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

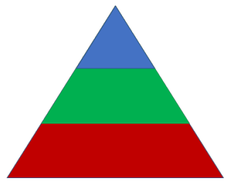
Part II

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

Recap

System Flexibility

Energy service



Useful vs. used energy

Causes of energy use

Key activities driving demand

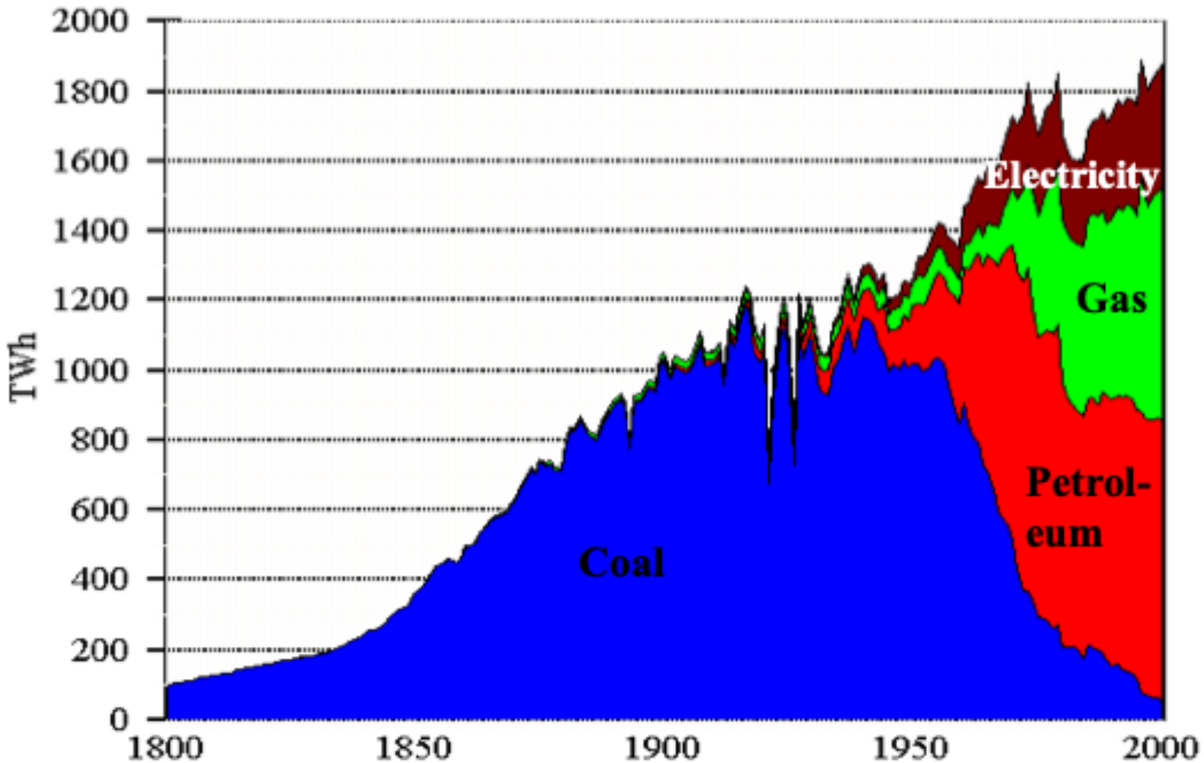
To understand causes we need (up to) three things

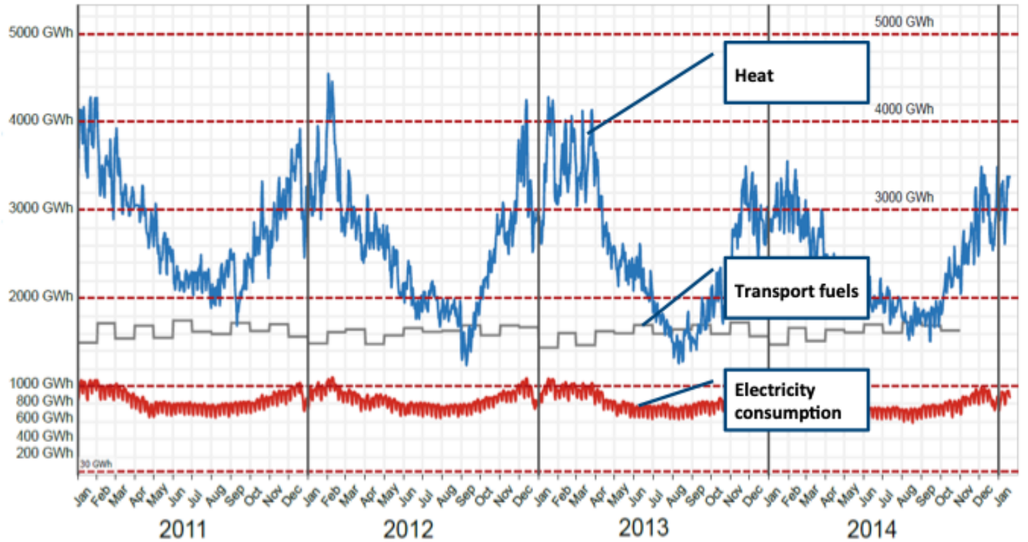
Causal model

Observation

Do something

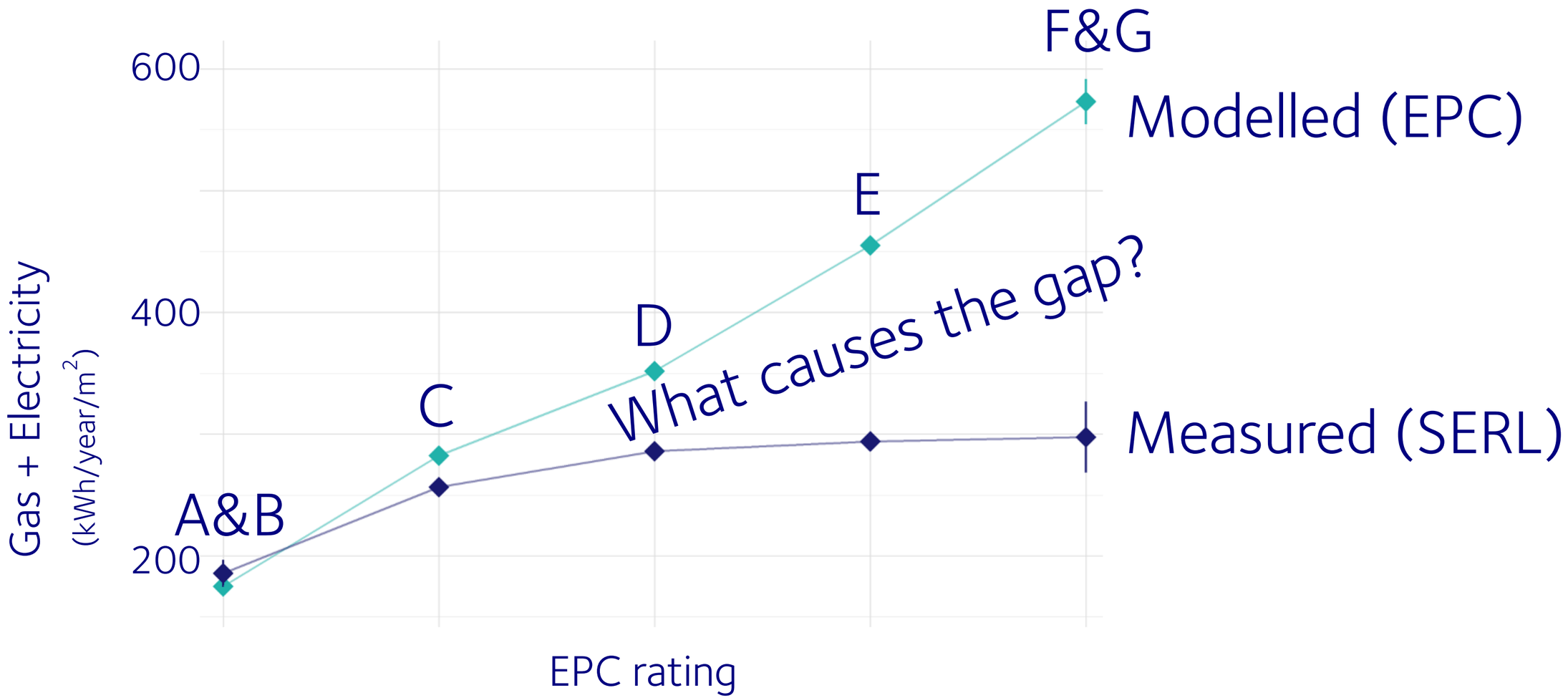
Heat – the elephant in the room





Source: University of Sheffield

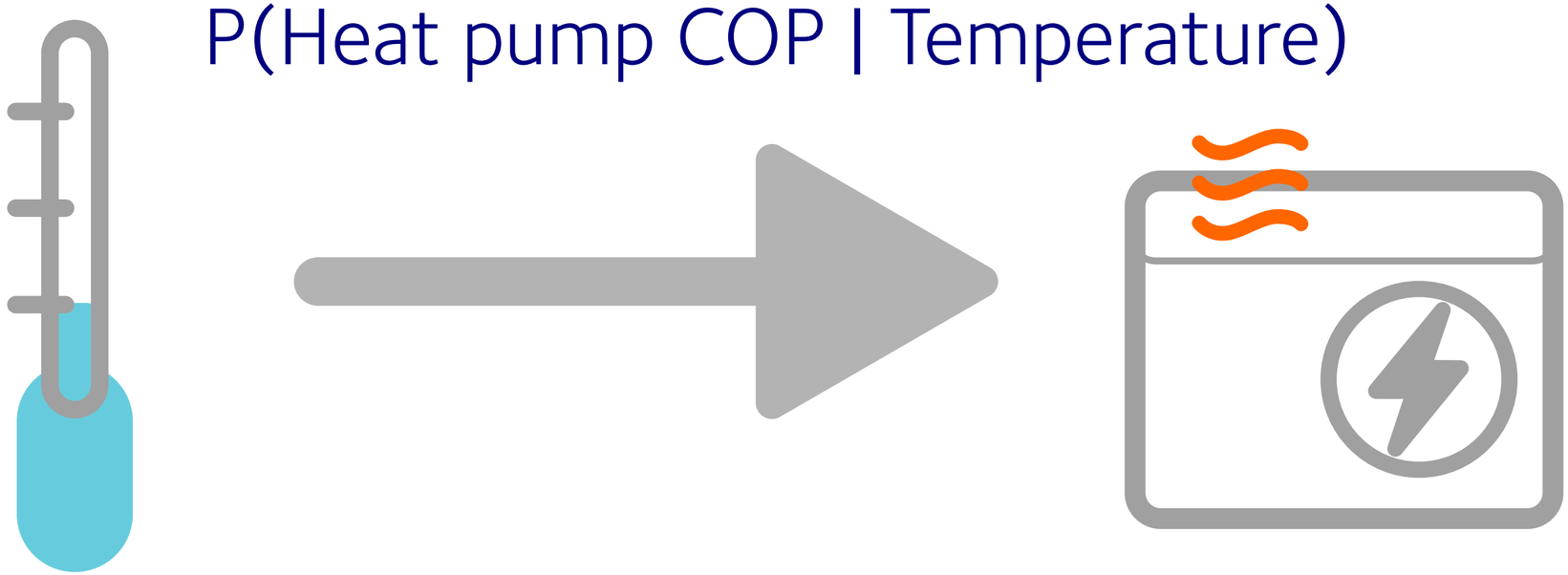
Model vs Reality: EPCs are poor preditors of demand



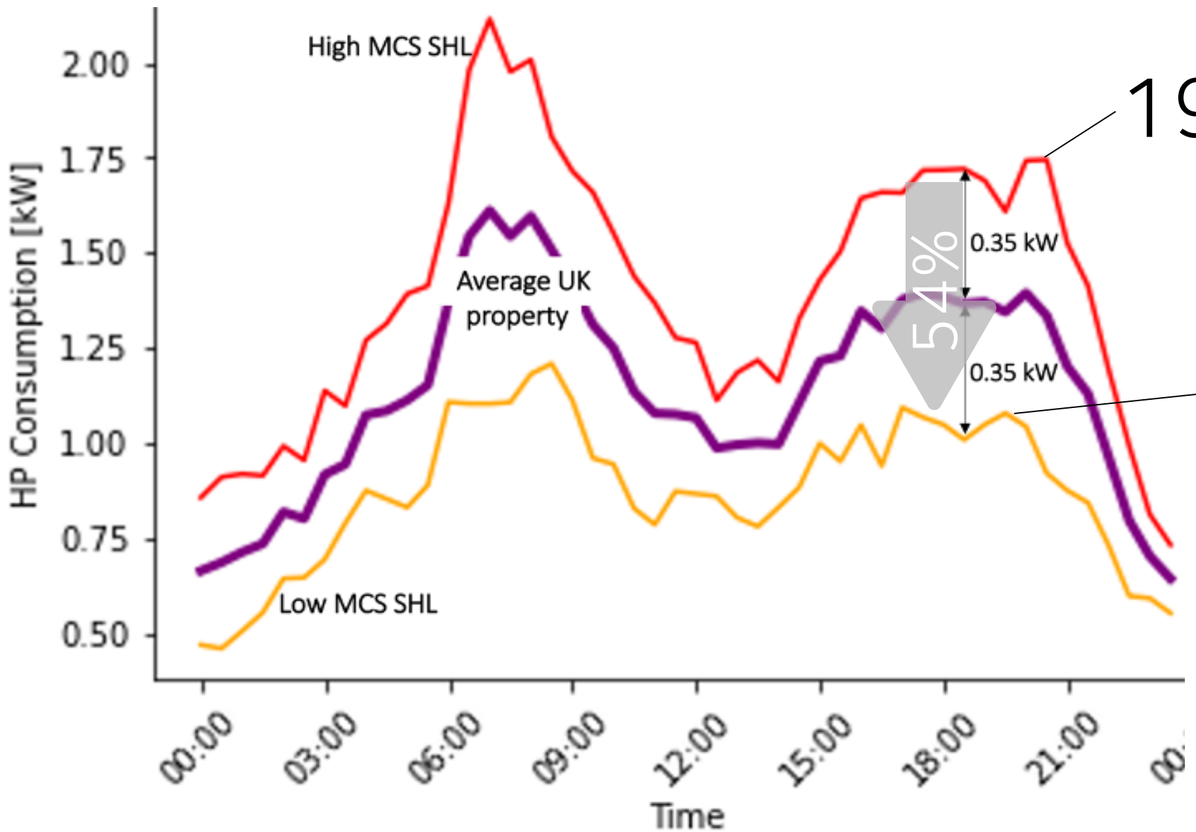
https://doi.org/10.1016/j.enbuild.2023.113024

