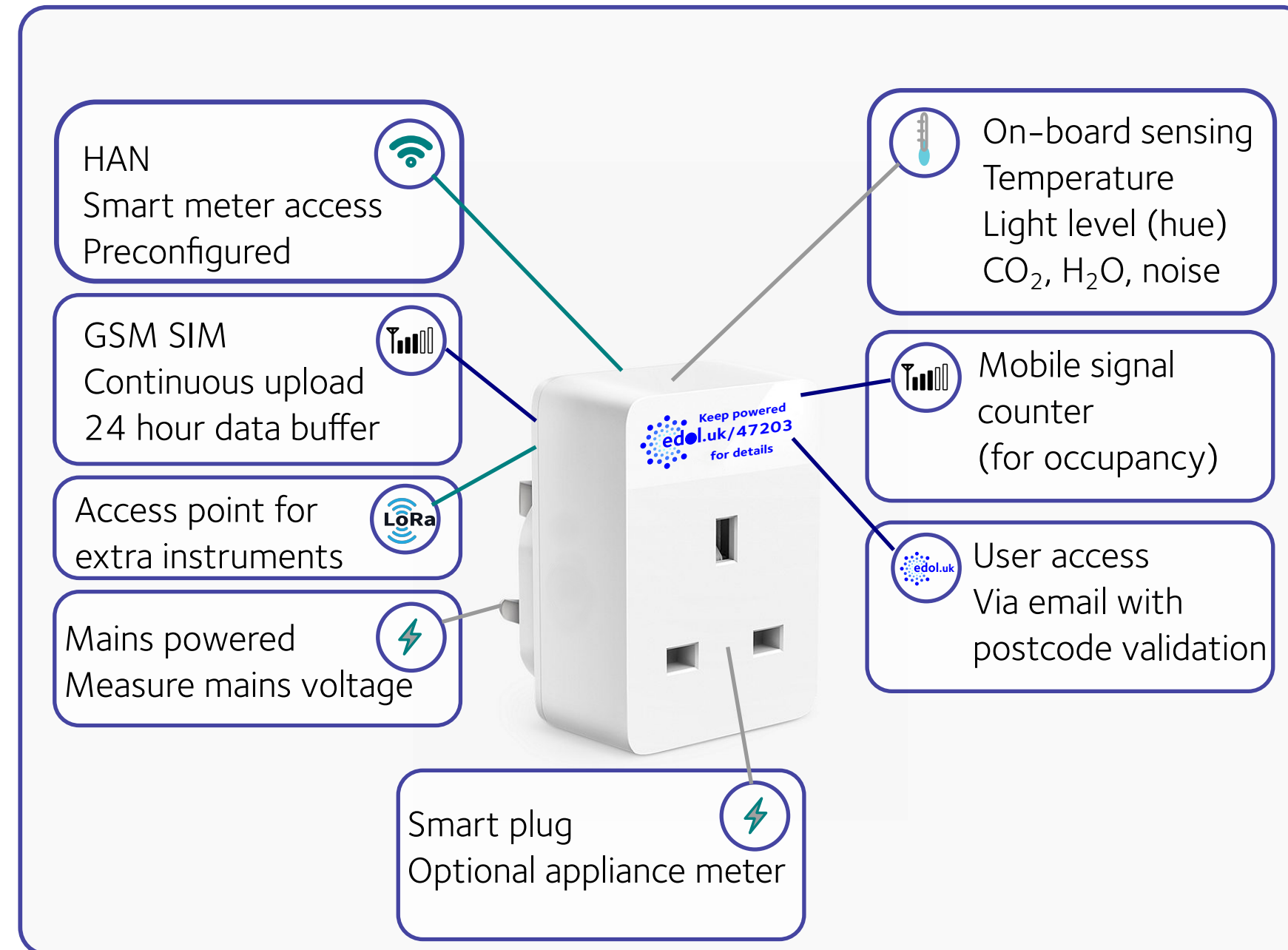
Connect the Ethernet cable to your router
Done.



The device automatically connects your smart meter.
Please leave it plugged in during the study.
If you have any questions, email support@joymeter.uk



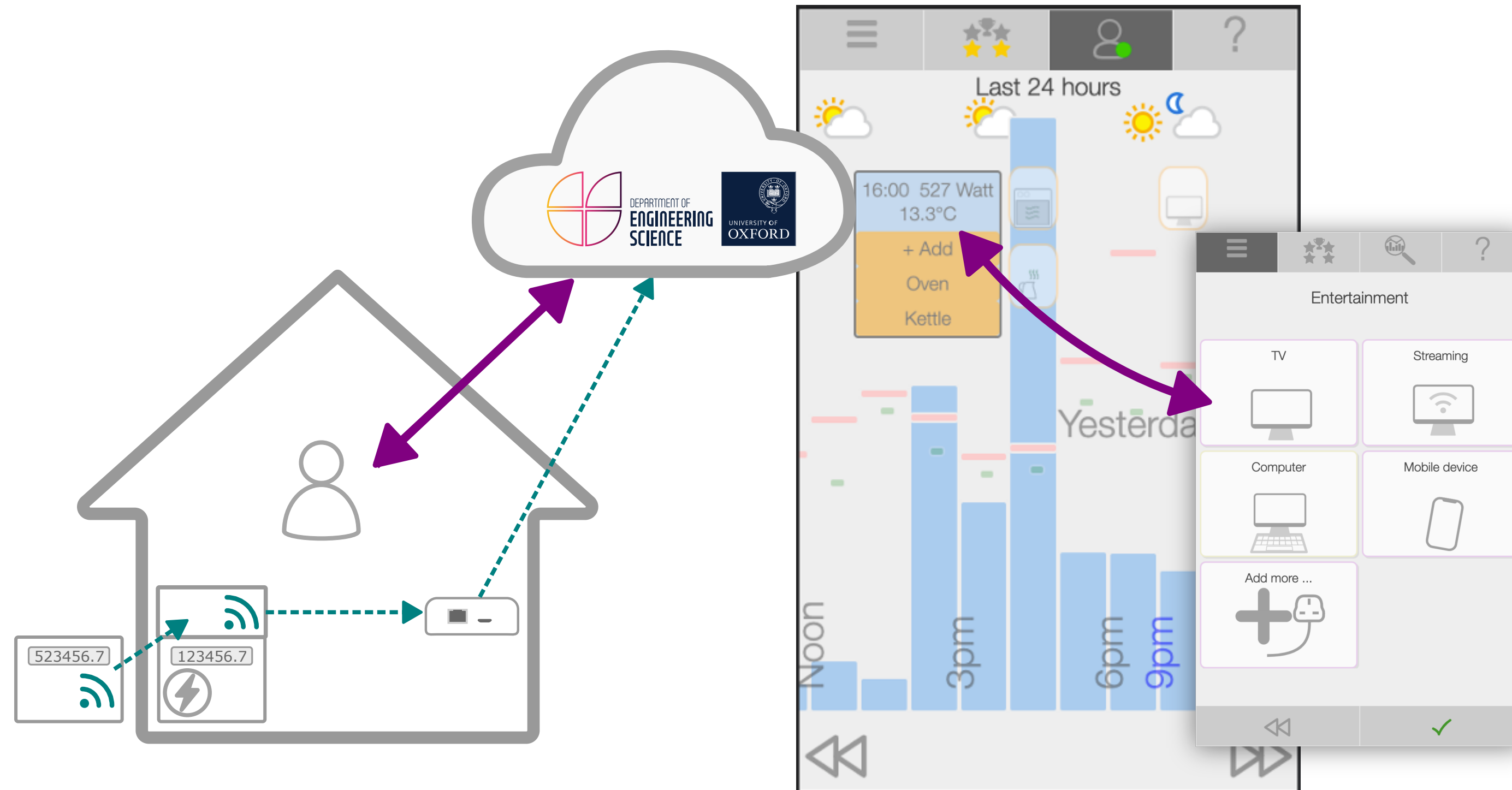
EDOL Dream Data Instrument (EDDI)



Learning (two ways)

