Mitigating practical and ethical issues in sensor-based real world studies

Ben Bedwell
University of Nottingham

Colley et al. (2013) **Exploring Reactions to Widespread Energy Monitoring**, Proceedings of 14th IFIP TC 13 International Conference on Human Computer Interaction

Q. Can a day long personal energy footprint be tracked, made legible, and promote sustainable action?

C-AWARE

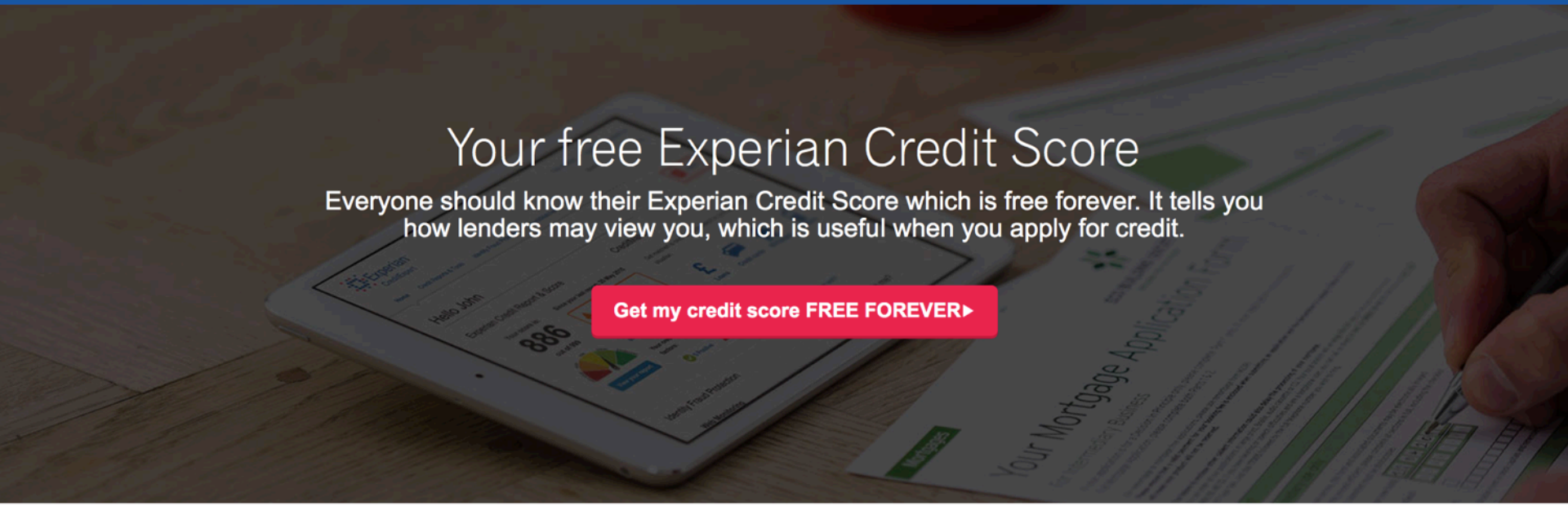
Experian

Already have an Experian account? **Log in**

Search...

Our Products | Credit Report & Score | Mortgages | Credit Cards | Loans | Identity Fraud | Blog

Home › CreditMatcher › Experian Credit Score



Your free Experian Credit Score

Everyone should know their Experian Credit Score which is free forever. It tells you how lenders may view you, which is useful when you apply for credit.

Get my credit score FREE FOREVER▸

What is a credit score?

Whenever you apply for credit, the lender will check your borrowing history and how you typically repay money you've borrowed. This happens when you apply for credit such as a loan, credit card, mortgage, car finance…even a mobile phone contract.

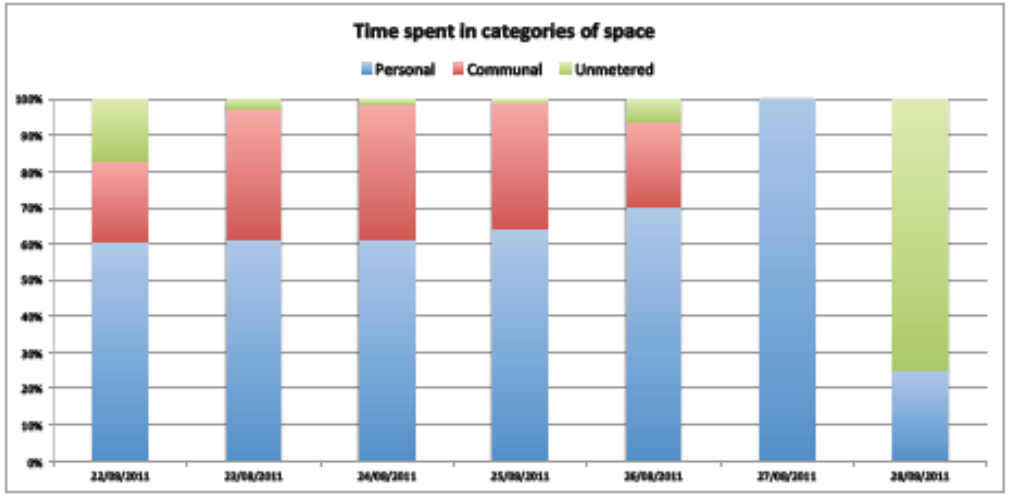
They'll look at your credit history which is based on your credit report and will show things like if you have a mortgage, how much you owe on credit cards and if you've missed payments in the past.