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

P(Heat pump COP | Temperature)



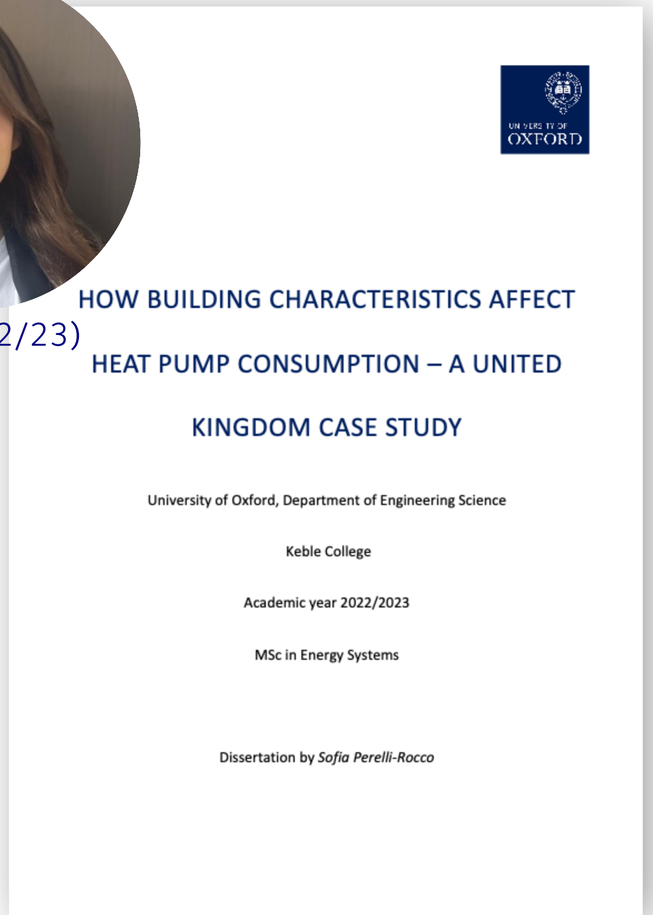
Some data: heat pumps work on cold days and even better in efficient homes



19.3 °C

19.7 °C

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



UNIVERSITY OF OXFORD

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

University of Oxford, Department of Engineering Science

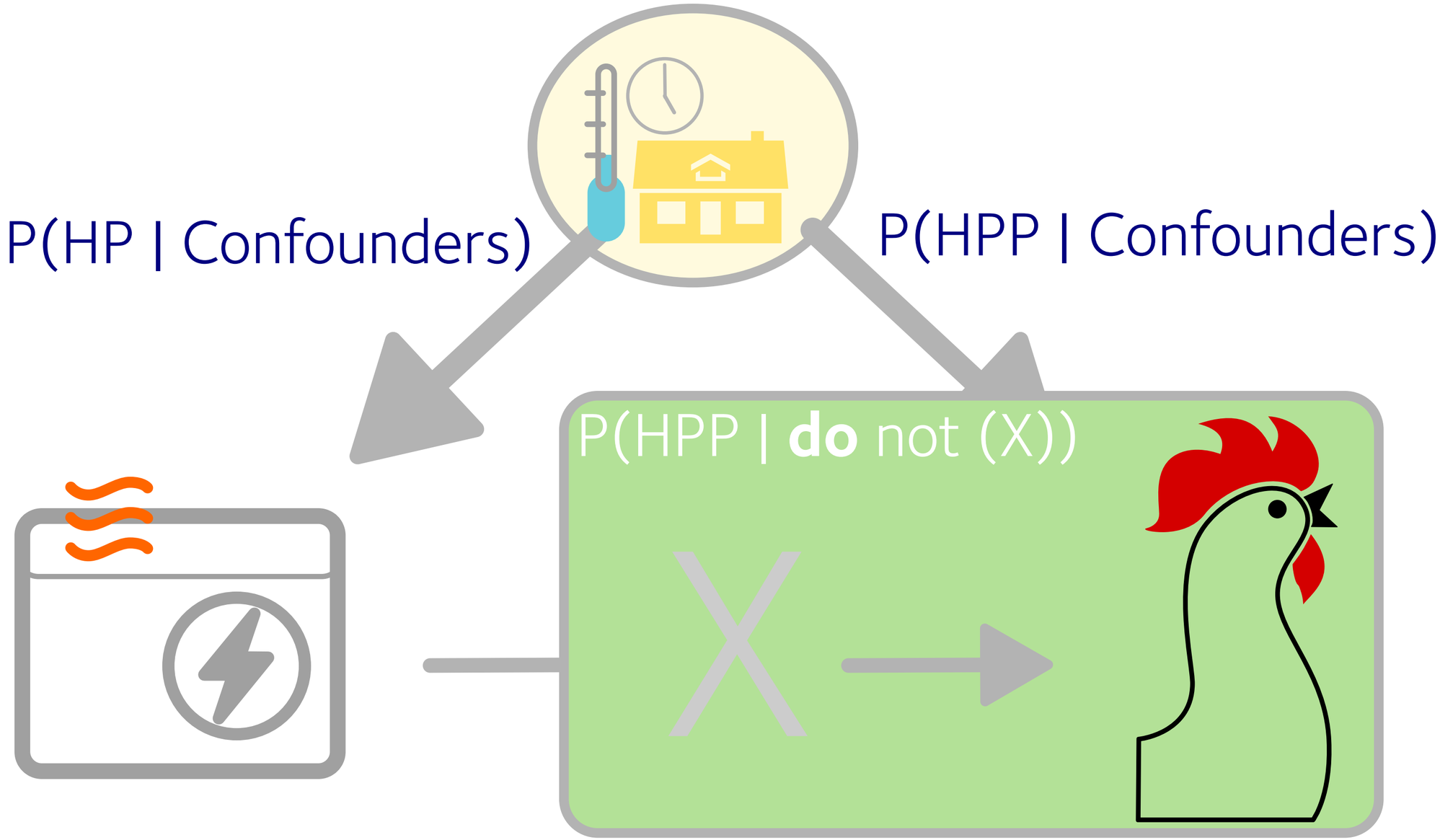
Keble College

Academic year 2022/2023

MSc in Energy Systems

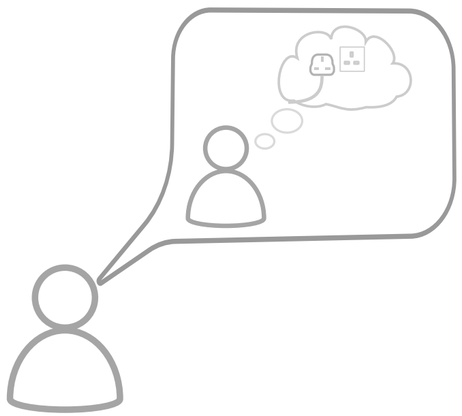
Dissertation by *Sofia Perelli-Rocco*

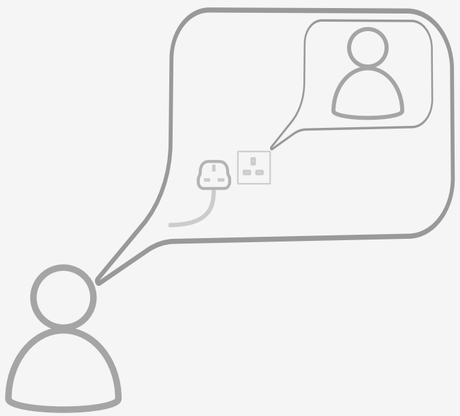
Big data: What improves heat pump performance?



Observation is not enough – make a change

	No data	Little data	Big data
Understanding Demand	What do **I think** people do	What do **peope** think they do	What does **data** say people do
Changing Demand	What **I think** people **would do**, if…	What **peope** think they **would** do, if…	What **data** says people **did do**, when…





No data: I think… demand falls when prices rise

oxford_uni

Dynamic pricing

noun

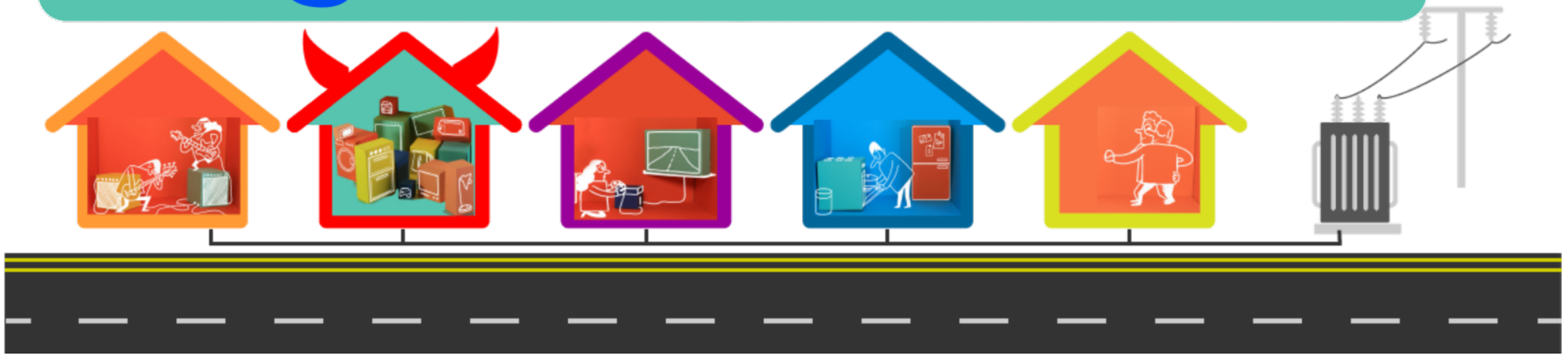
The practice of varying the price for a product or service to reflect changing market conditions; in particular, the charging of a higher price at a time of greater demand.