Phases

- 1) You tell us
training
- 2) Verify suggestions
reinforcement learning
- 3) Feedback
 - Timely
 - Accurate
 - ActionablePersonal Messages

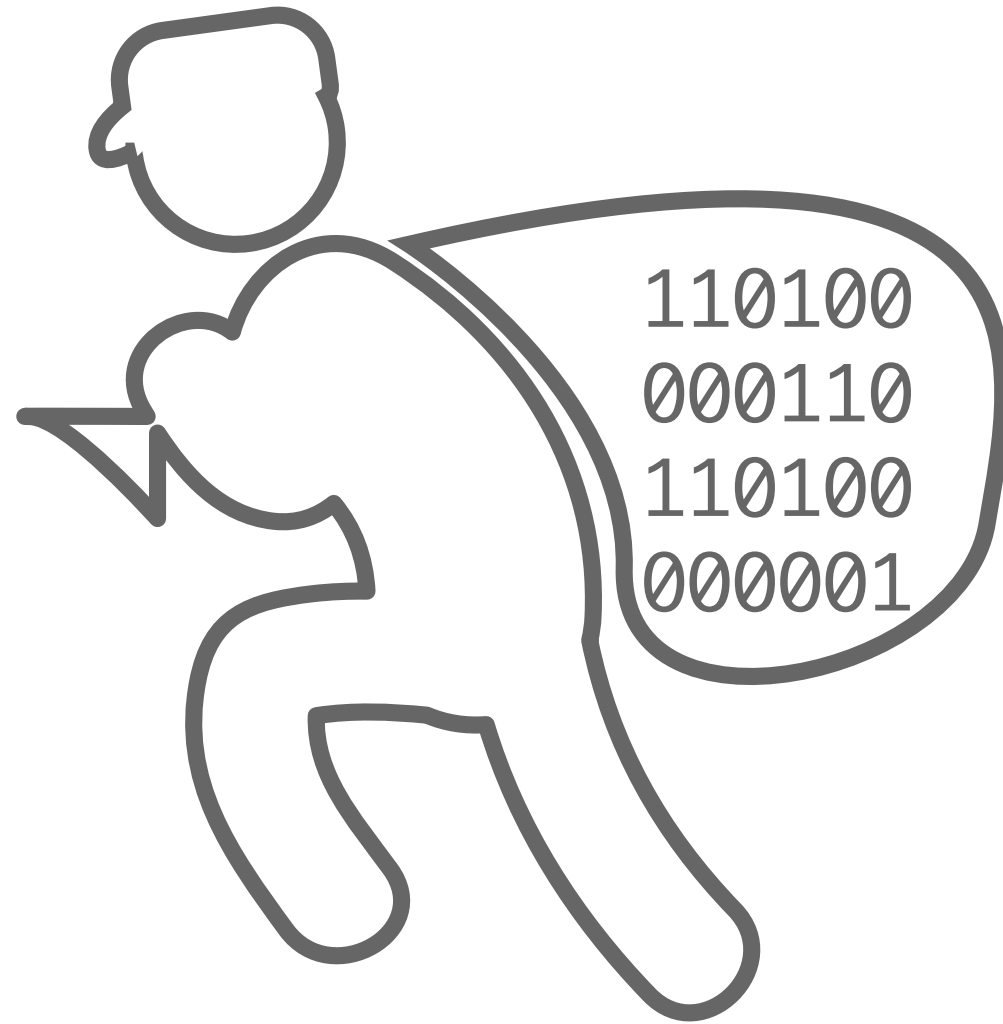


Privacy

Is this what informed consent looks like?