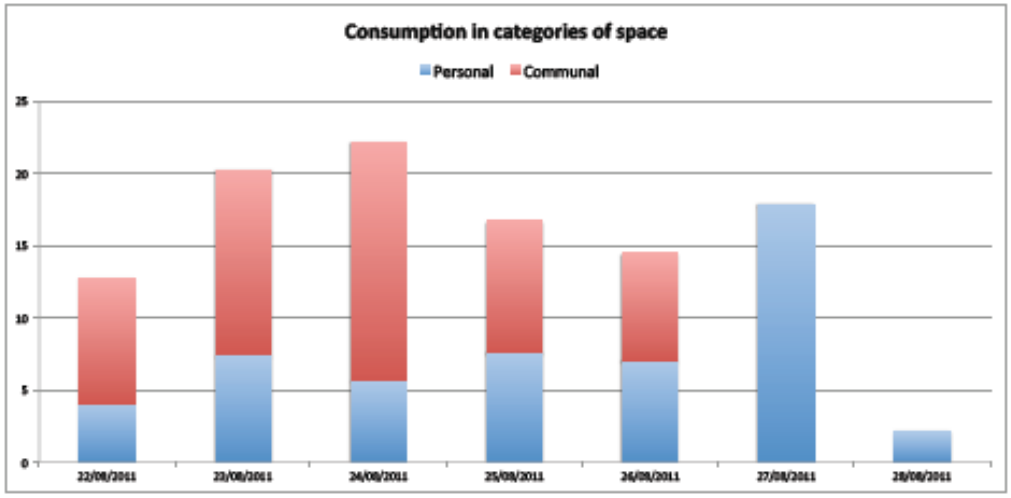
This is combined with the other information you fill in on the credit application form, and past information they've got on you (for