14.5K 127 1,287

oxford_uni NEW: Oxford University Press announce shortlist for... more

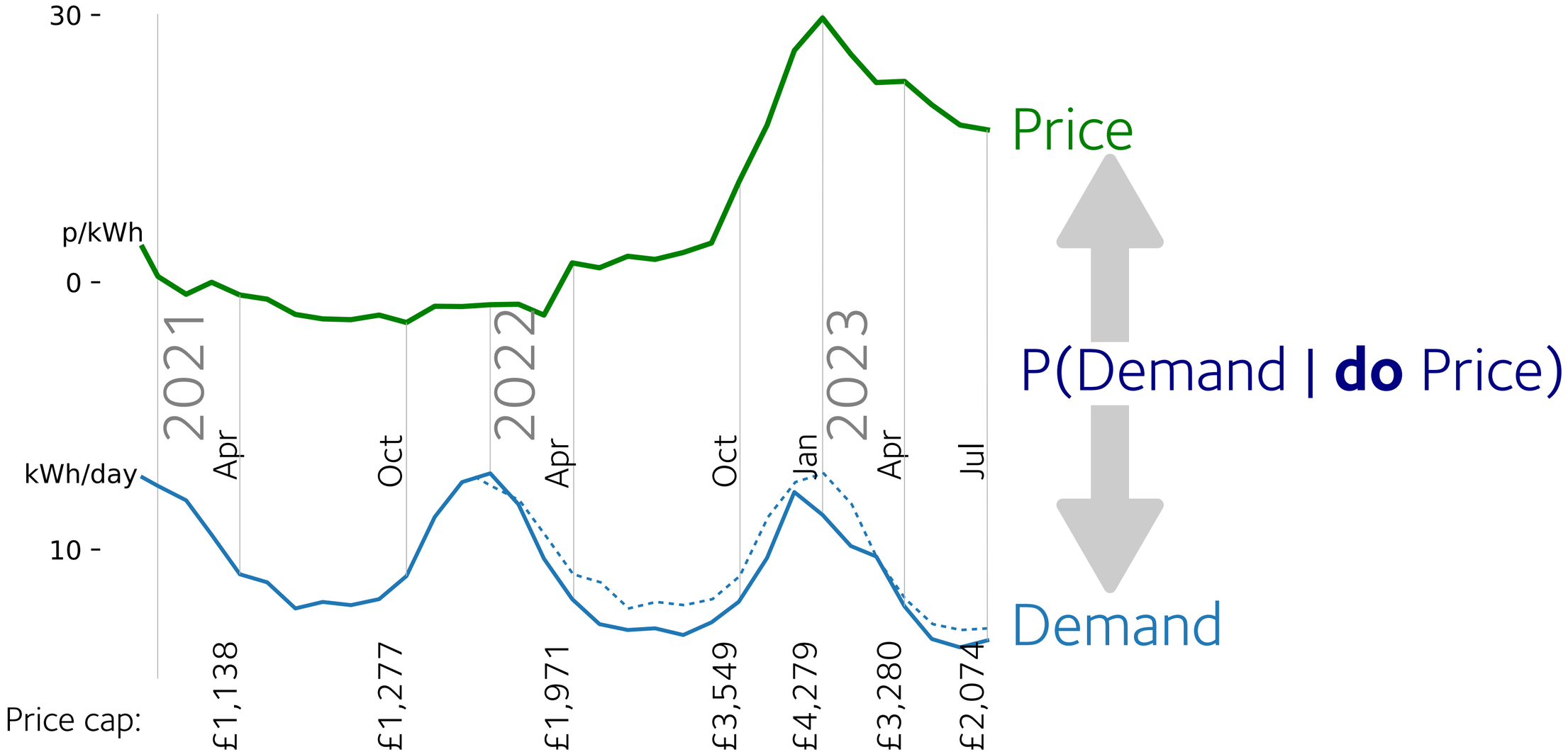
(c) Matt

Neighbours from Hell

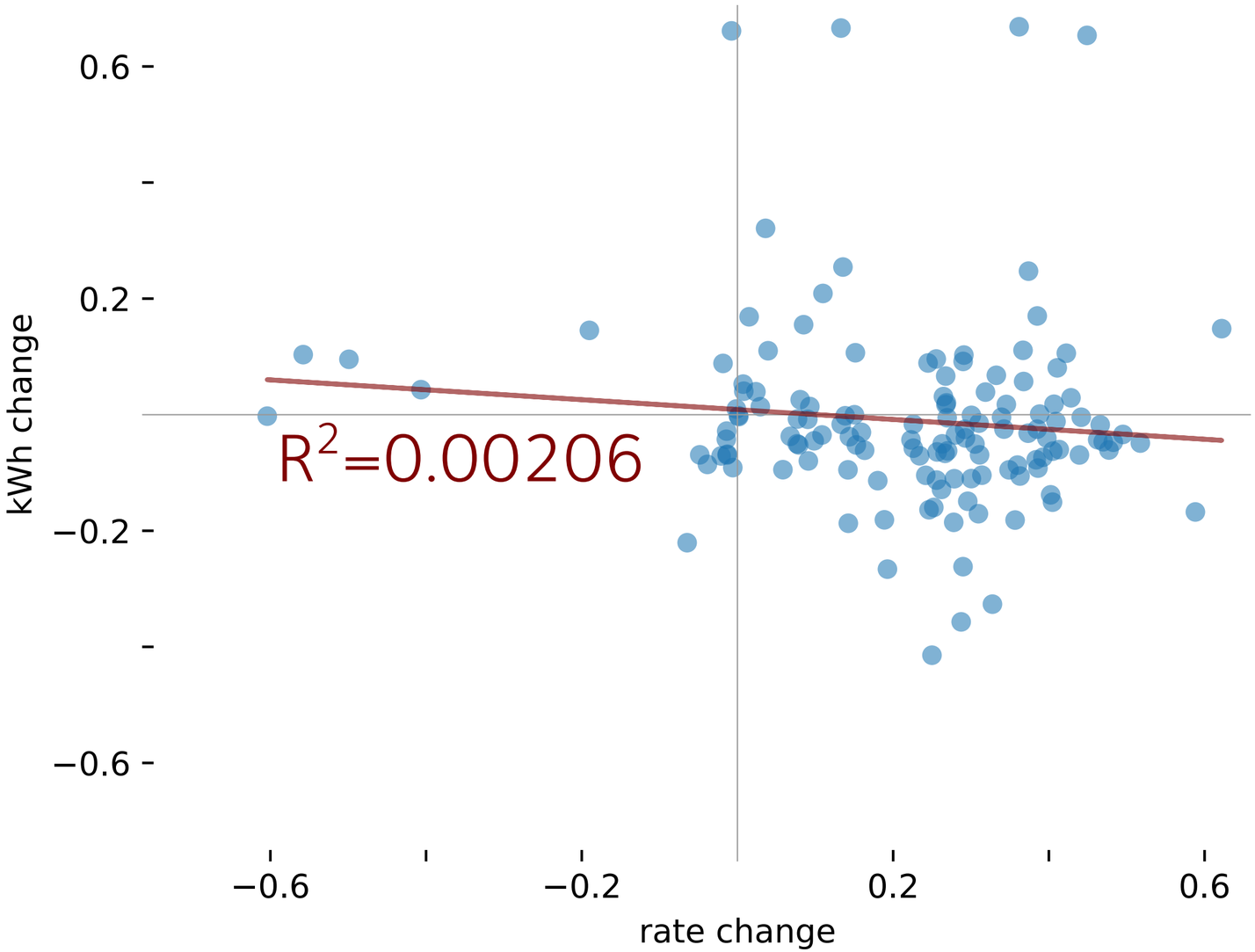


energy-use.org

Little data: demand falls when prices rise



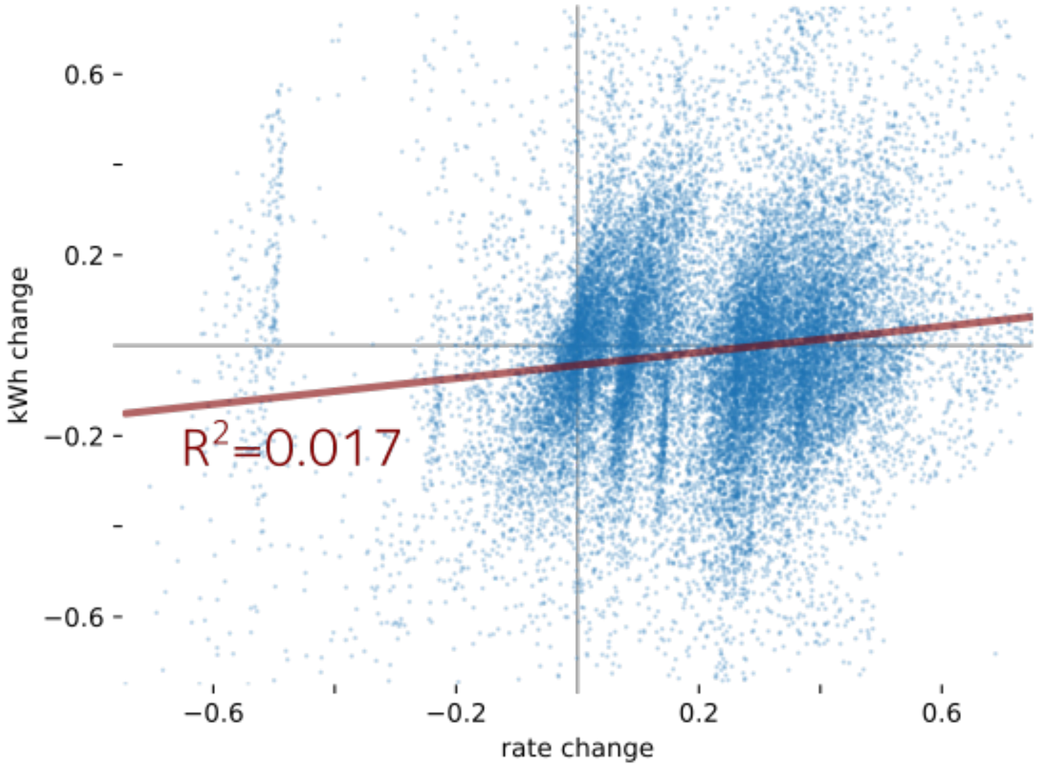
Medium data: negative price elasiticity?

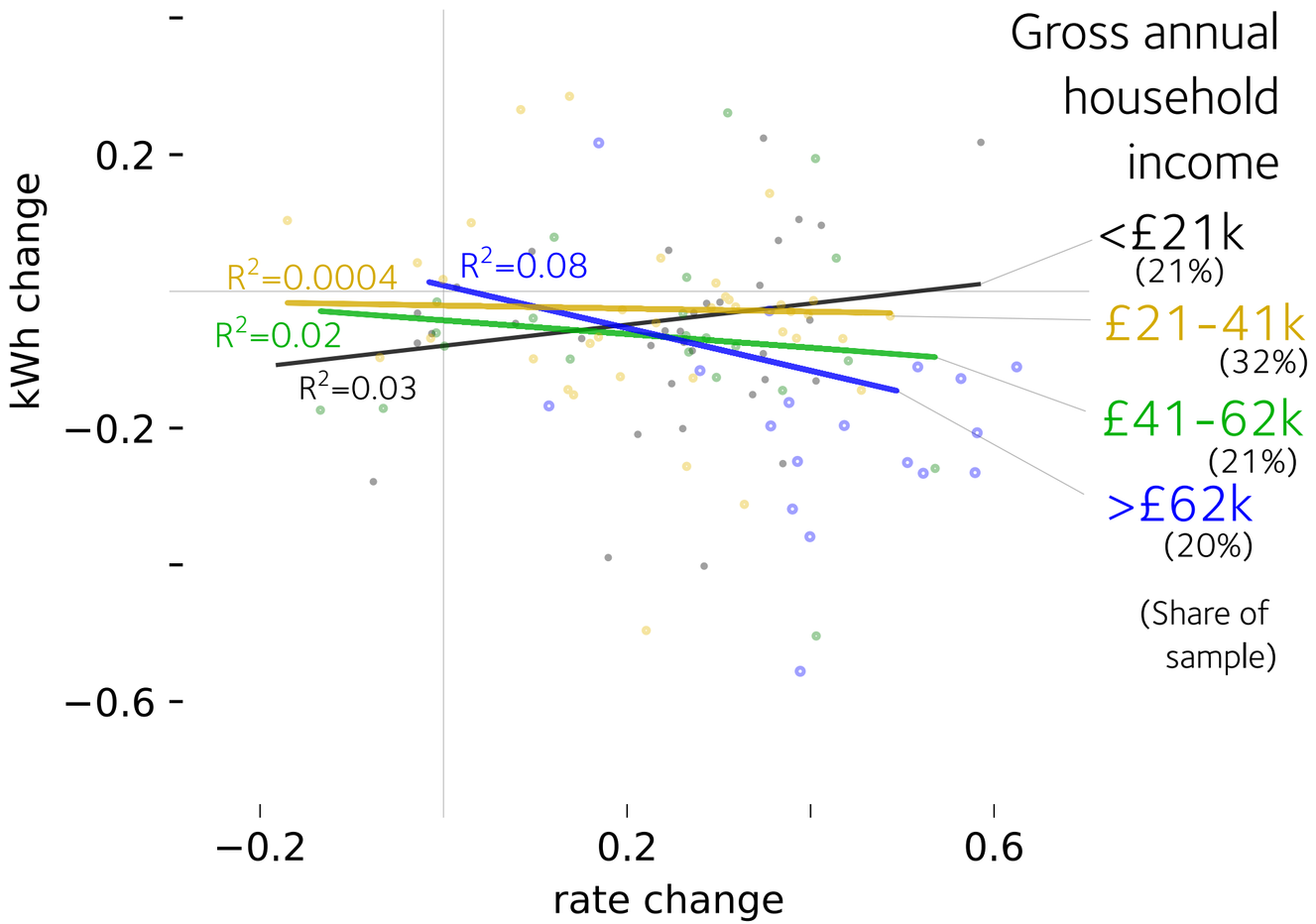


Jan 2022
vs.
Jan 2023

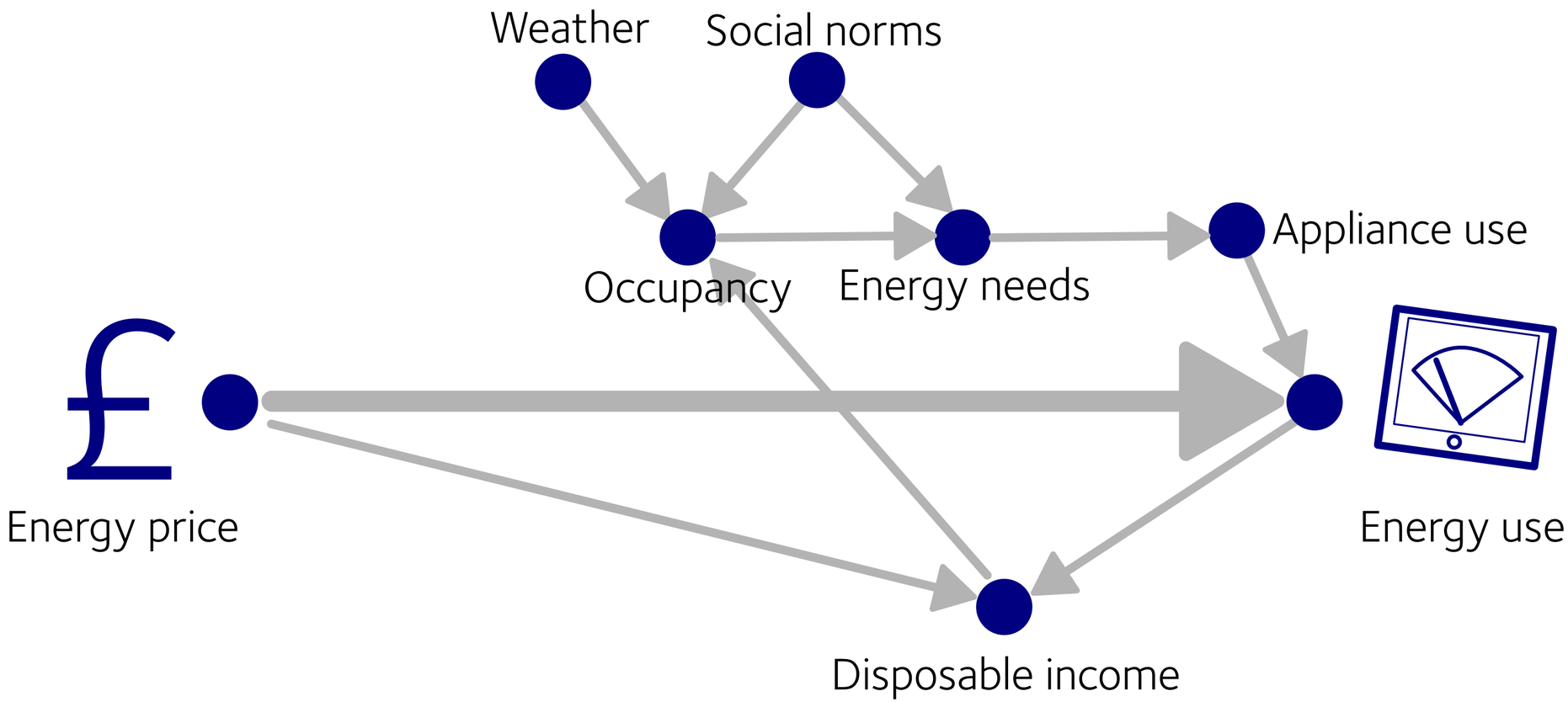
Big data: … it depends

Price elasticity is weak and depends on circumstances





Causal model: What **causes** energy demand to change?