It is unclear what is sensitive and why



Energy use? EPCs are public

Occupancy? Lights and windows are visible to all

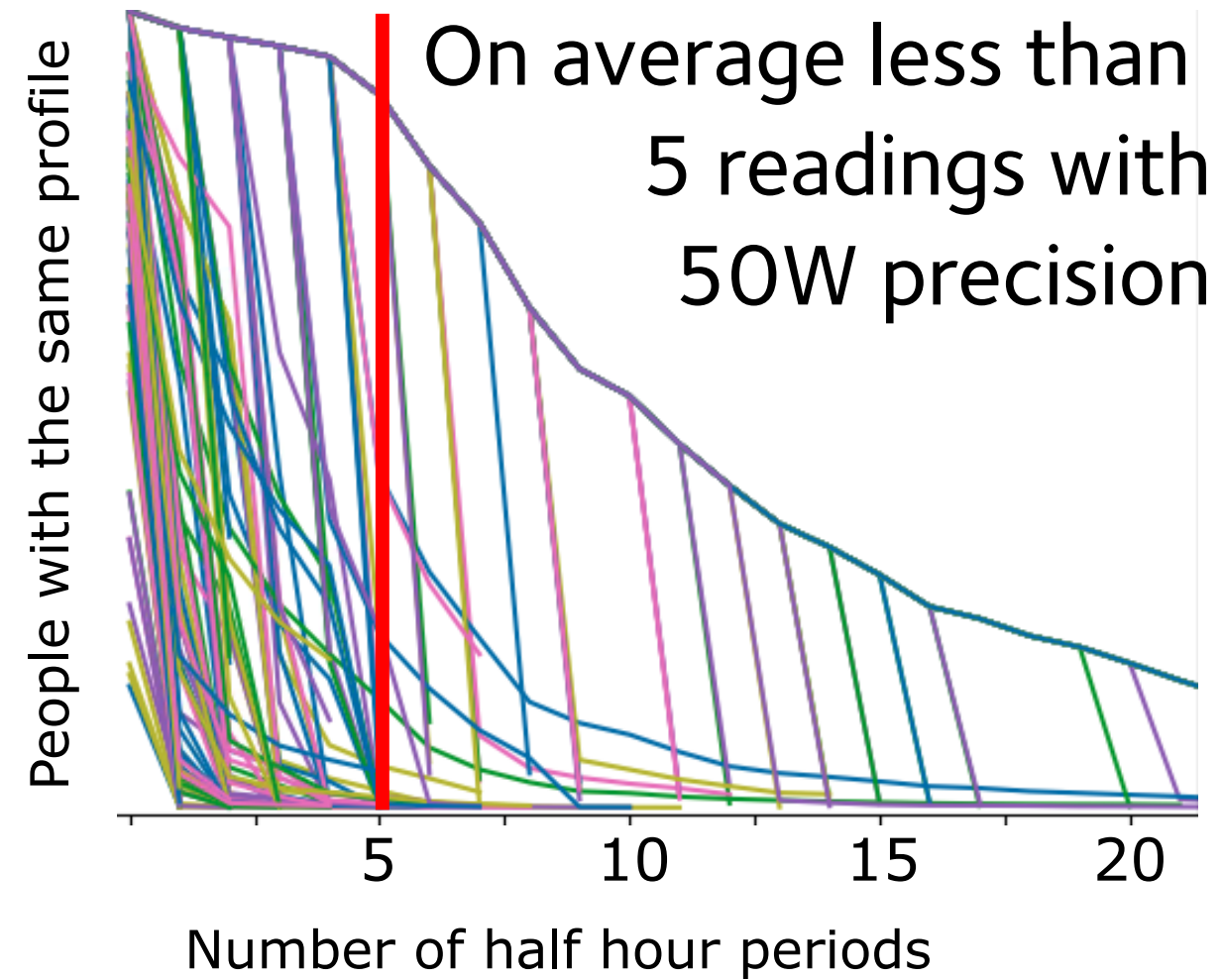
Privacy? Spying spouses

Practices? Profiles reveal faith

Identity? How unique is the data

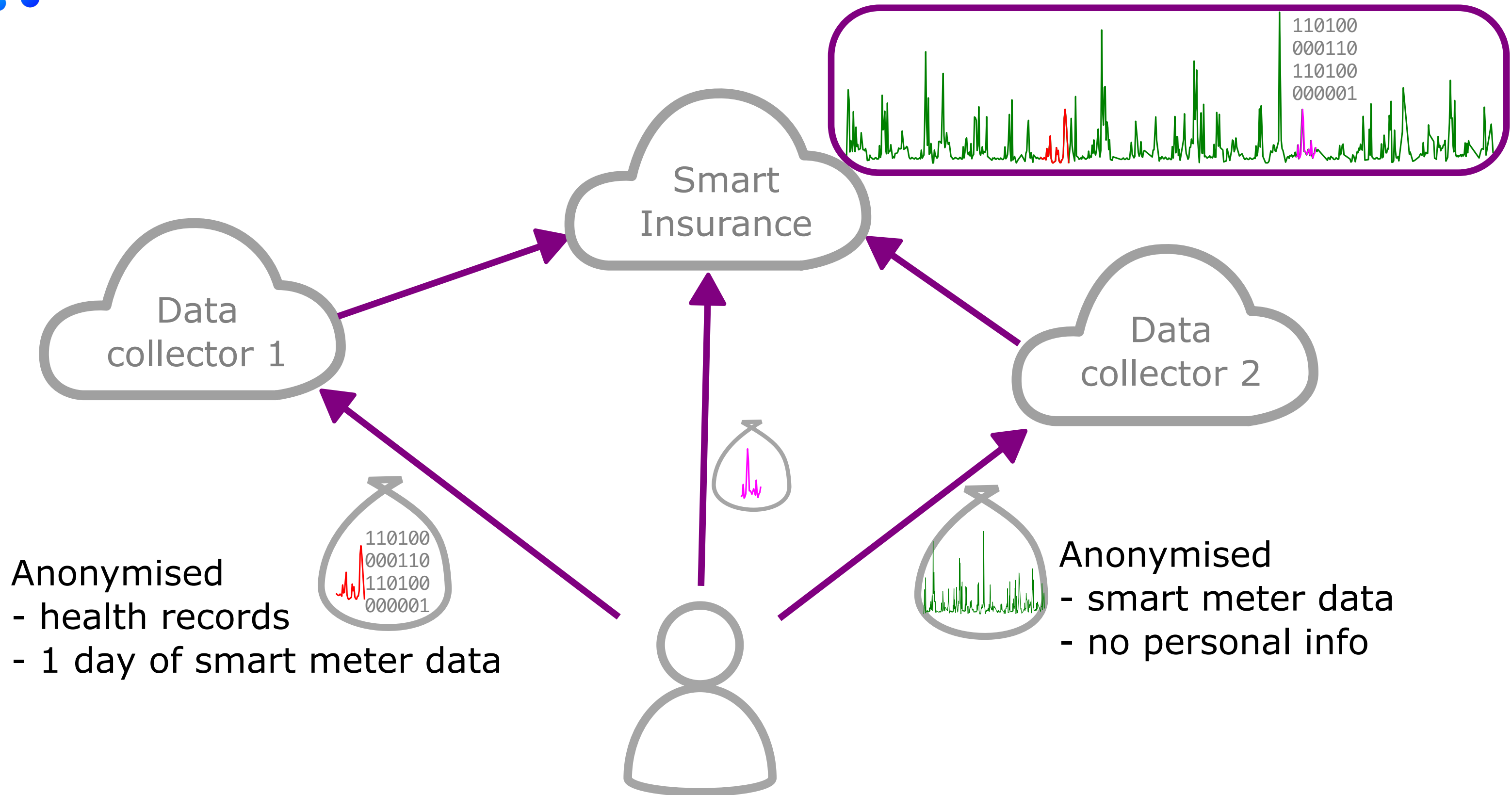


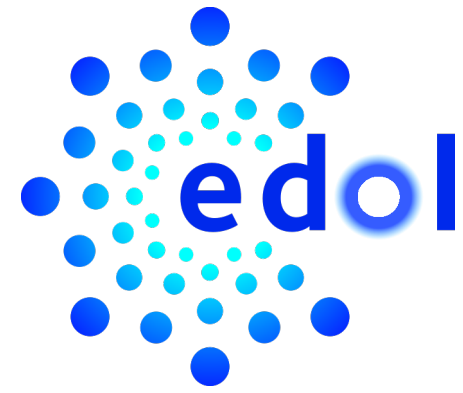
How much smart meter data does it take to uniquely identify **you**?





Linking can turn harmless data into revealing data





**We need to de-identify data
while maintaining data integrity**

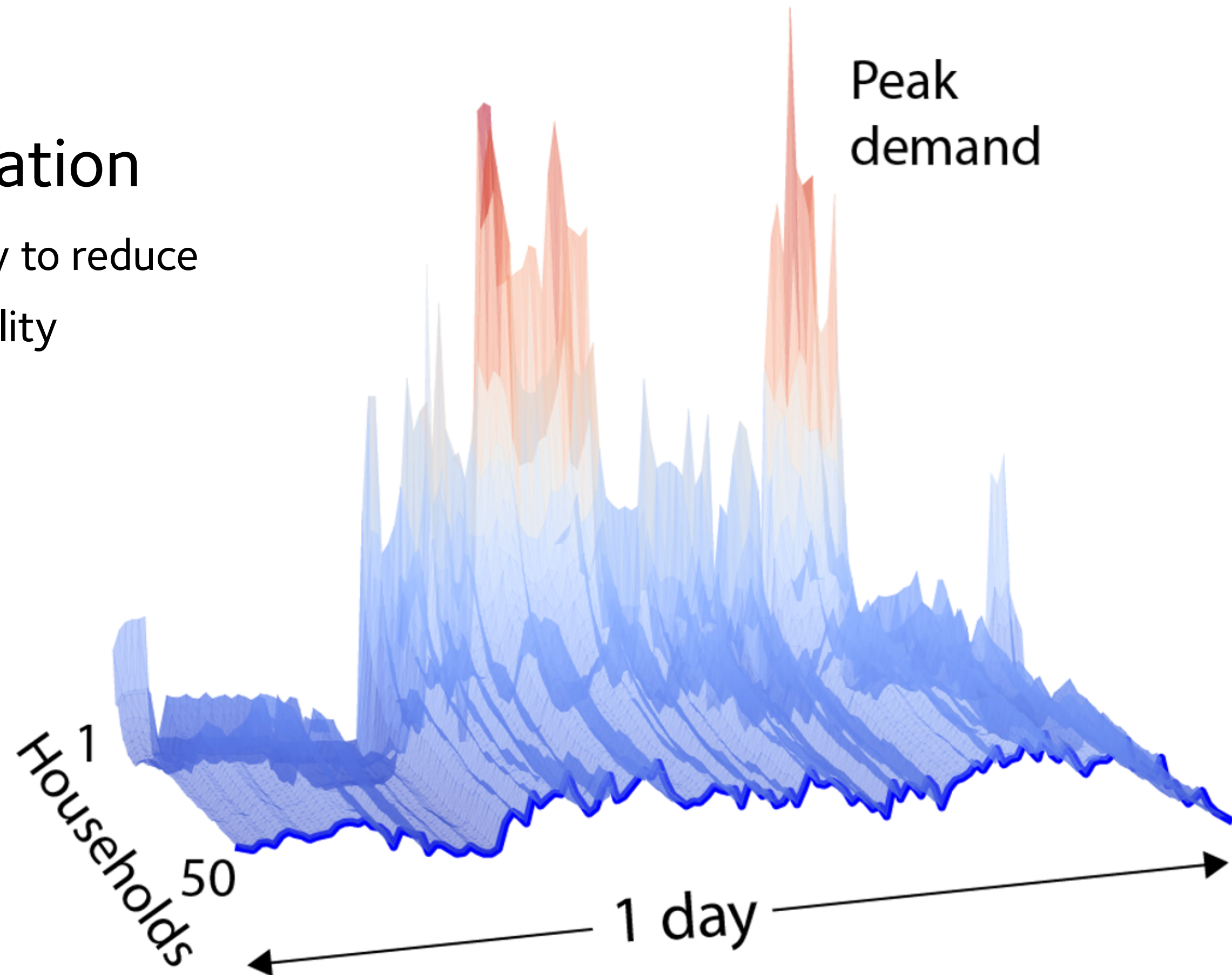
Approaches

- 1) Aggregate Rule of '10' (or 3?) – arbitrary, defusing and unreliable
- 2) Cluster Maintains some relevant features (e.g. heat pump cluster)
- 3) Synthesise Allows to generate even hypothetical profiles