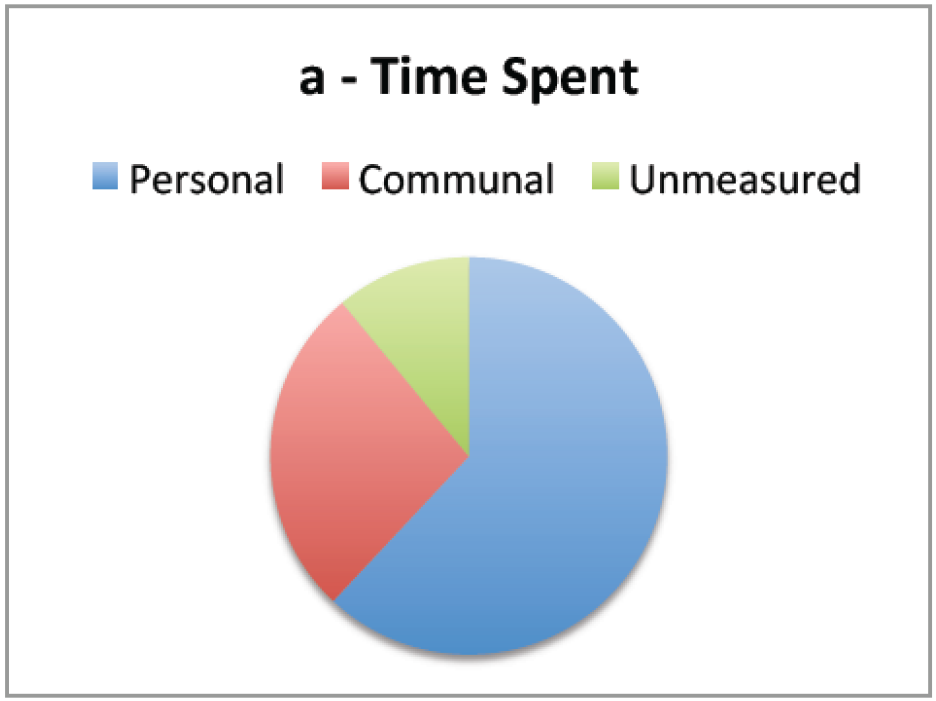
Study

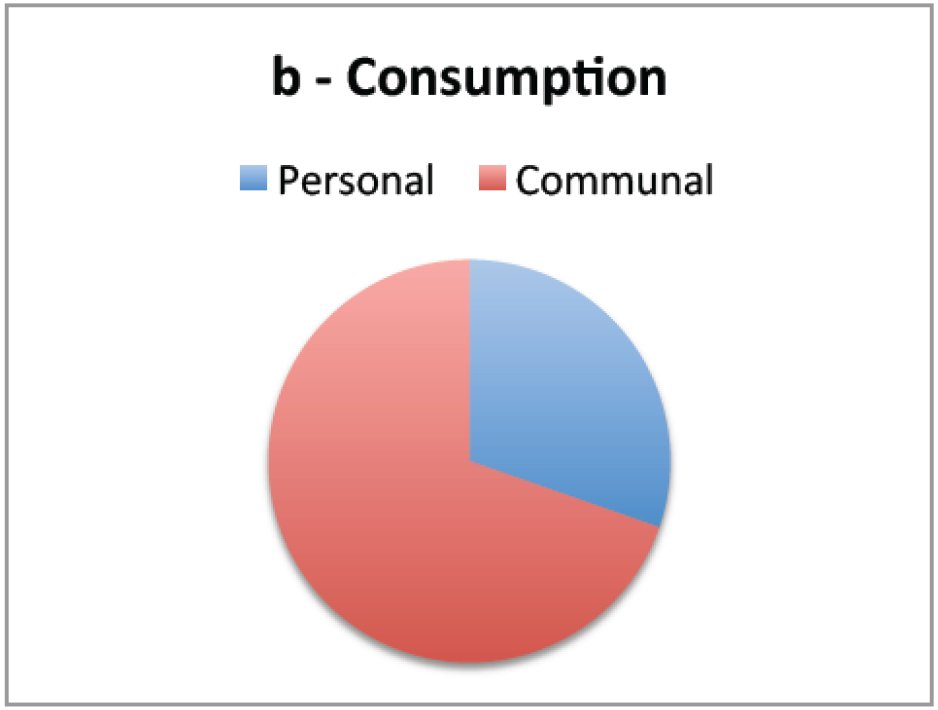
Technology probe methodology

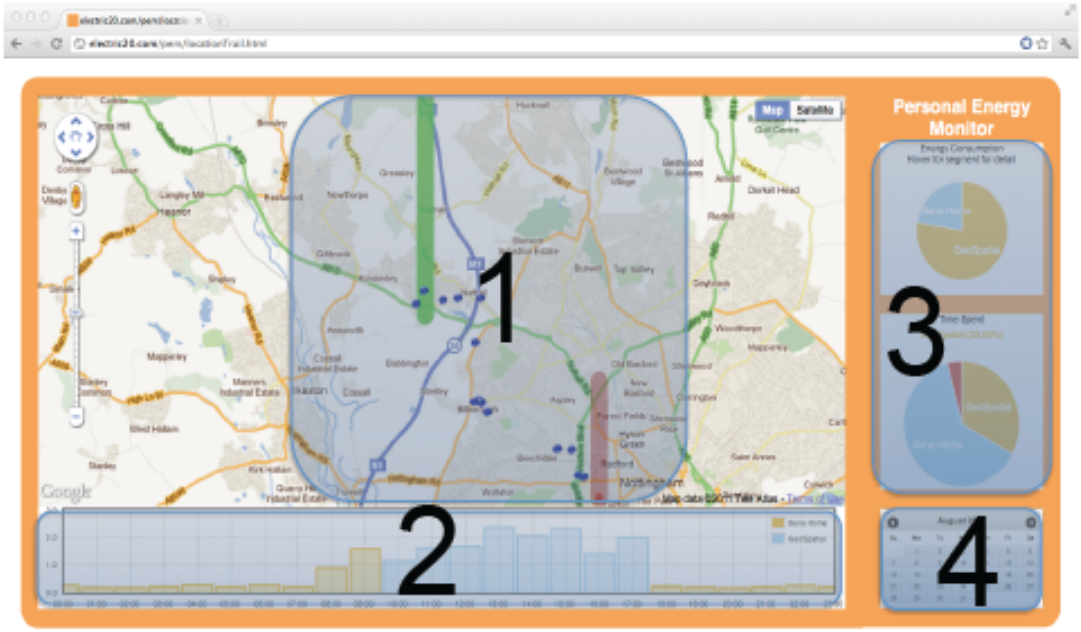
- 5 real users; variety of lifestyles
- 7 days living with the probe (30 days of monitoring)
  - Workplace BEMS
  - Domestic energy monitor
  - Self-reported travel
- Post-hoc data analysis and interviews