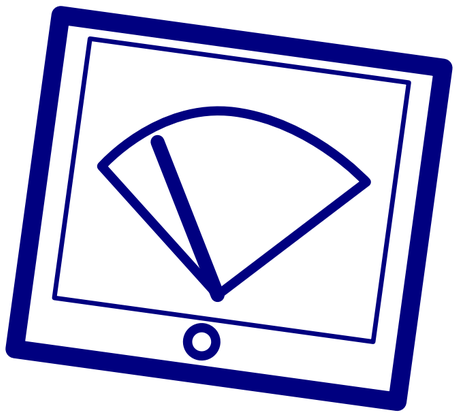


No data: I think… people will never give up dinner for DSR

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

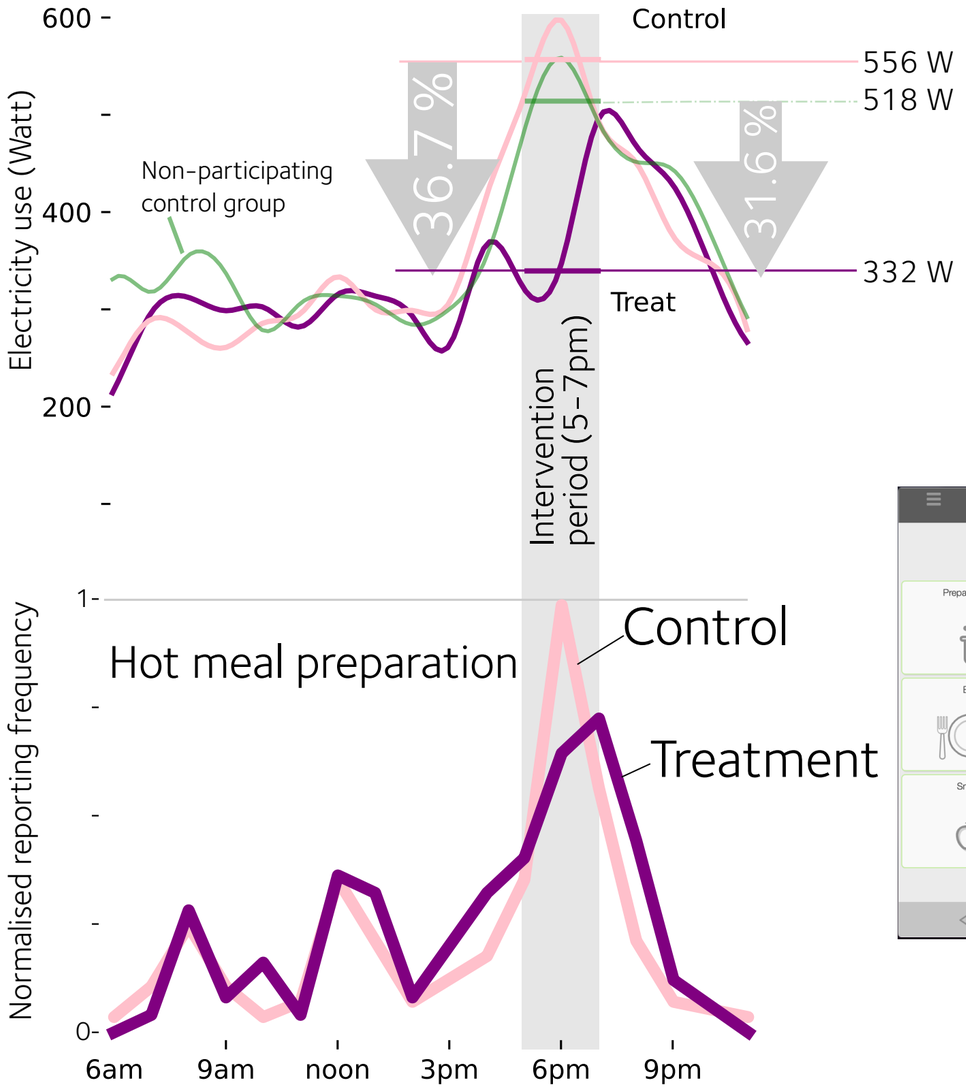
P(E | Life)

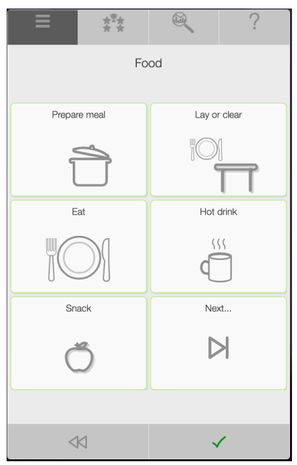
P(E | Life + **do** (Ask))

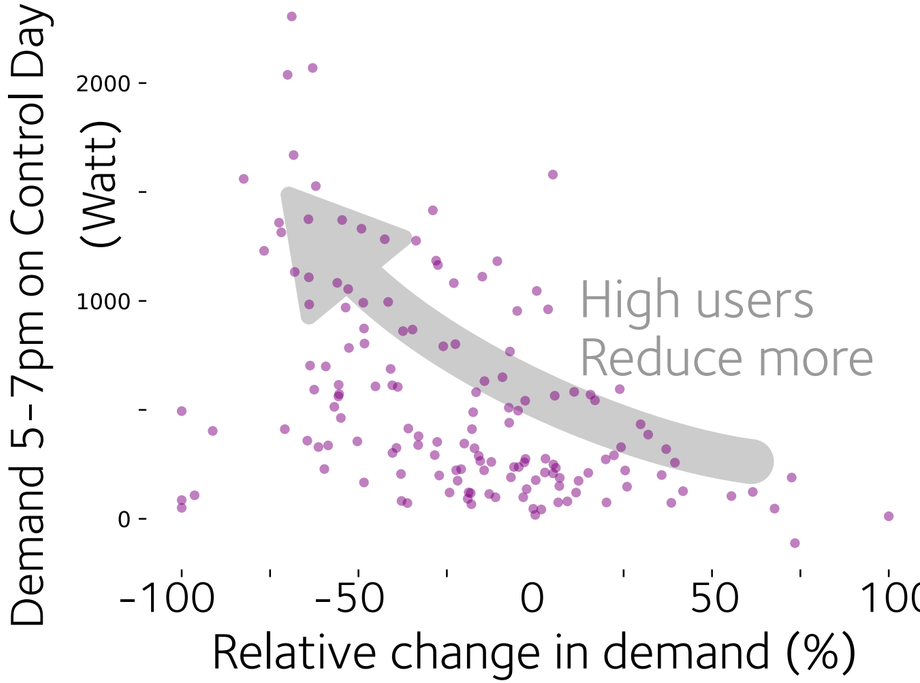


Little Data: Control and intervention:

Responses are significant, repeatable and effective



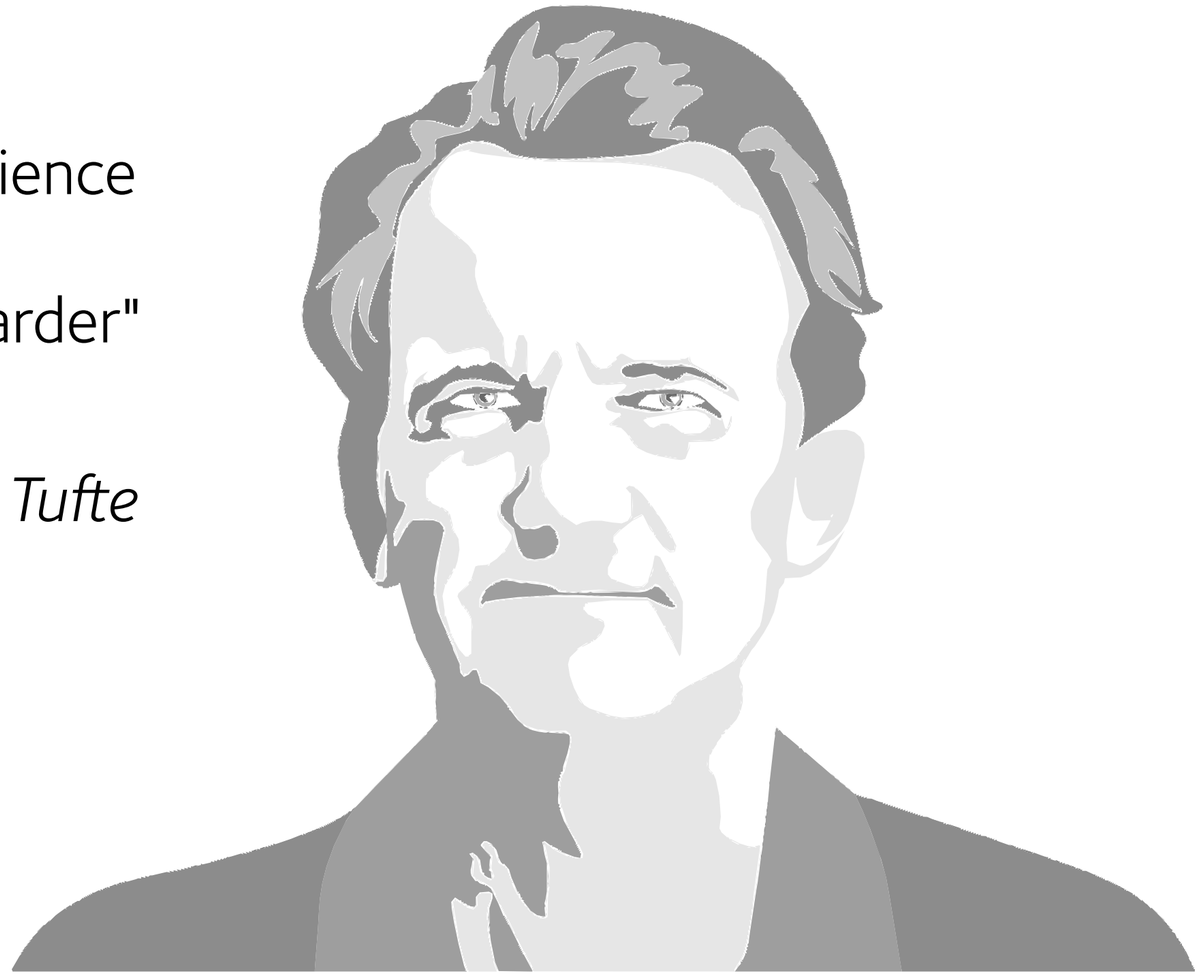




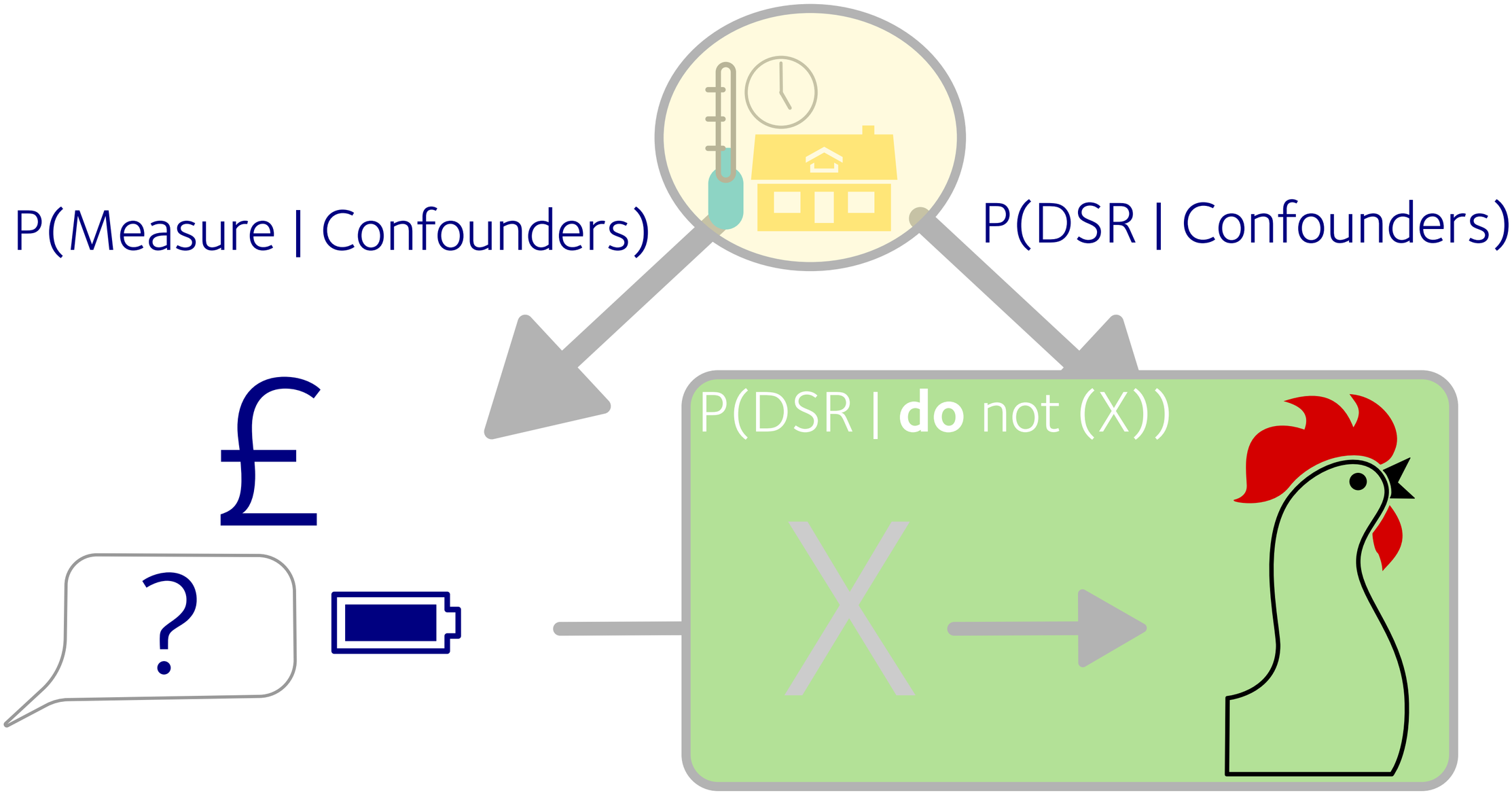
"Understanding human behaviour isn't rocket science

– it's harder"

Edward Tufte



Big data: Who/what delivers demand side responses?