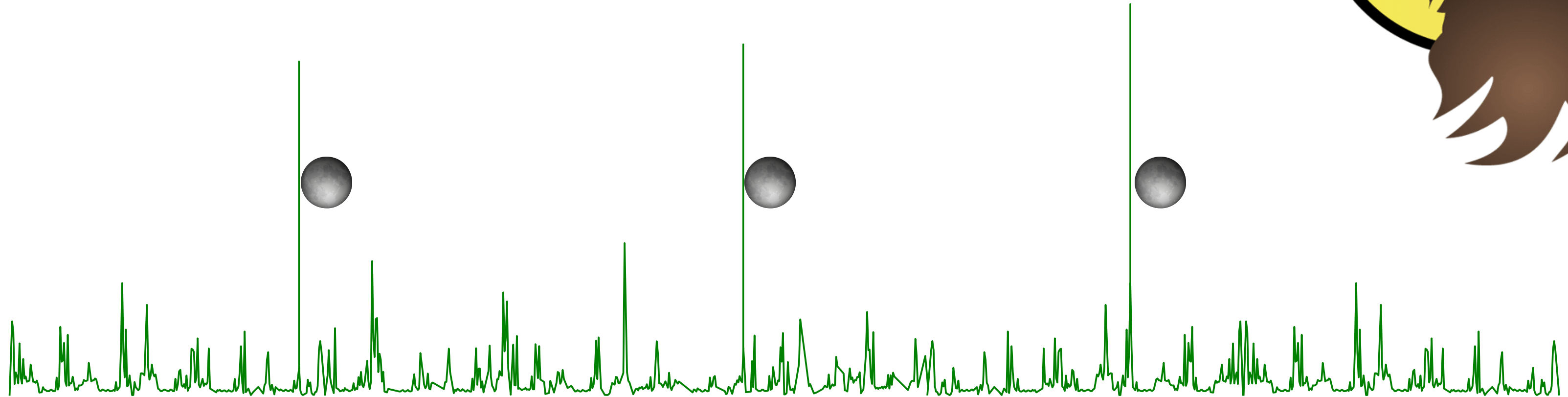
Aggregation

an easy way to reduce

- identifiability
- utility



A werewolf wishes for their identity to be protected. Would aggregation help?





John Corsten

Energy Systems MSc (2023/24)

Can synthetic data provide a better balance between consumer
privacy and data utility than [aggregation]

Quantifying Privacy in Smart Meter Data: A
Comparative Analysis of Aggregation and
AI-Generated Synthetic Data