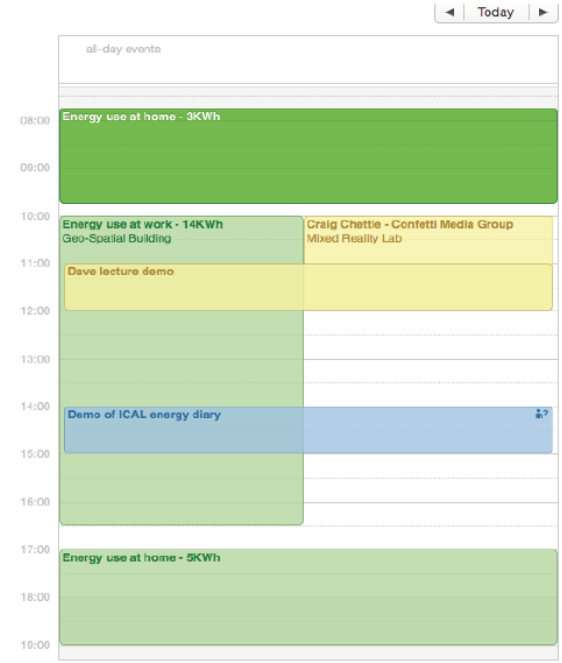

Time spent in categories of space
Personal
Communal
Unmetered
100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
22/08/2011
23/08/2011
24/08/2011
25/08/2011
26/08/2011
27/08/2011
28/08/2011


Consumption in categories of space
Personal
Communal
25
20
15
10
5
0
22/08/2011
23/08/2011
24/08/2011
25/08/2011
26/08/2011
27/08/2011
28/08/2011


a - Time Spent
Personal
Communal
Unmeasured


b - Consumption
Personal
Communal


Personal Energy Monitor
1
2
3
4


Today
all-day events
08:00
09:00
10:00
11:00
12:00
13:00
14:00
15:00
16:00
17:00
18:00
19:00
Energy use at home - 3KWh
Energy use at work - 14KWh
Geo-Spatial Building
Craig Chettle - Confetti Media Group
Mixed Reality Lab
Dave lecture demo
Demo of ICAL energy diary
Energy use at home - 5KWh

Devil in the context

Data that is/will be collected is the simplest of starting points

- Comparing apples to oranges can be dangerous
  - "The work consumption makes my home look like a piss in the ocean; looks like I can relax" (rebound)
  - "I can't turn the heating down even though its too warm here; at home I can just turn the heating off" (instrumentality)
  - "[My friend] is awful – so wasteful – I feel like my data is getting tarnished by their awfulness; I couldn't use [my data] to get a good energy deal"
  - "So I should really be working from home more often – it's much better for the environment"

Issues: practical & ethical

The missing and the non-measured

- Movement traces and personal energy are effective tools for recall of behaviour
- Many misconceptions about how and why energy is consumed
- Missing data can undermine (intended) psychological impact

Visits, sharing and privacy

- Another window into the lifestyle of friends and family
- Another potential exploit?

Skatova et al. (2016) **The Role of ICT in Office Work Breaks**, Proceedings of the 2016 ACM CHI Conference on Human Factors in Computing Systems

Q. Are wearable cameras an effective alternative to diary studies & ethnography for capturing context?

DATAWEAR

Wearable Cameras

Characteristics

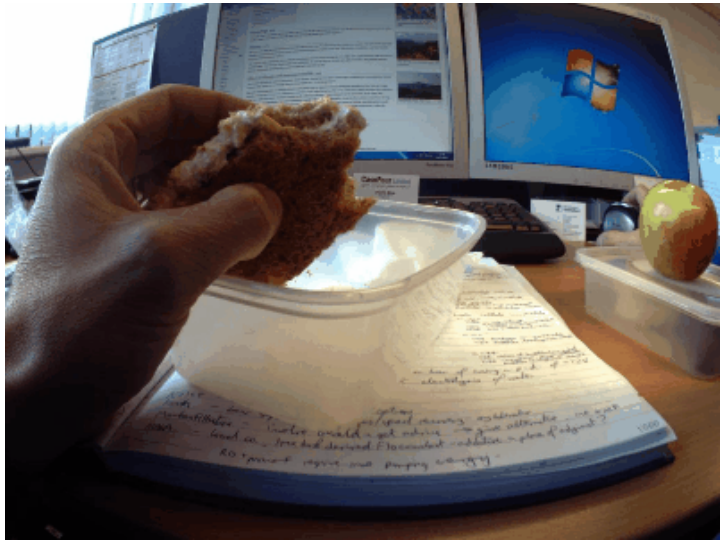
- Small
- First-person perspective
- Continuous/automatically-triggered shooting
- Companion app