Energy Demand Observatory and Laboratory and Forensics

Engineering and Physical Sciences Research Council

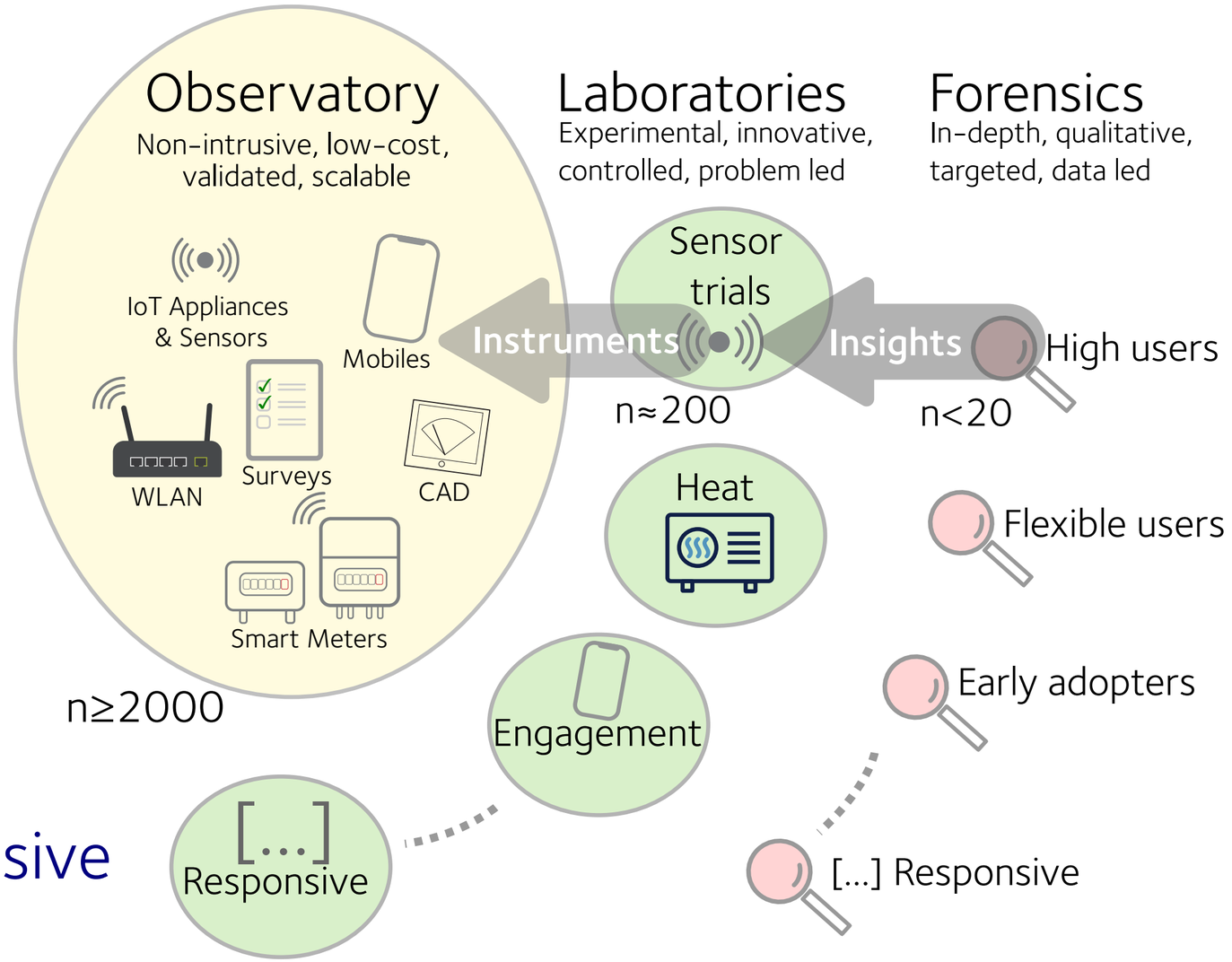
School of Geography and the Environment

Department of Engineering Science

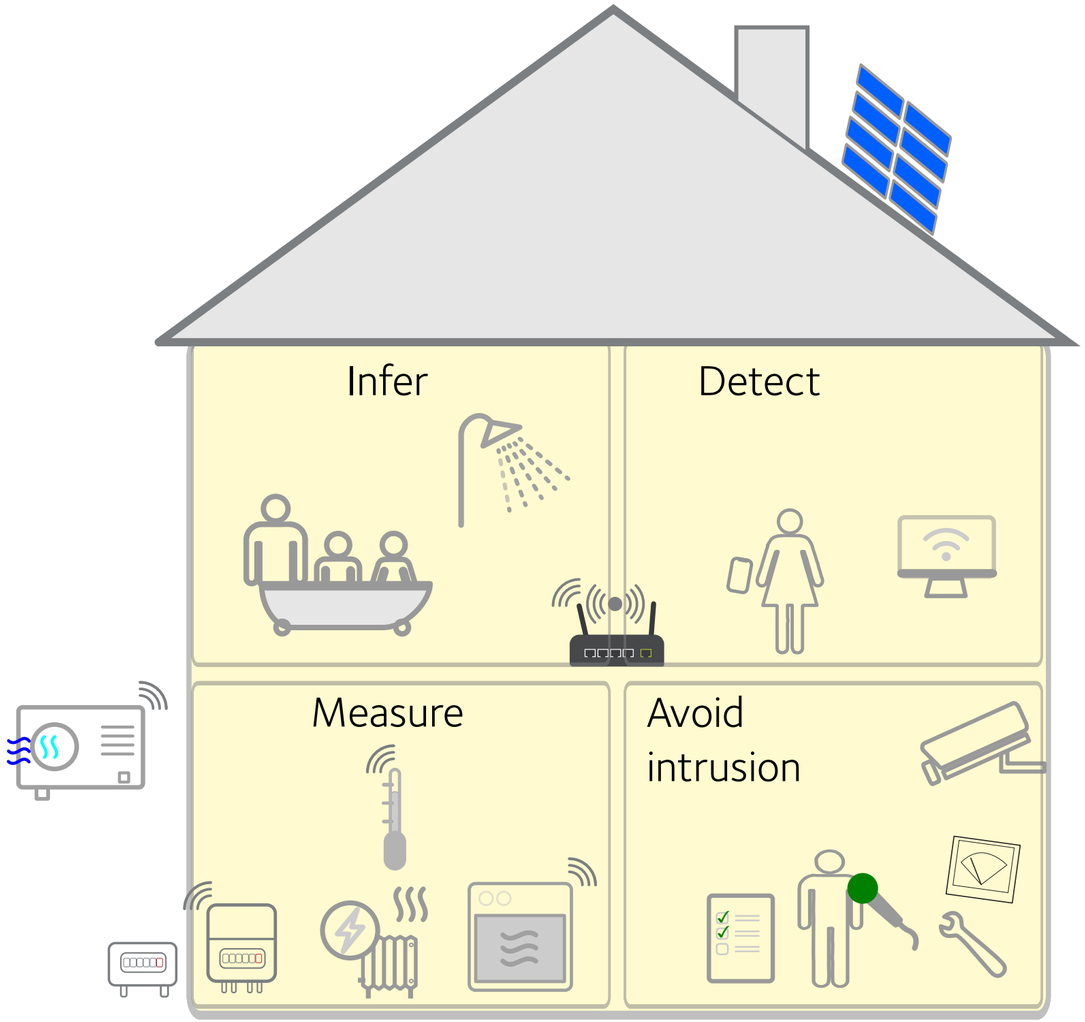
University of Oxford

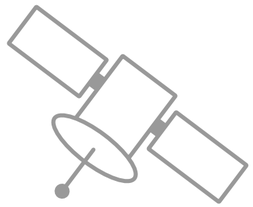
UCL The Bartlett

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



edol Observatory



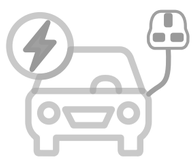


Key development steps

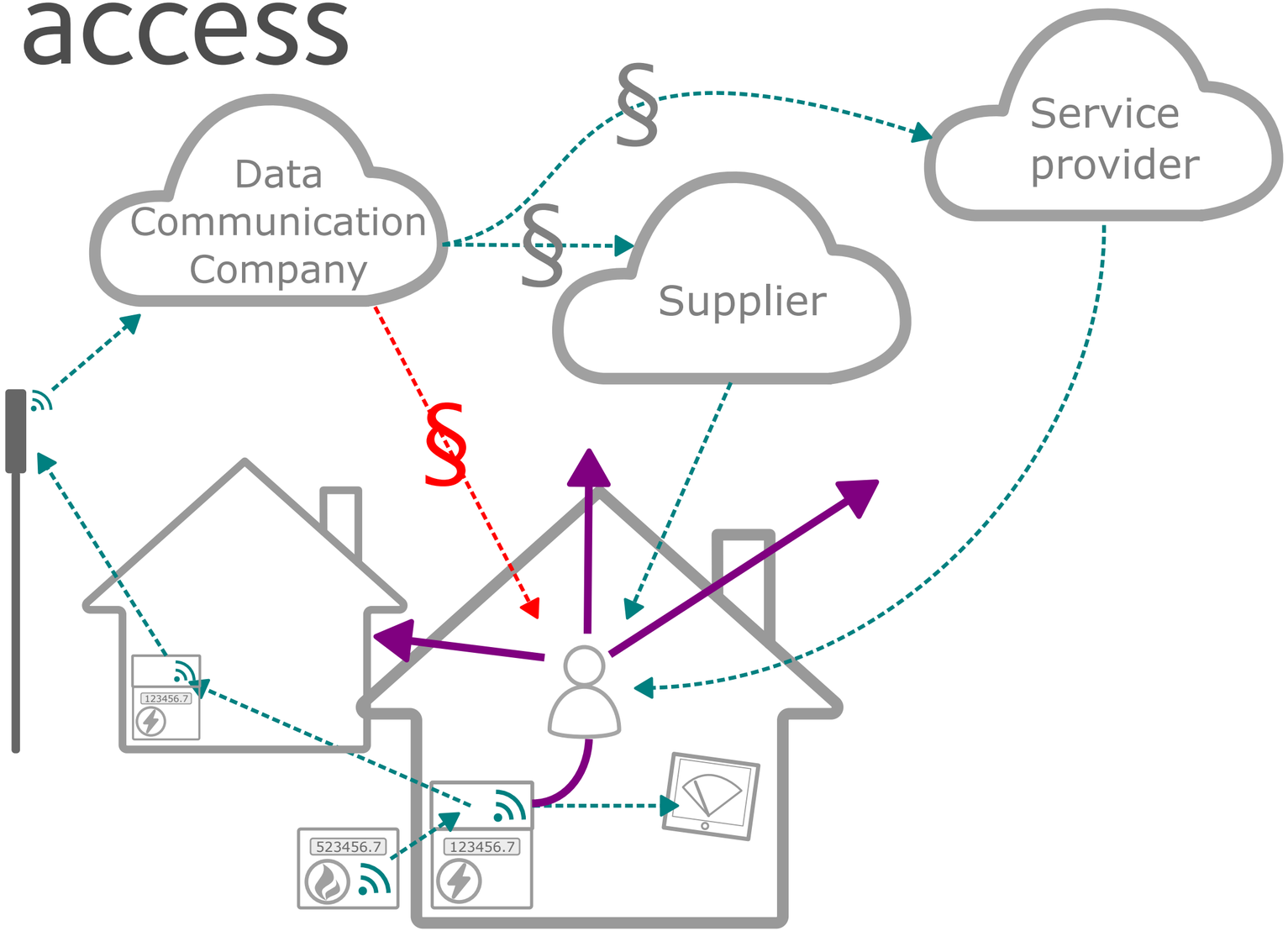
1) Identify and validate technology options

2) Minimise the need for hardware and intrusion

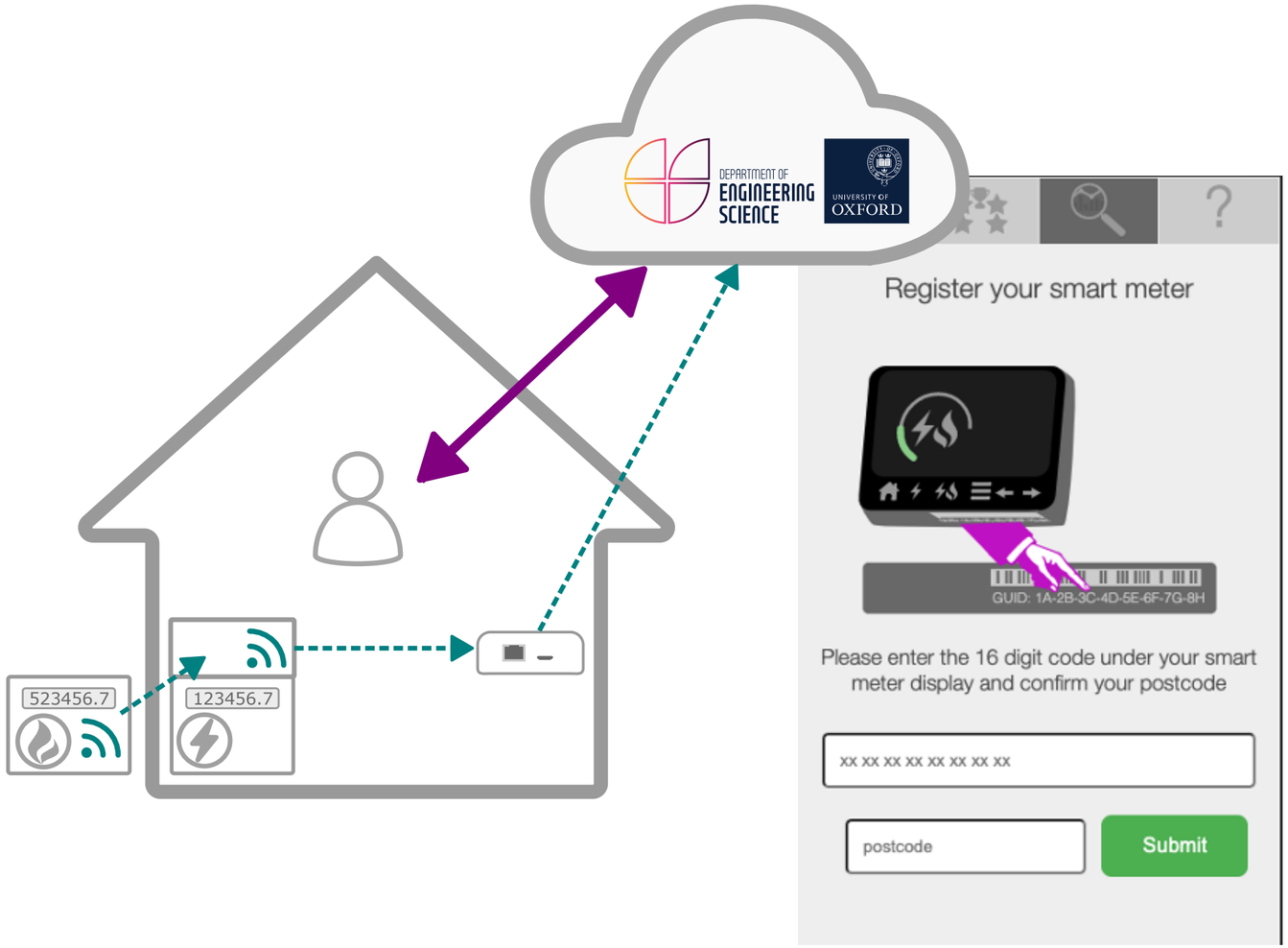
3) Use accessible sources of data



Data access


Data
Communication
Company
Service
provider
Supplier
§
§
§
123456.7
523456.7
123456.7