John Corsten

Wolfson College

University of Oxford

A dissertation submitted for the degree of

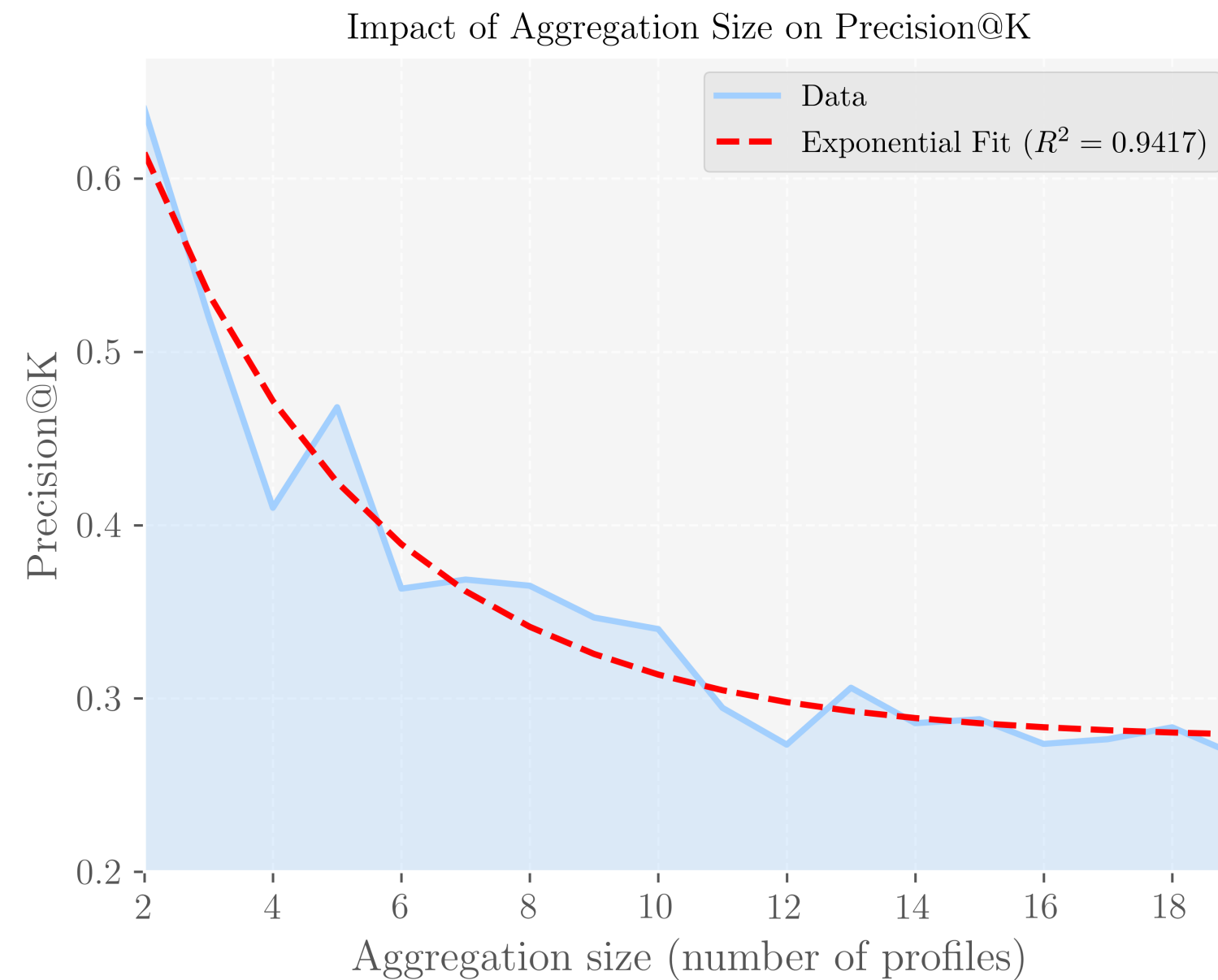
MSc in Energy Systems

2024

Word count: 14,926

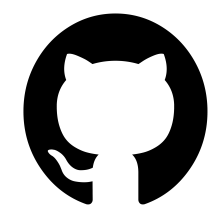
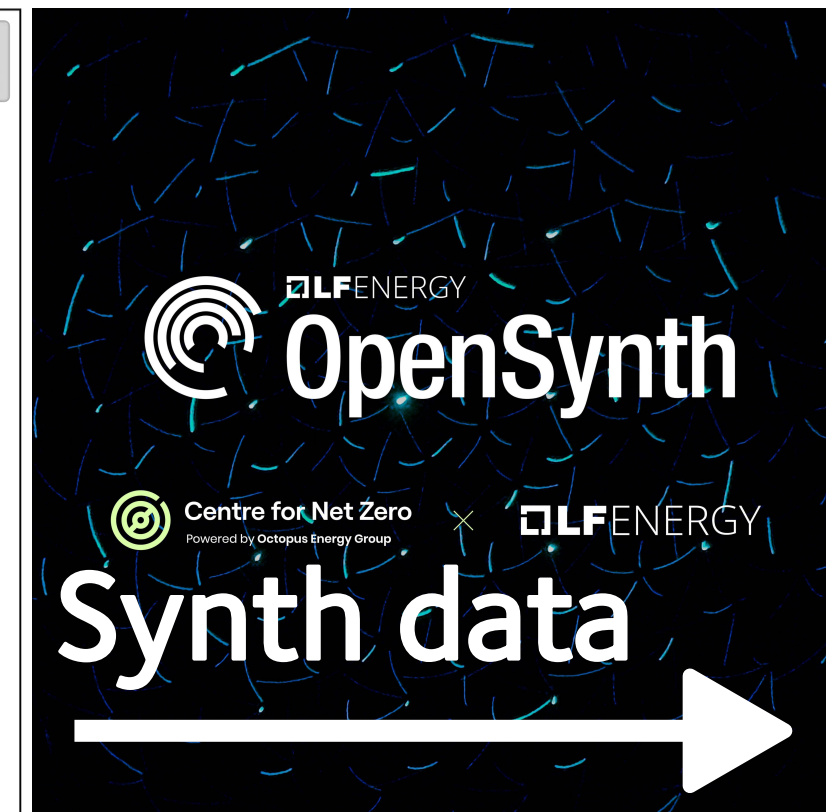
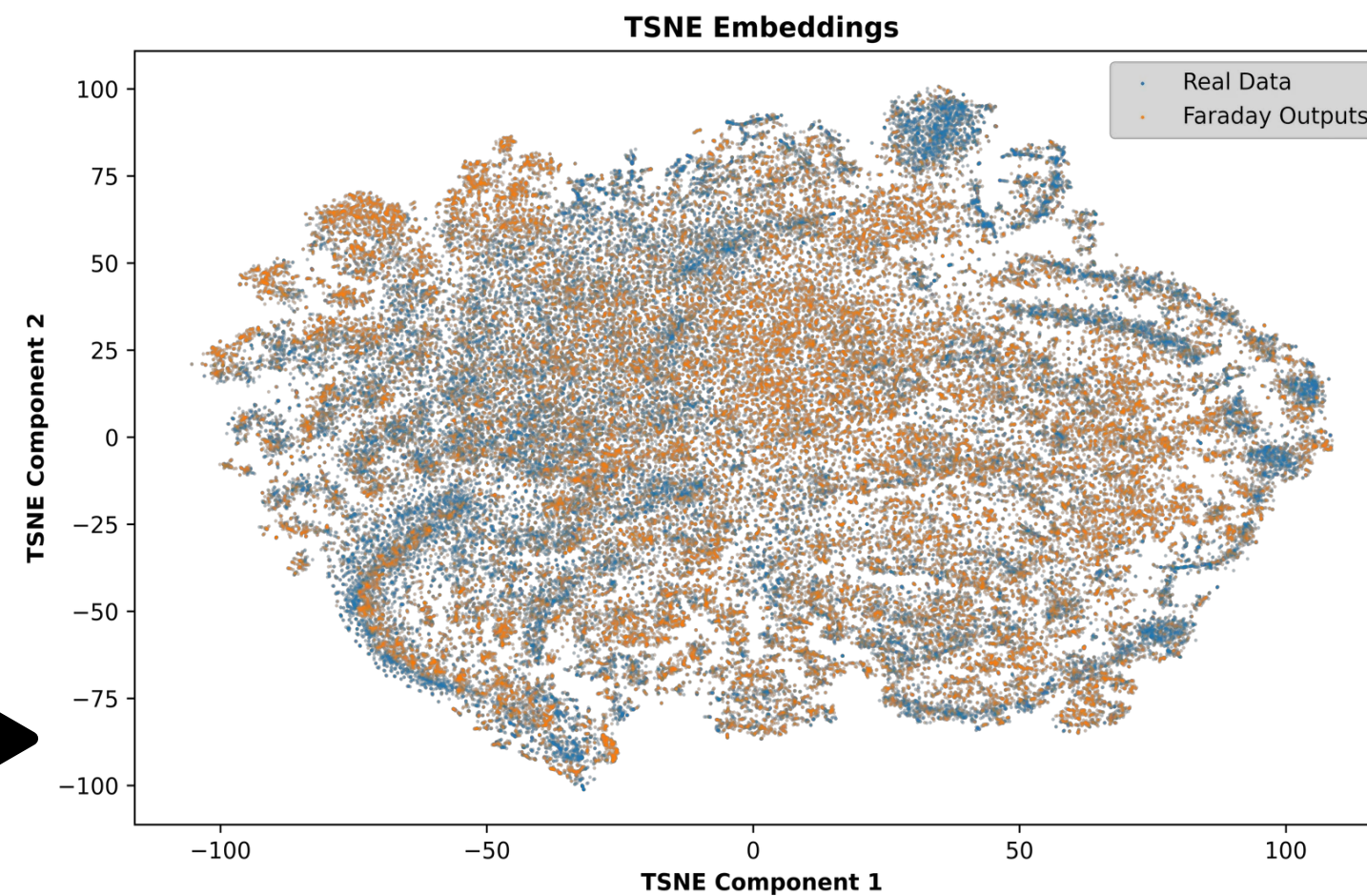
What are the chances that a random profile can be correctly identified as member of the training data?