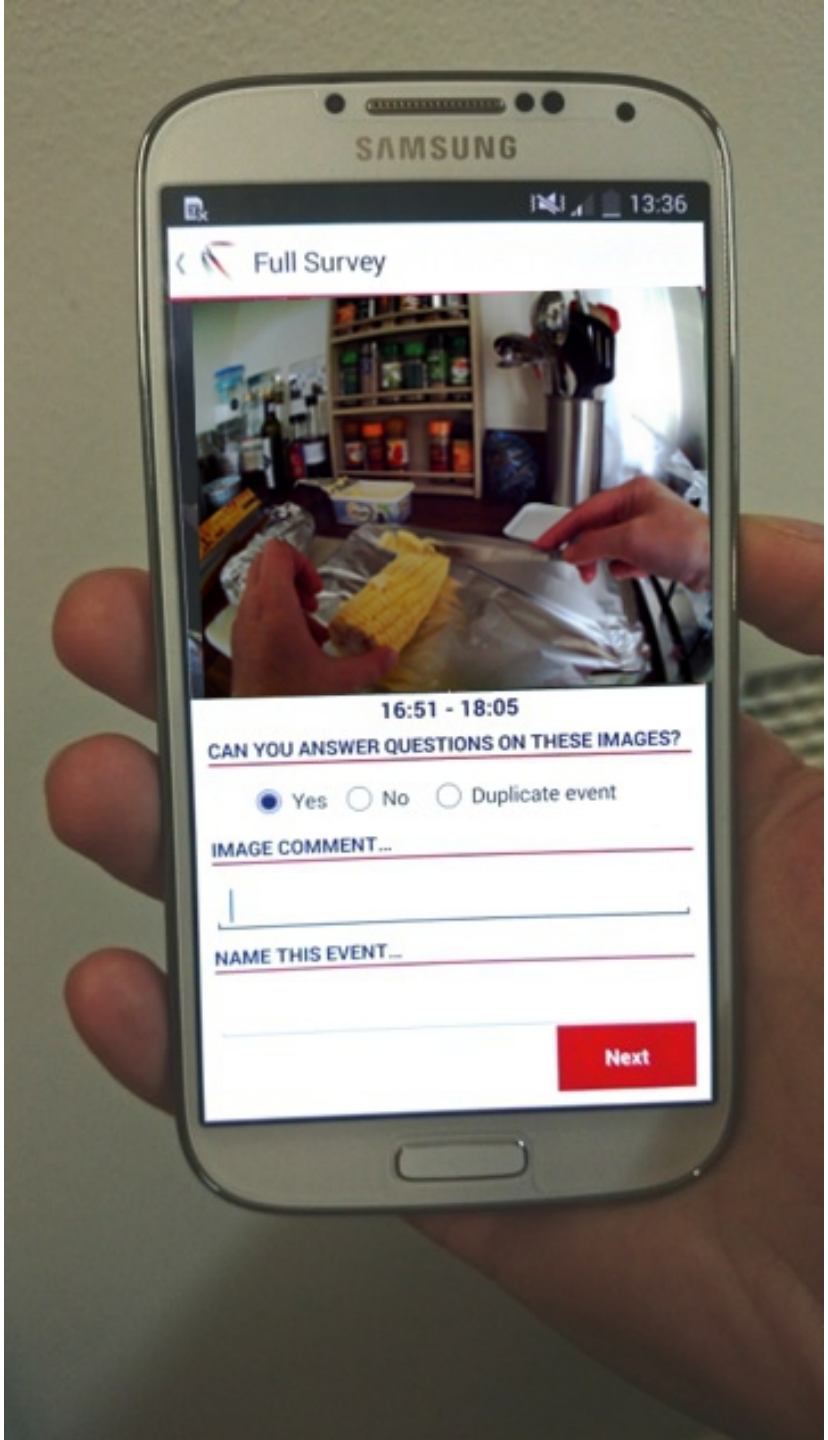
Examples

- SenseCam; Autographer
- Narrative
- GoPro

blog.autographer.com (originally)


KEEP CALM AND CALL FRINGE DIVISION




SAMSUNG
13:36
Full Survey
16:51 - 18:05
CAN YOU ANSWER QUESTIONS ON THESE IMAGES?
Yes
No
Duplicate event
IMAGE COMMENT...
NAME THIS EVENT...
Next

Study

Why study use of ICT at work?