Data access



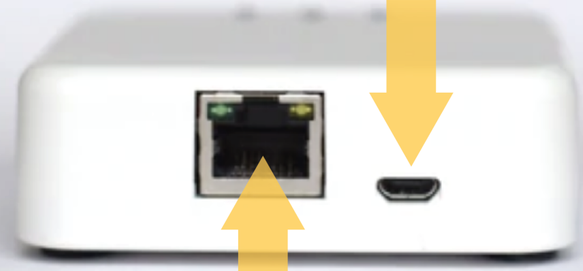
GLOW

ReNEW

UNIVERSITY OF OXFORD

Your Smart Meter Access Device

1 Connect the USB cable to power

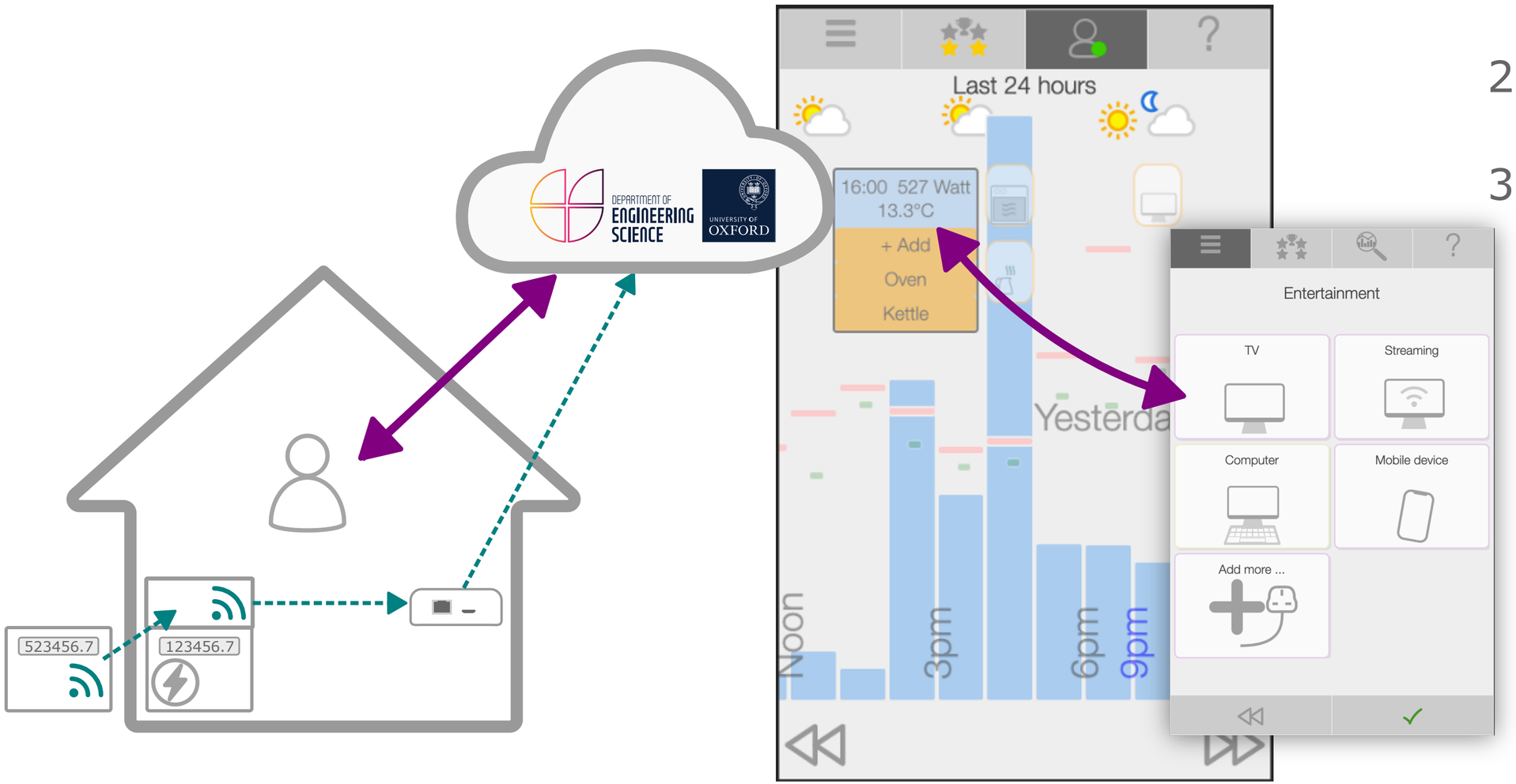


2 Connect the Ethernet cable to your router

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

Learning (two ways)



Phases

1) You tell us

   training

2) Verify suggestions

   reinforcement learning

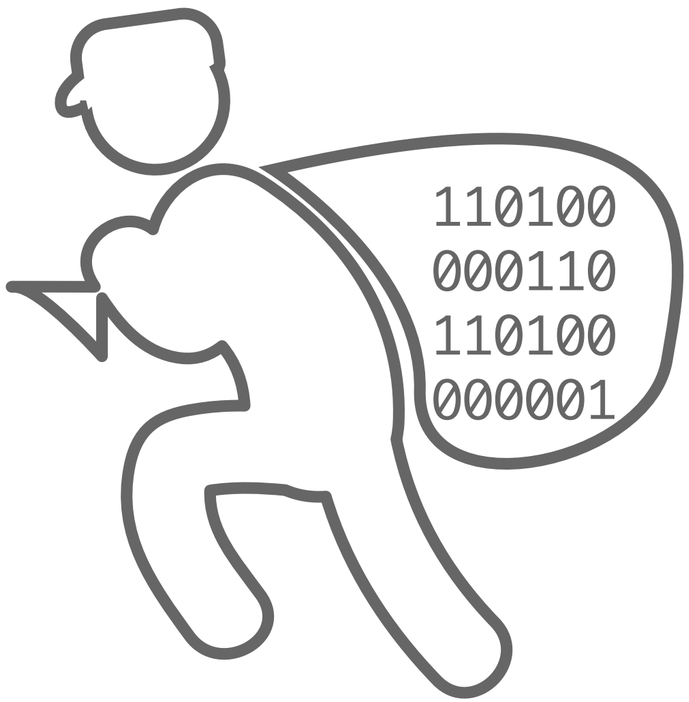
3) Feedback

   - Timely
   - Accurate
   - Actionable

   Personal Messages

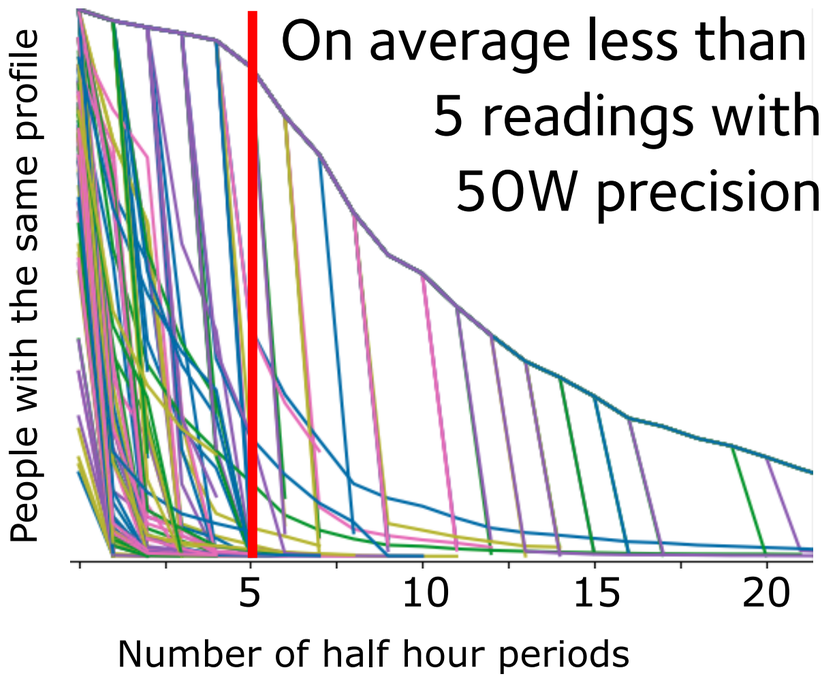
Privacy

It is unclear what is sensitive and why

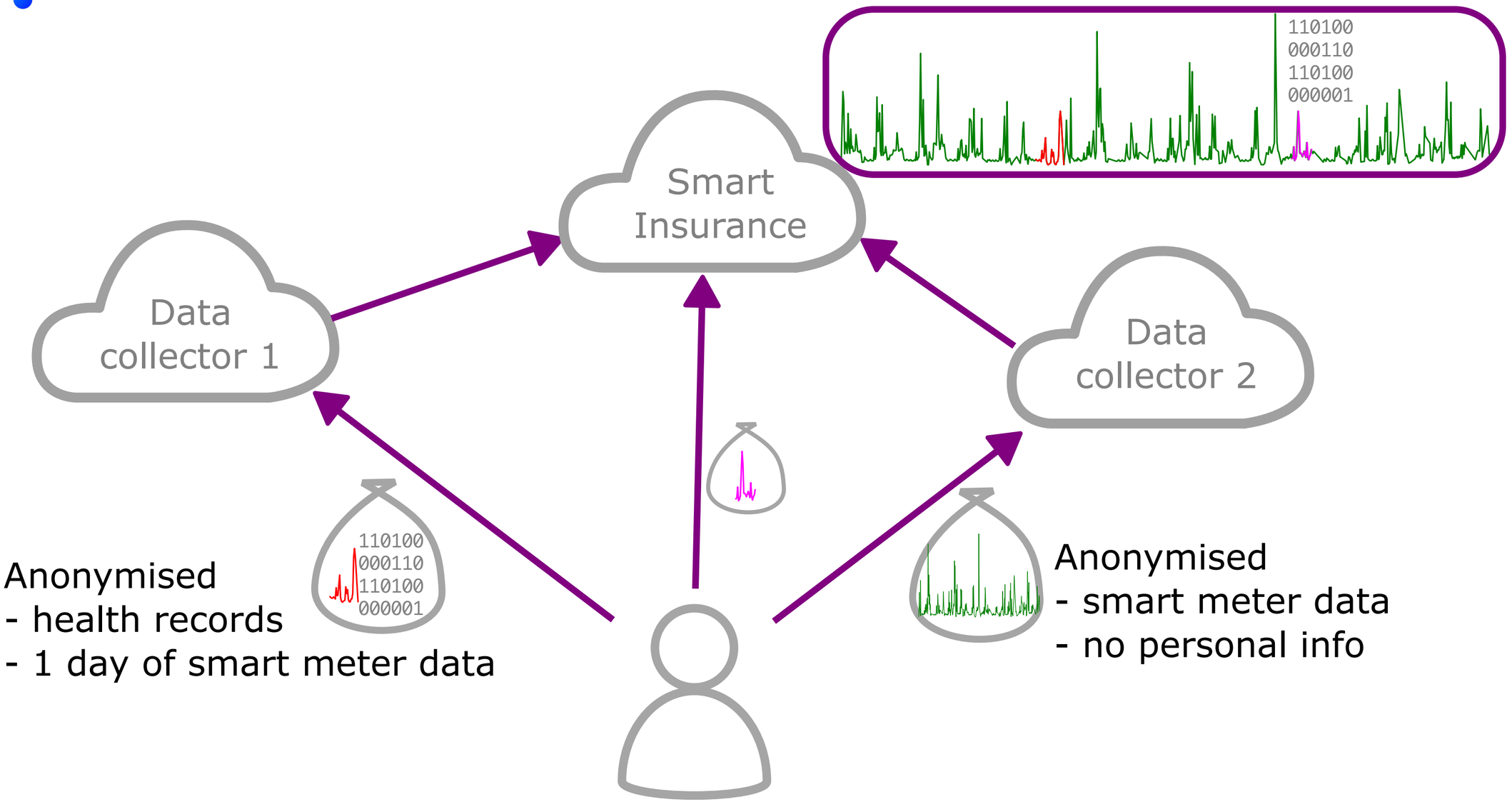


Energy use?	EPCs are public
Occupancy?	Lights and windows are visible to all
Privacy?	Spying spouses
Practices?	Profiles reveal faith
Identity?	How unique is the data