Random forest
membership
inference
attack



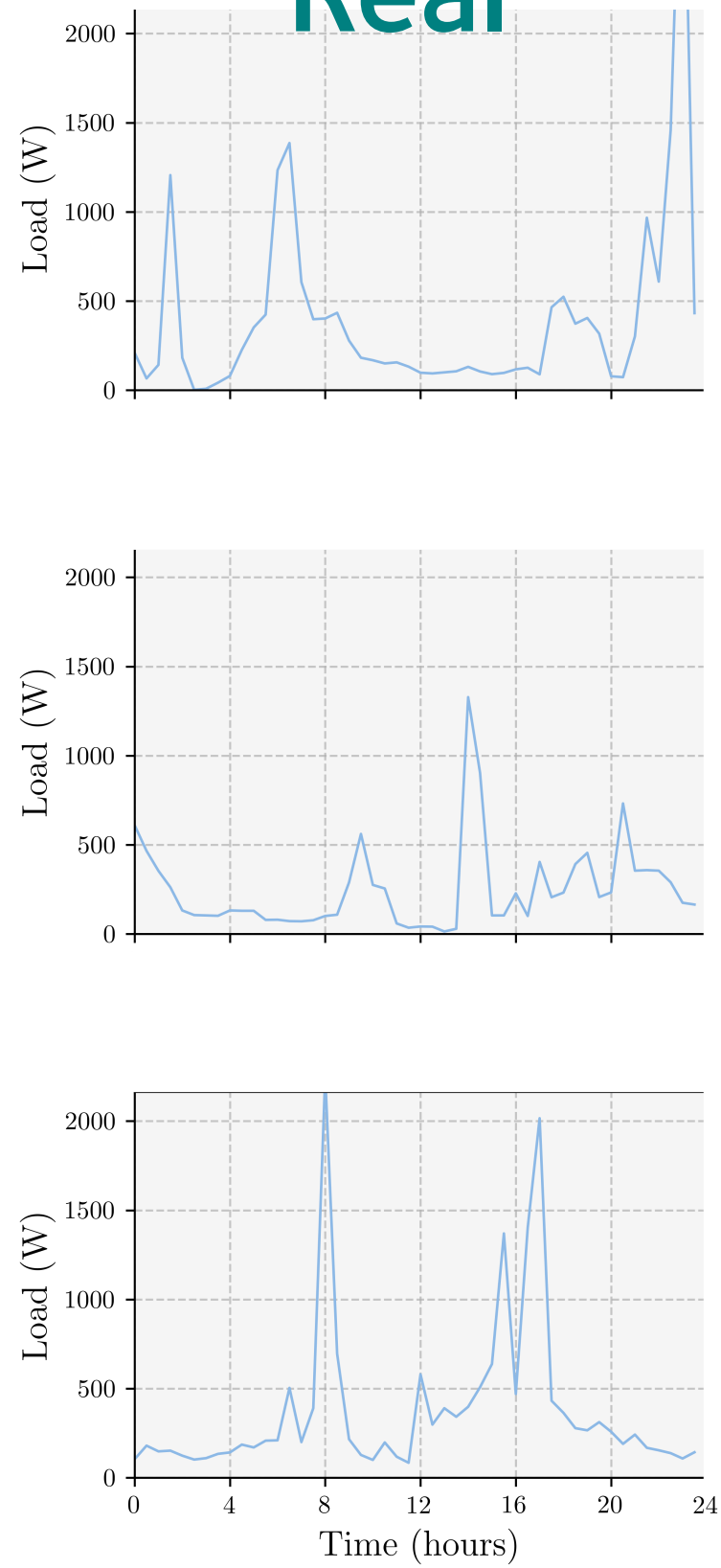


Real data

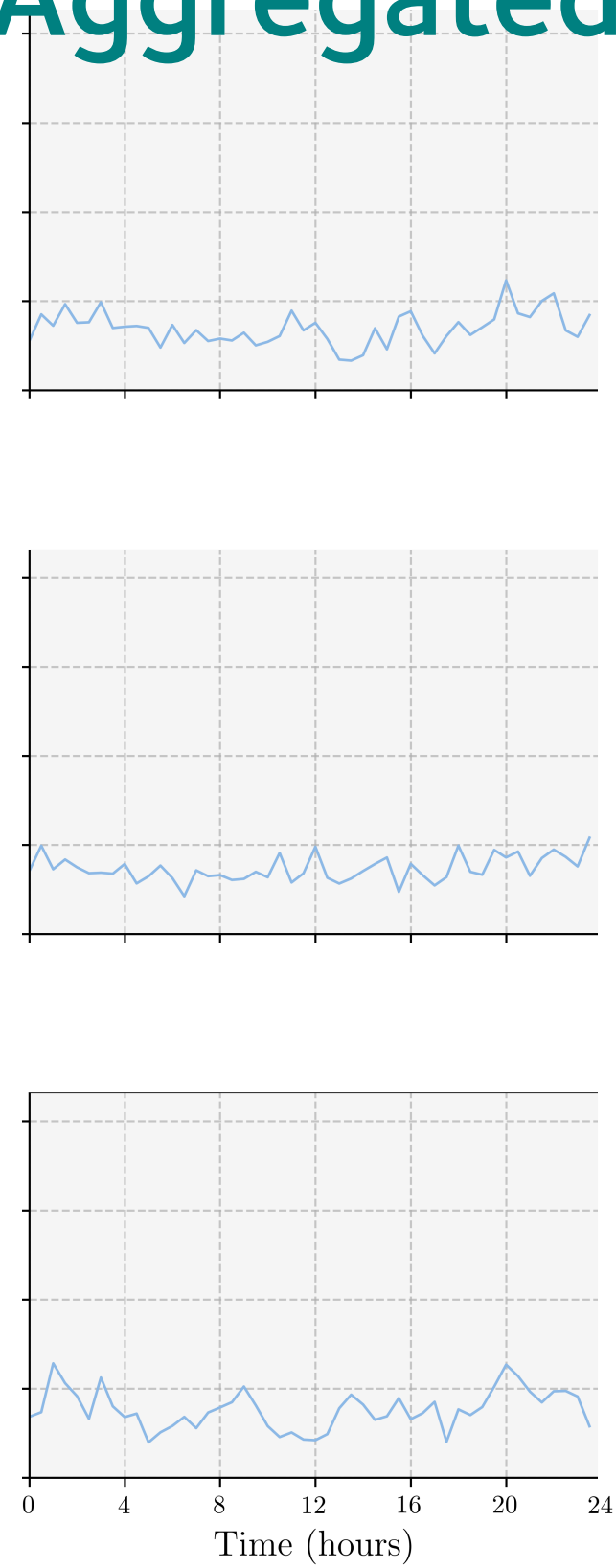


OpenSynth-energy/OpenSynth

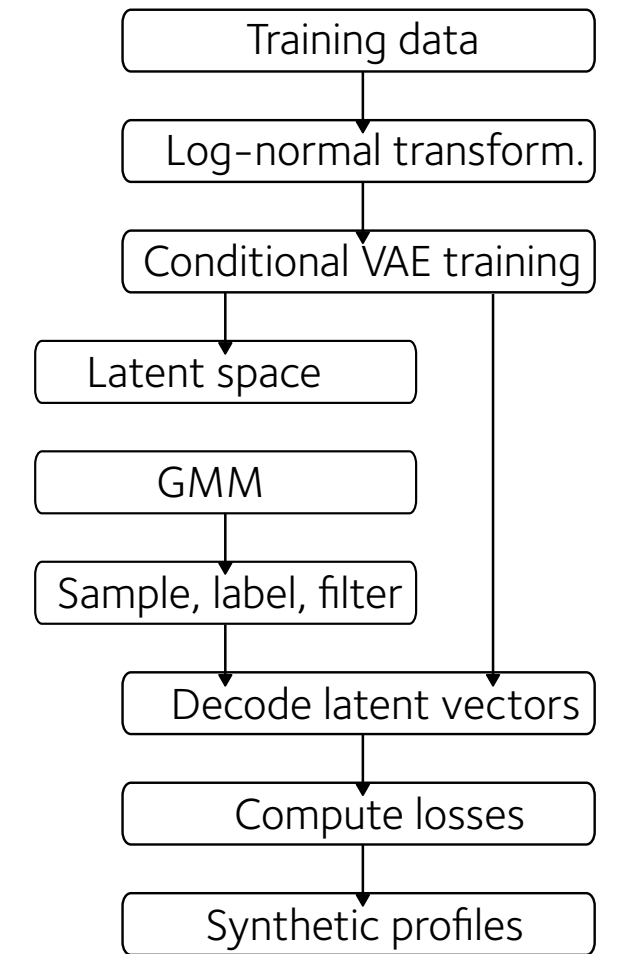
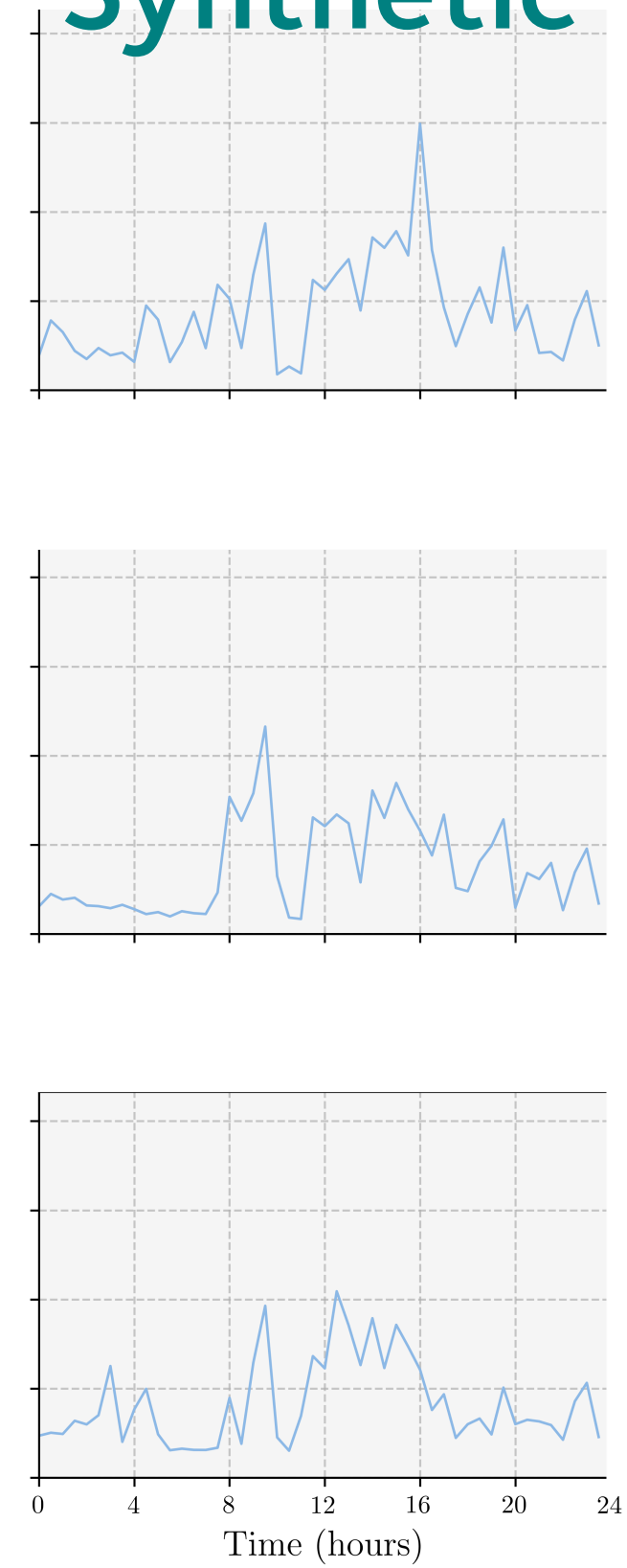
Real