- Tools of work vs. distractions
- Personal ICT is invasive/pervasive

Data

163,662 images

- 291 to 2880 images per day (3 hours to 7 hours)
- 88% coded

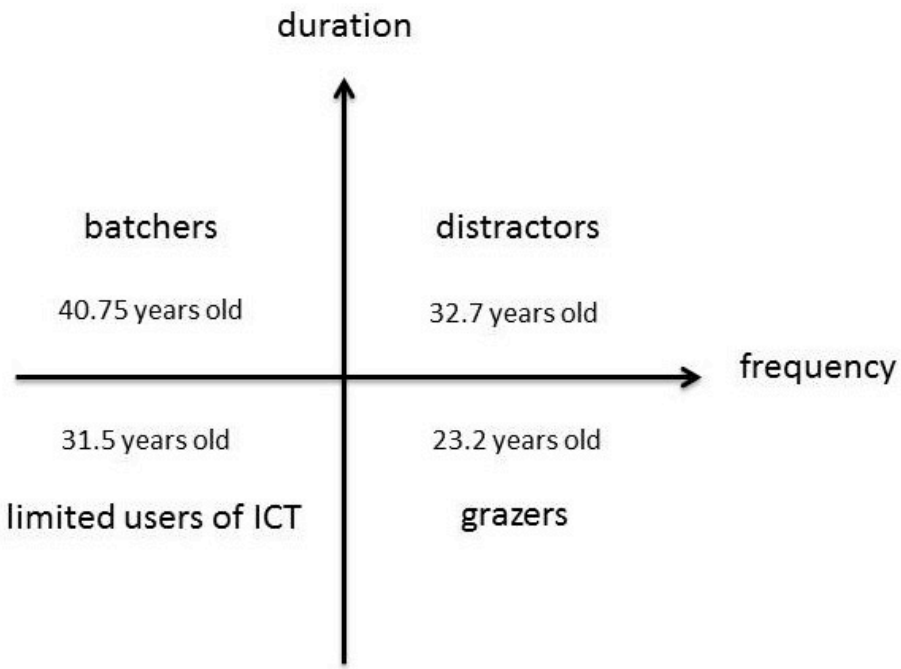
Surveys

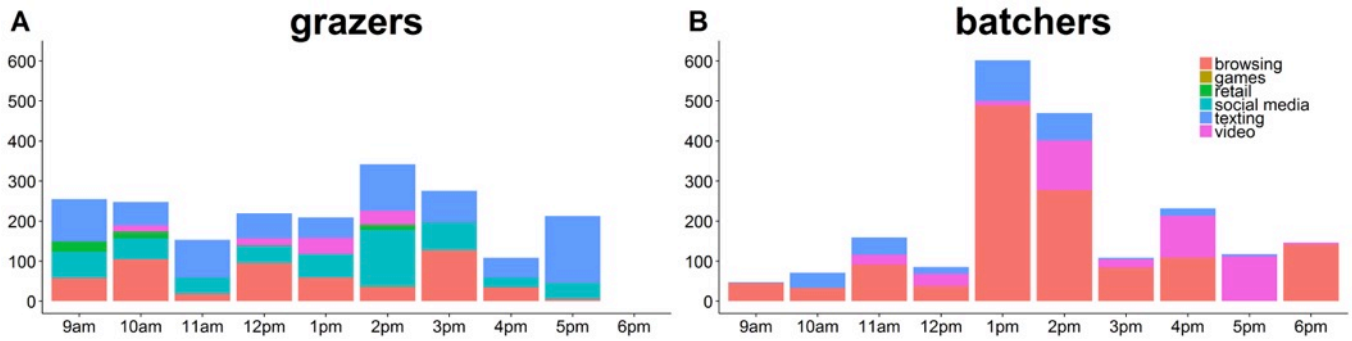
- Pre- and post-study
- Fatigue and need for recovery

Patterns of non-working

Non-work at work

- 1 hour of non-work activities per day (4 minutes to 2 hours) or “diluted” work
  - 5 minutes outdoors
  - 10 minutes socialising
  - 10 minutes food and drink
  - **30 minutes digital**
- As a group …
  - Early morning email, web browsing at lunch, occasional digital breaks elsewhere


duration
batchers
40.75 years old
distractors
32.7 years old
frequency
31.5 years old
limited users of ICT
23.2 years old
grazers


A
grazers
600
500
400
300
200
100
0
9am
10am
11am
12pm
1pm
2pm
3pm
4pm
5pm
6pm
B
batchers
browsing
games
retail
social media
texting
video

Non-work and wellbeing

Traditional recovery activities disappearing?