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

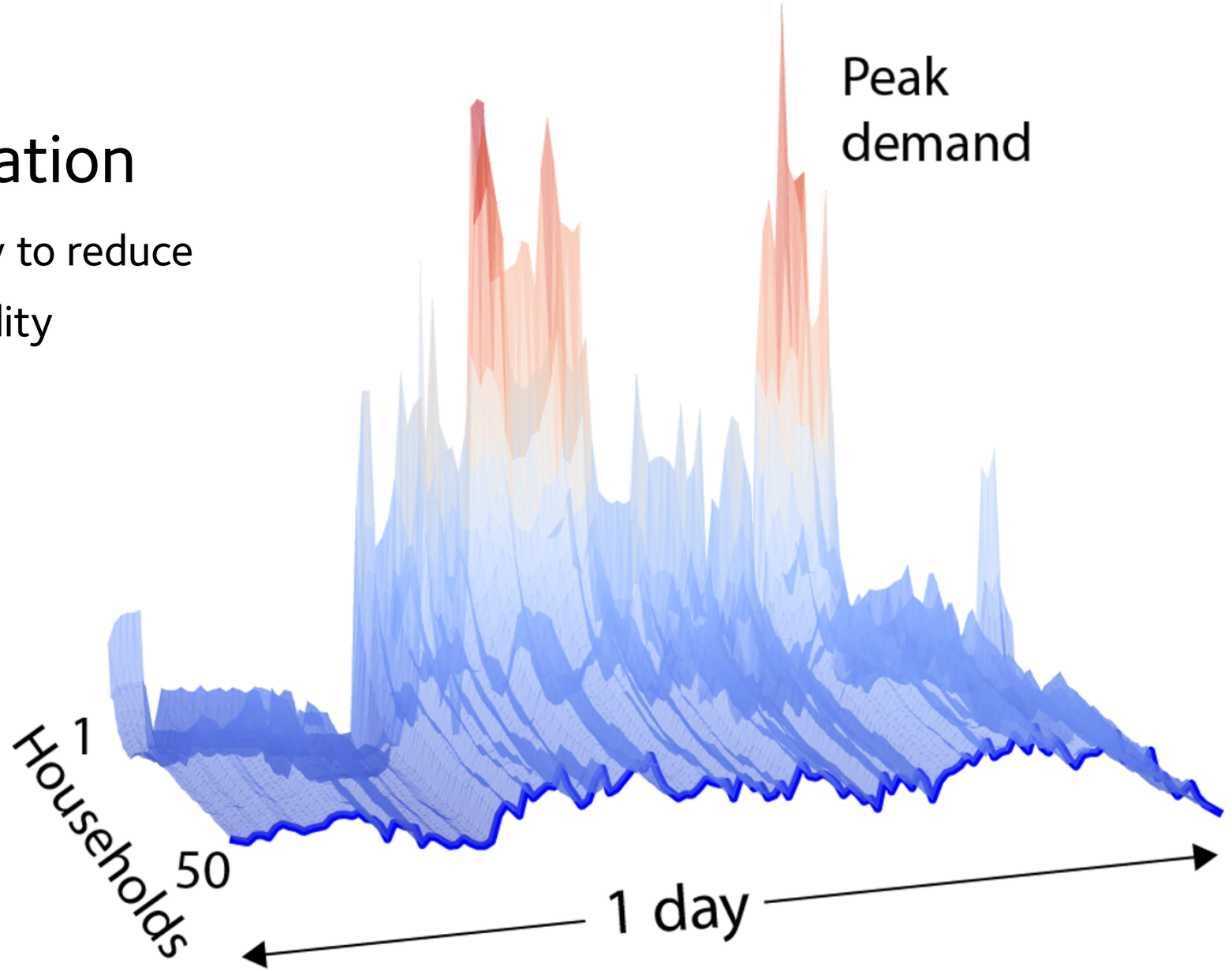
Approaches

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

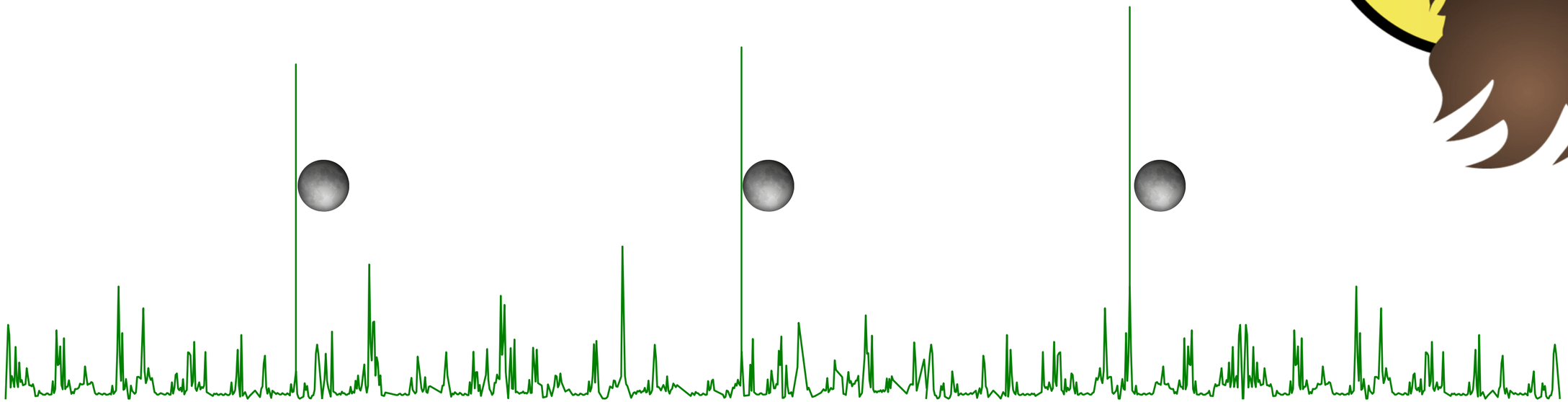
Aggregation

an easy way to reduce

- identifiability
- utility



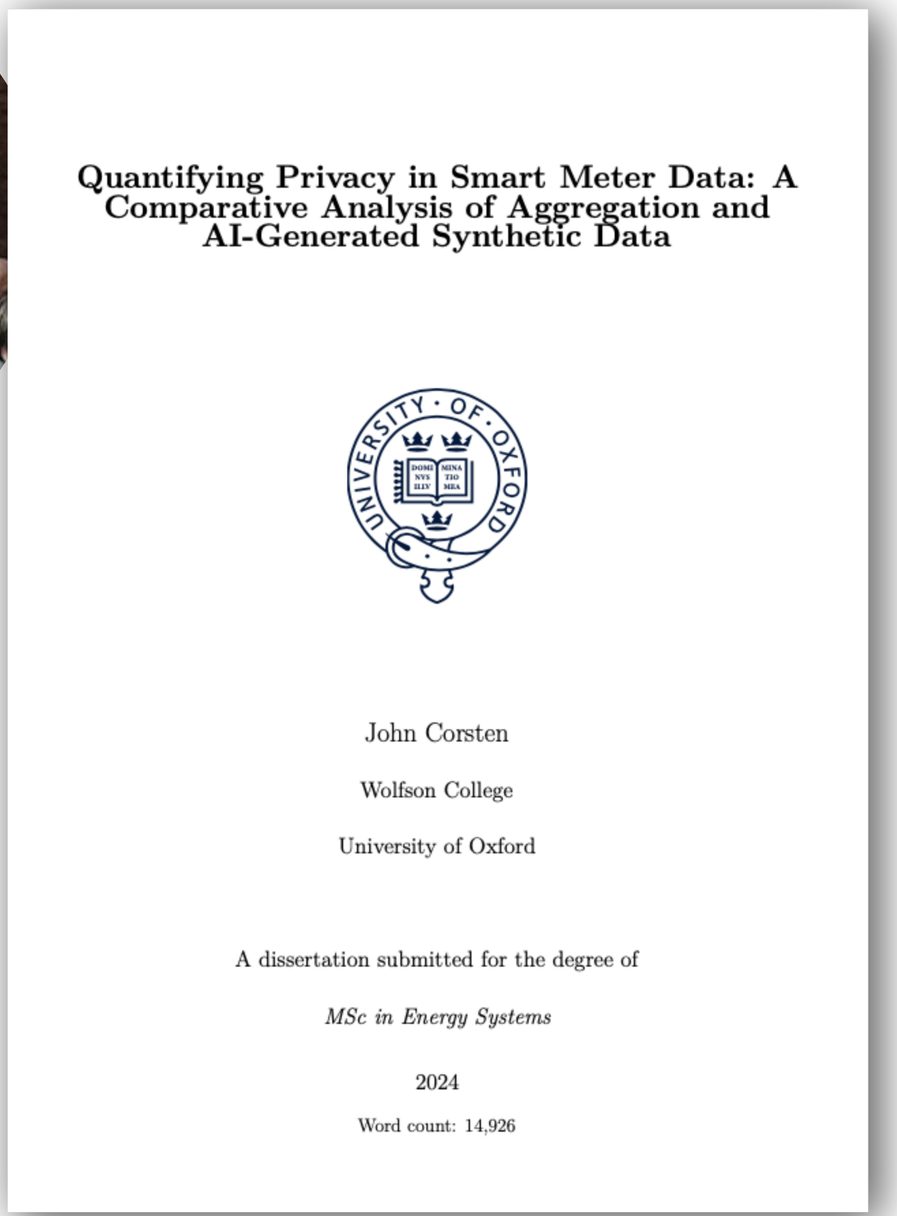
A werewolf wishes for their identity to be protected. Would aggregation help?



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

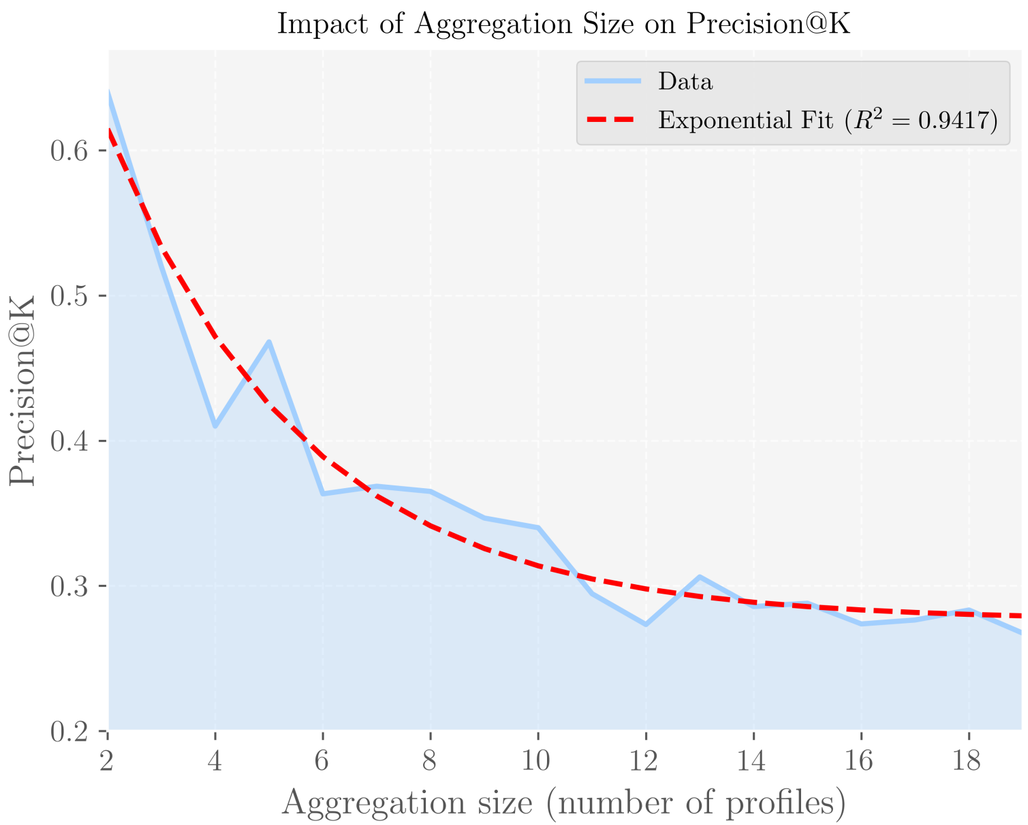
MSc in Energy Systems

2024

Word count: 14,926

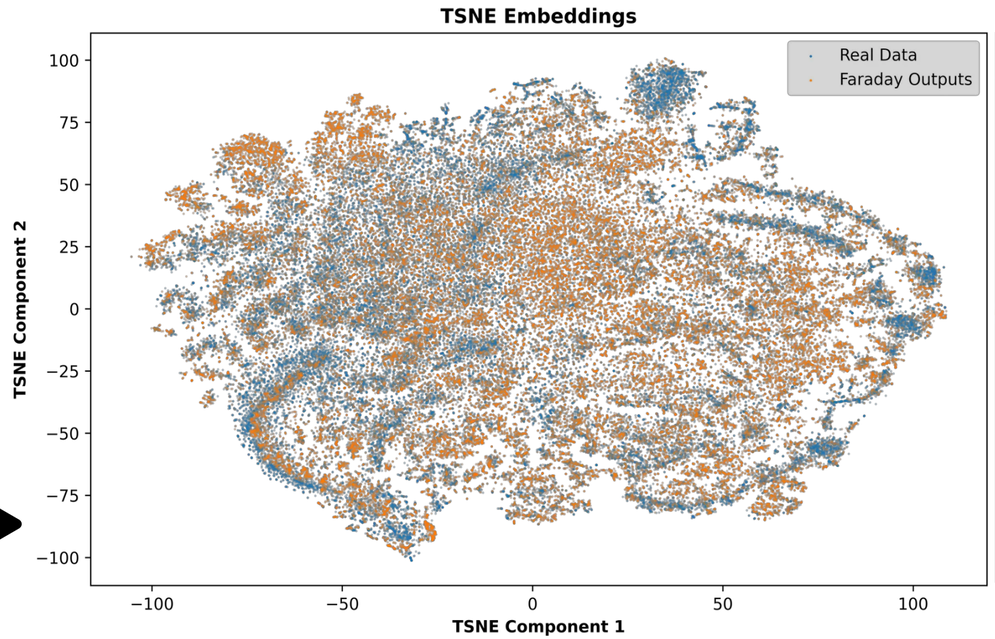
What are the chances that a random profile can be correctly identified as member of the training data?