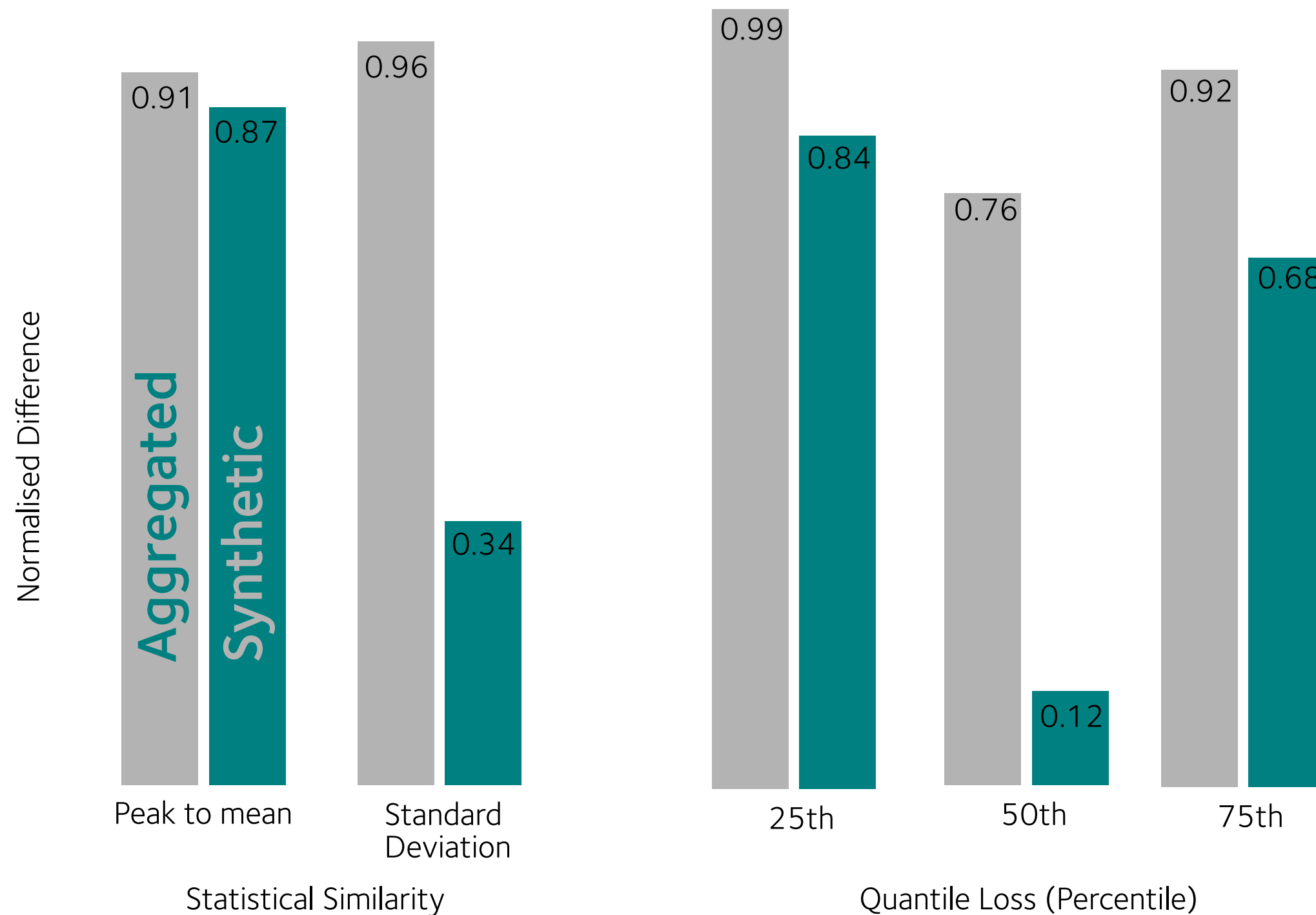
Aggregated



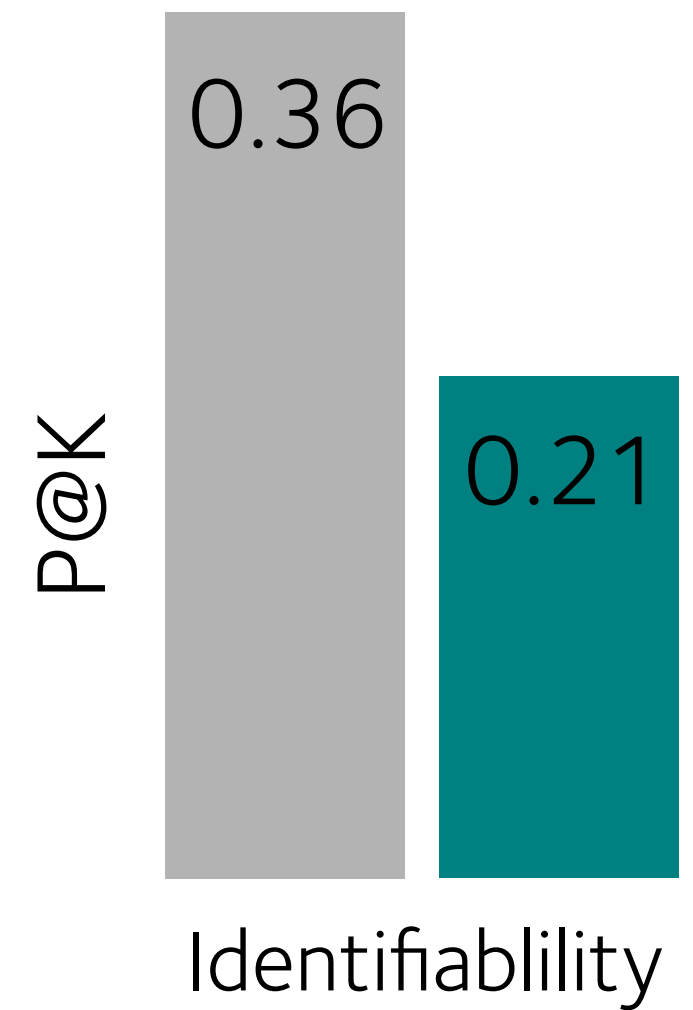
Synthetic



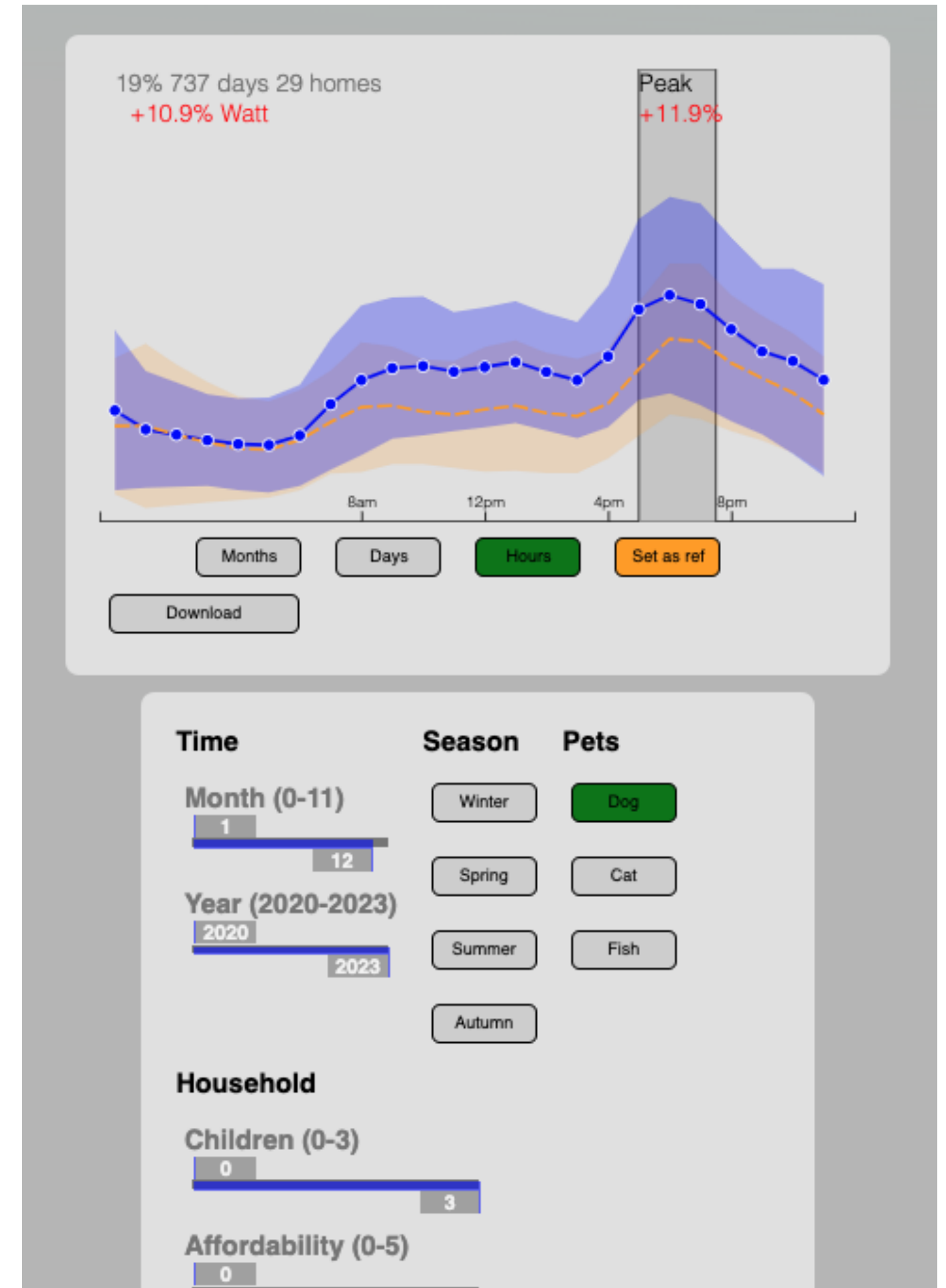
Utility



Privacy

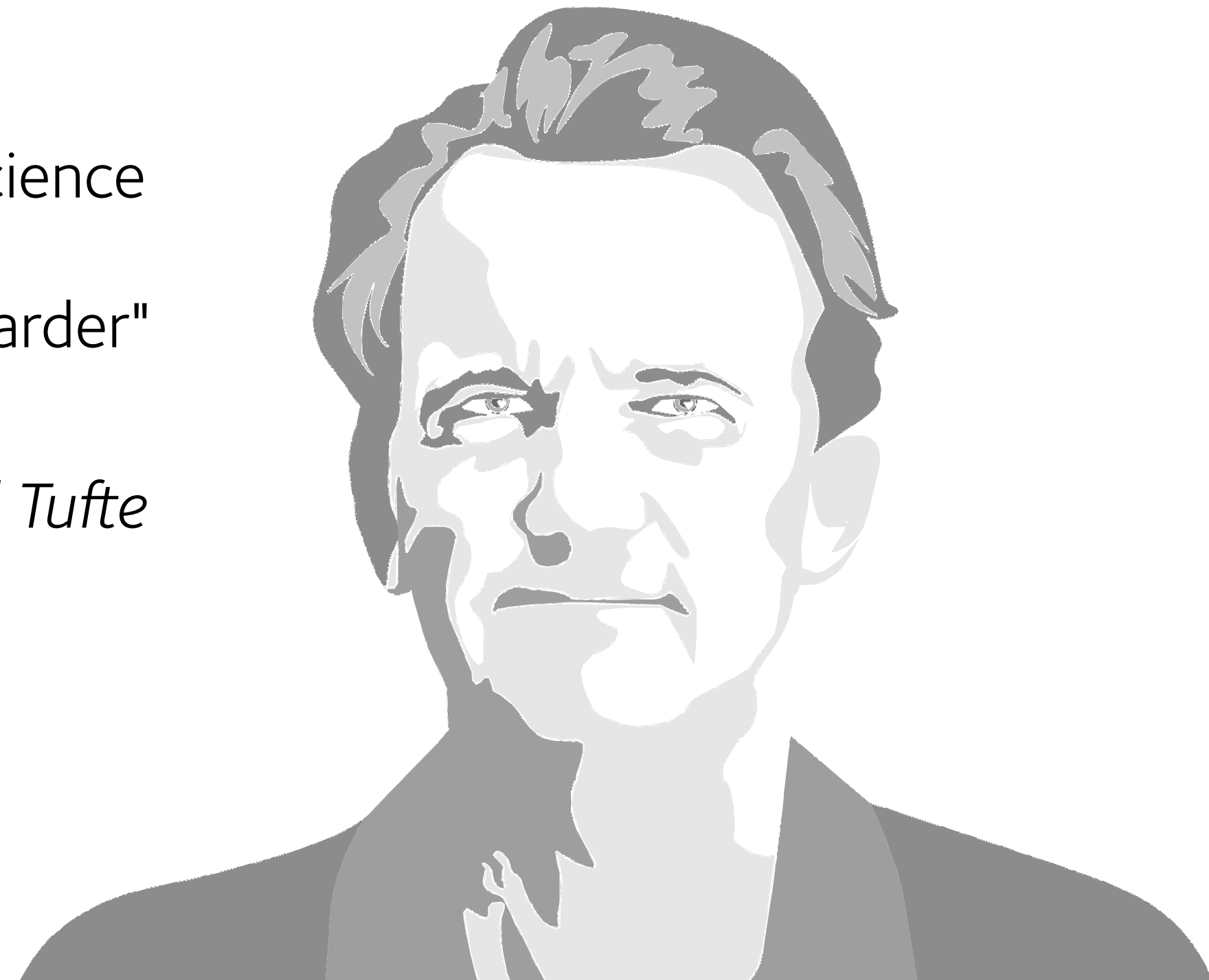


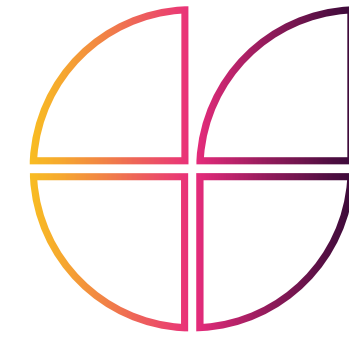
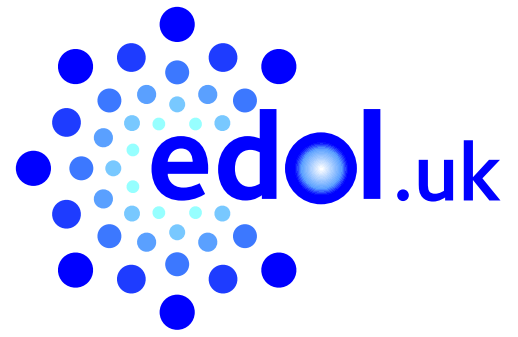
Power explorer:
energy-use.org/data



"Understanding human behaviour isn't rocket science
– it's harder"

Edward Tufte





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Thank you

philipp.grunewald@eng.ox.ac.uk