- No lunch break for grazers

Digital becomes attractive as the day wears on

- Non-work events become more substantial later in the day for distractors (but not for grazers)

Frequency of non-work digital is associated with wellbeing

- Higher frequency = greater fatigue
- Longer duration = greater recovery

Is grazing an immature strategy, or a response to new responsibilities?

- Digital Natives have a distinct need to establish digital social networks and maintain digital identity
- Grazing often used to deal with out-of-work responsibilities – “freeing up home time”

Issues: practical & ethical

A stressful method for participants?

- Responsibility for ethical adherence shifted towards participant
  - How to gain informed consent from 3rd parties?
  - How to identify sensitive situations?
  - How to censor thousands of images?
- Perceived responsibility for results
  - Am I producing “good quality data”?

A research toolchain and process for wearable cameras

- Before: ethics training and resources for the participant
- During: habit-forming and proactive censorship
- Retrofitted security: an app for encrypting, redacting and offloading data
- Long term participant-as-researcher relationship

Goulden et al. (2017) **Wild interdisciplinarity: ethnography and computer science**, International Journal of Social Research Methodology, 20:2, 137-150

Q. Can an experimental technology be deployed and studied in a digitally-excluded community?

PAWS

Digital Exclusion

A social Grand Challenge

- Internet access can be considered a human right
- Access not ubiquitous
- How might domestic infrastructure be reengineered to provide ubiquitous access?

Public access wi-fi service (PAWS)

- Citizens piggyback on wi-fi provided by Sharers
- A social contract between neighbours, not with an ISP (e.g. BT Wi-fi)

The study

Interdisciplinary and participatory

- Computer Scientists and Sociologists
- University and an inner-city neighbourhood
  - ~72% Internet access (vs. ~92% city average)

In-the-wild technology trial

- 3 months of secure, free wifi (as a Sharer or Citizen)
- Anonymous monitoring of the performance of the tech
- Optional interviews on the lived experience

Table 1. Recruitment in numbers.

Doors knocked	~2158
Recorded responses (i.e. door answered)	730
Potential sharers	98 (13.4% of responses)
Potential citizens	36 (4.9% of responses)
Sharers (i.e. PAWS installed)	21(+1 hub[a])
Potential pairs[b]	17
Realised pairs	2

Table 1. Recruitment in numbers.

Doors knocked	~2158
Recorded responses (i.e. door answered)	730
Potential sharers	98 (13.4% of responses)
Potential citizens	36 (4.9% of responses)
Sharers (i.e. PAWS installed)	21(+1 hub[a])
Potential pairs[b]	17
Realised pairs	2

R[ecruiter]: *Would you like to have the Internet?*
Man: *No, that's alright. I'm not interested.*
R: *May I ask why not?*
Man: *Cos it's a load of f**king b***ocks.*

Learning about the other

Sociologists can't multitask

- An ethnographic approach is not possible around an experimental technology
- The sociologist – as the trusted partner – must be the one to fix the technology
- Burden of academic, technical and emotional labour is heavy

Computer Scientists can't fix your wi-fi

- Understanding whether two homes *could* share seemed impossible
- "Radio physicists know what the answer is in theory; the lab engineers know what the answer is by simulation; computer scientists don't care what the range is, they care what the throughput or latency is."
- Even *within* disciplines, skills can vary greatly

Issues: practical & ethical

Problems of time

- In sensitive/unfamiliar settings researchers cannot “move fast and break things”
  - Lead time must be spent building a relationship and setting expectations
  - Technology cannot have “lab-level” robustness

Digital plumbing

- New technologies require a network of *other* technologies to function
  - The digitally-excluded are unlikely to have this infrastructure in place
  - Social deprivation often coincides with a lack of community spaces
  - Deployments of experimental tech must include the plumbing!