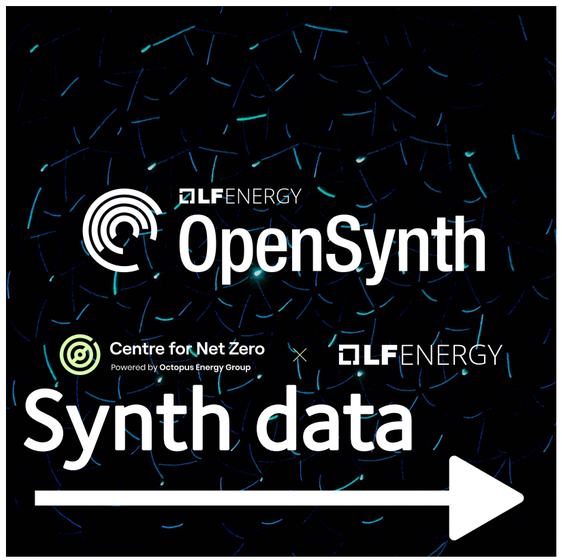
Random forest membership inference attack



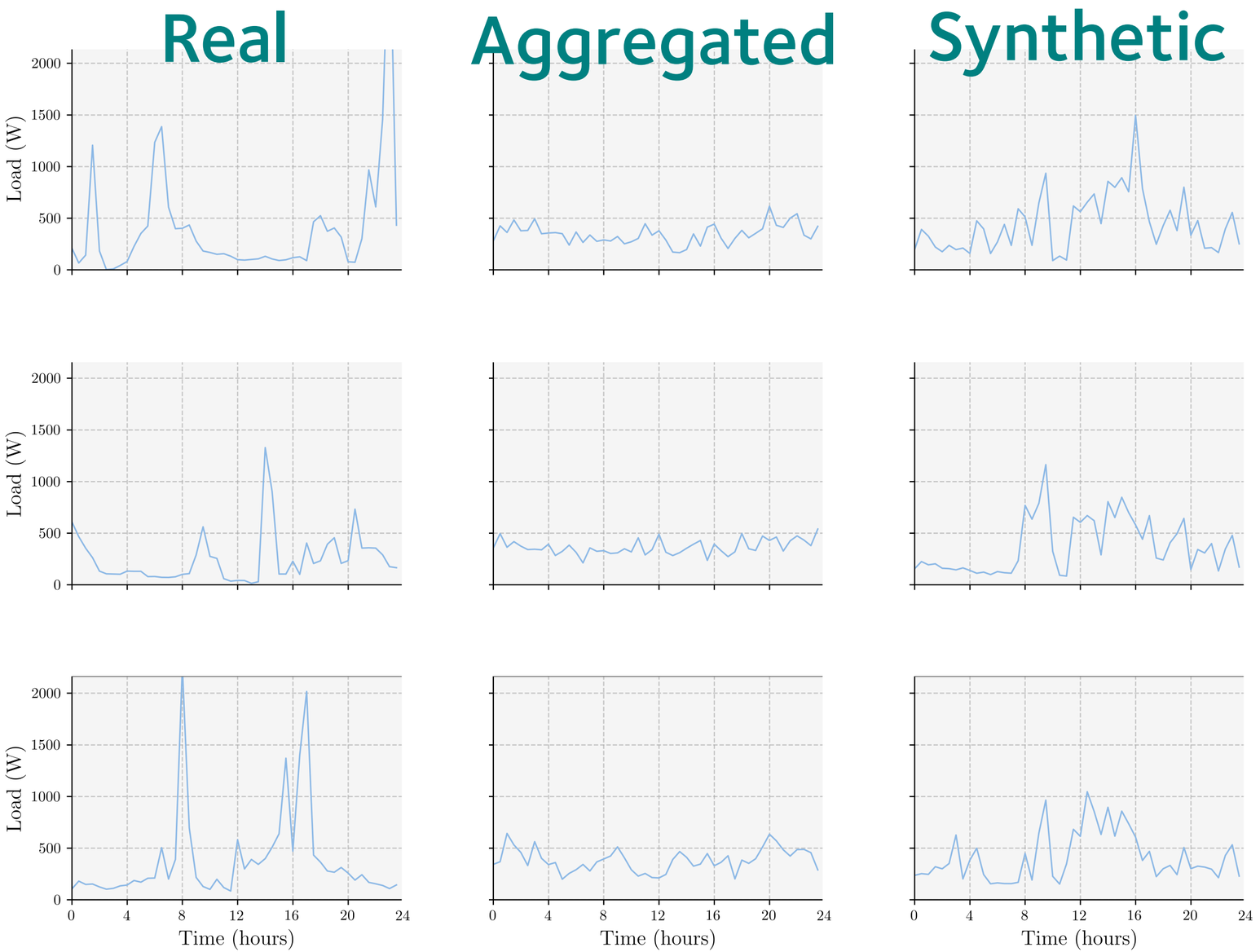
octopus energy

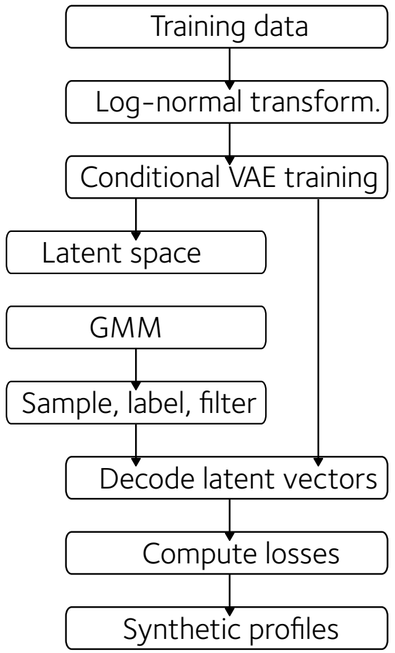
Real data



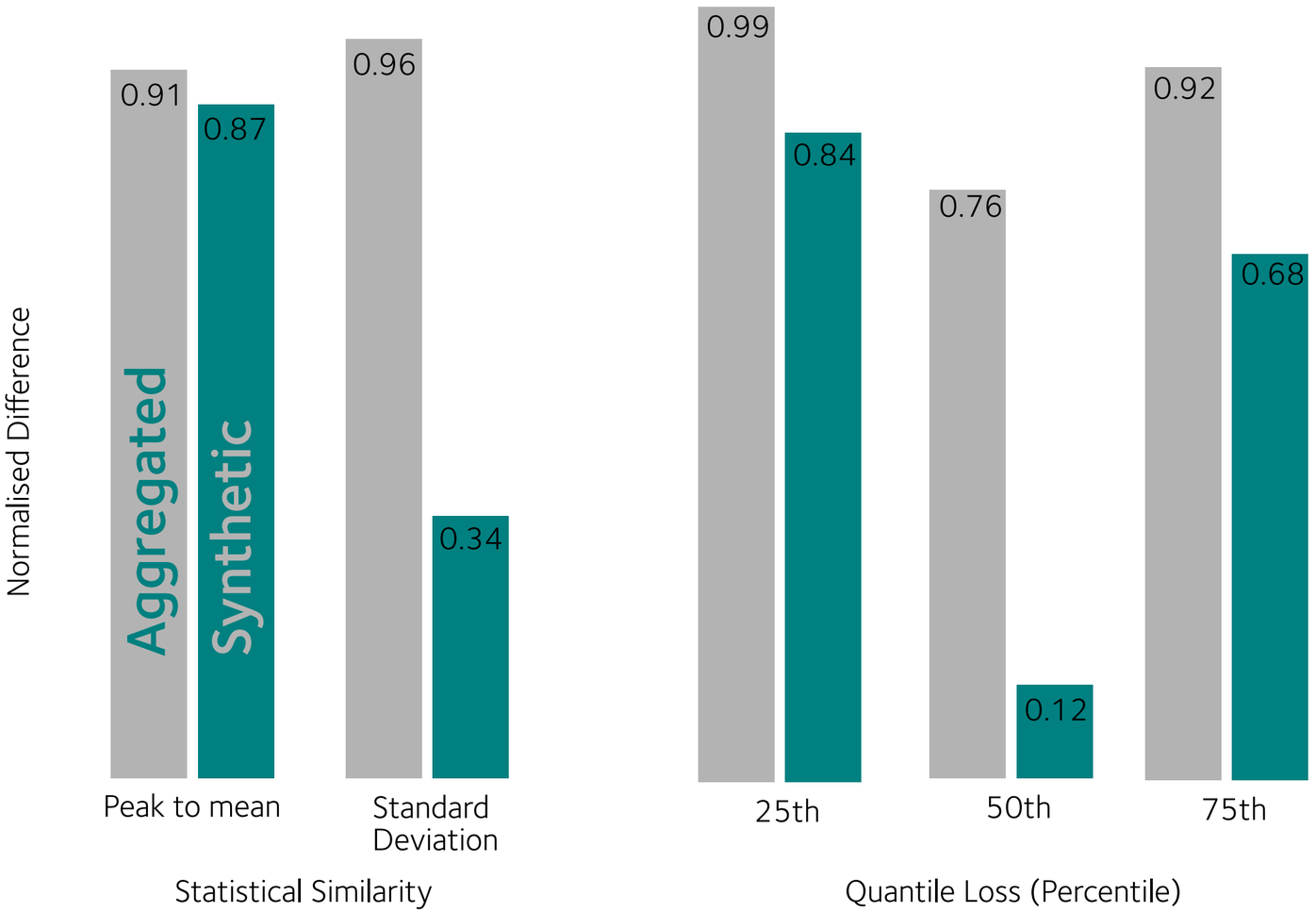


OpenSynth-energy/OpenSynth

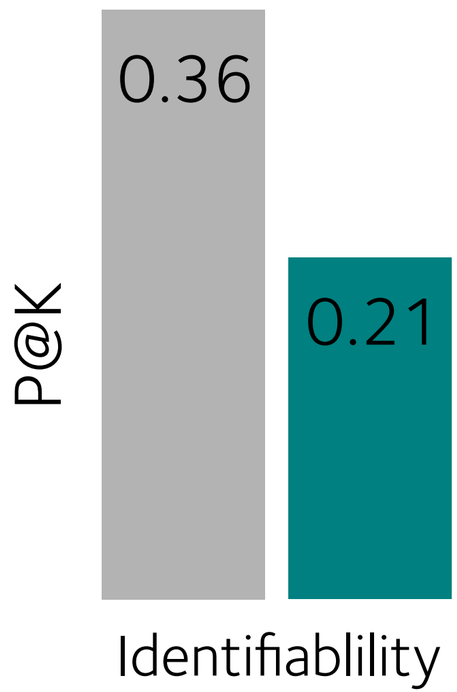

Real
Aggregated
Synthetic
Load (W)
0
500
1000
1500
2000
0
4
8
12
16
20
24
Time (hours)


Training data
Log-normal transform.
Conditional VAE training
Latent space
GMM
Sample, label, filter
Decode latent vectors
Compute losses
Synthetic profiles

Utility



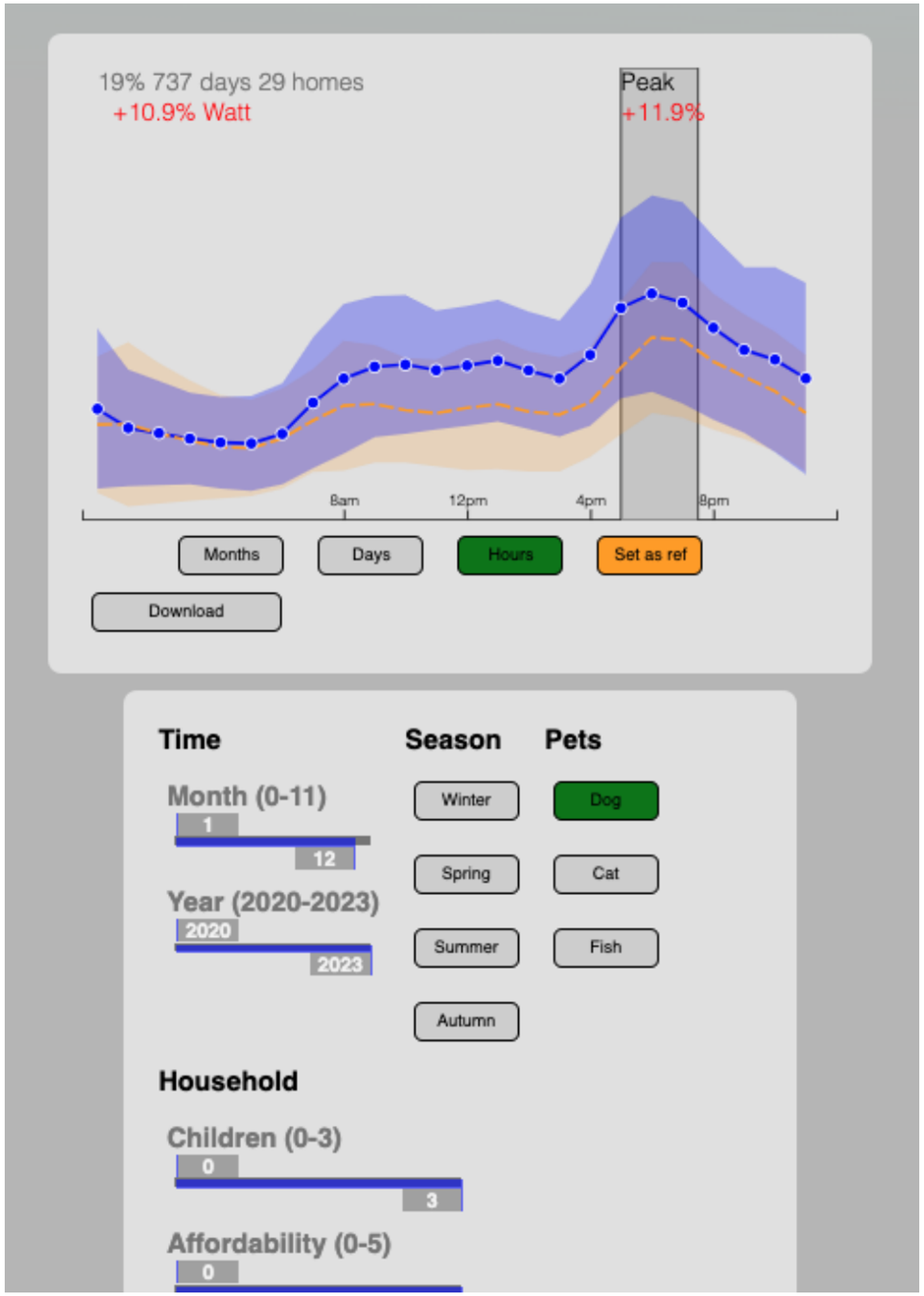
Privacy



Thank you

philipp.grunewald@eng.ox.ac.uk

Engineering and Physical Sciences Research Council

Power explorer:

energy-use.org/data