Going native … with each other

- Interdisciplinary research can lead to loss of independent thought
  - The sociologists “bought into” the technical concerns and ideals
  - Digital exclusion is not purely economic-technical
  - Maintaining a focus on each disciplines research goals is important, even if it means accepting that the technology failed

Bedwell et al. (2016) **Understanding Energy Consumption at Work: Learning from Arrow Hill**, Proceedings of the 19th ACM CSCW Conference on Computer-Supported Cooperative Work & Social Computing

Q. Can organisational consumption be quantified and apportioned to encourage sustainable behaviour?

C-TECH

Arrow Hill

Our research site

- Hybrid building
  - Restored Grade II* listed house from the 18th century; 2-6 person offices
  - New construction in 2010; 2600m^2 in several open plan offices
- Mixed occupancy
  - Recently merged organisations
  - Multiple departments (500+ staff)
  - Public and private spaces
- Performing well below the anticipated BREEAM “Excellent” rating

Arrow Hill

An existing source of energy data

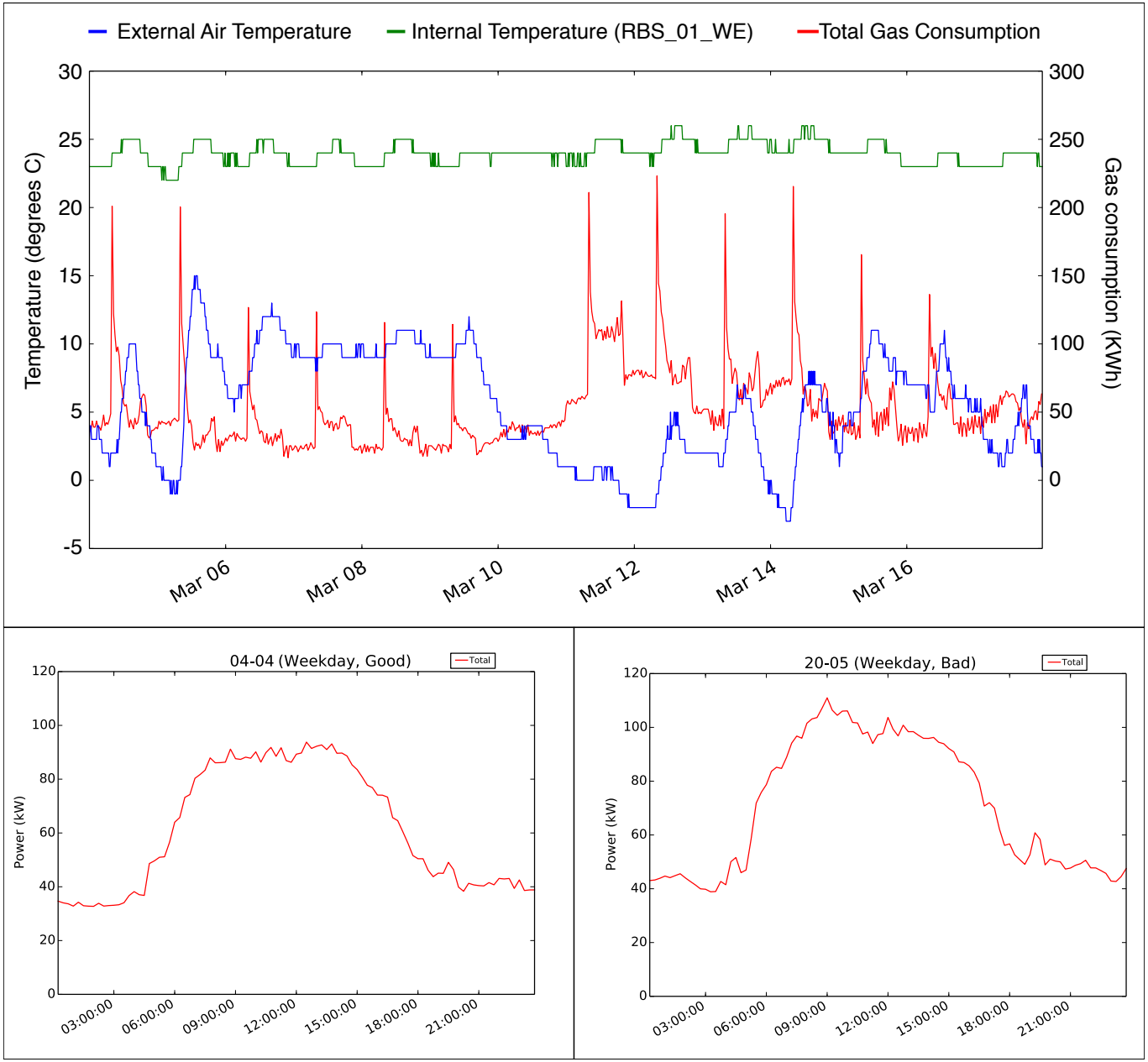
- Gas & Electricity
- Automated meter readings every 30 minutes; multiple meters break consumption down into building areas
- Extremely limited access to data for any staff
  - Basic web view and reporting – essentially unused
  - Energy monitoring system installed without integration strategy

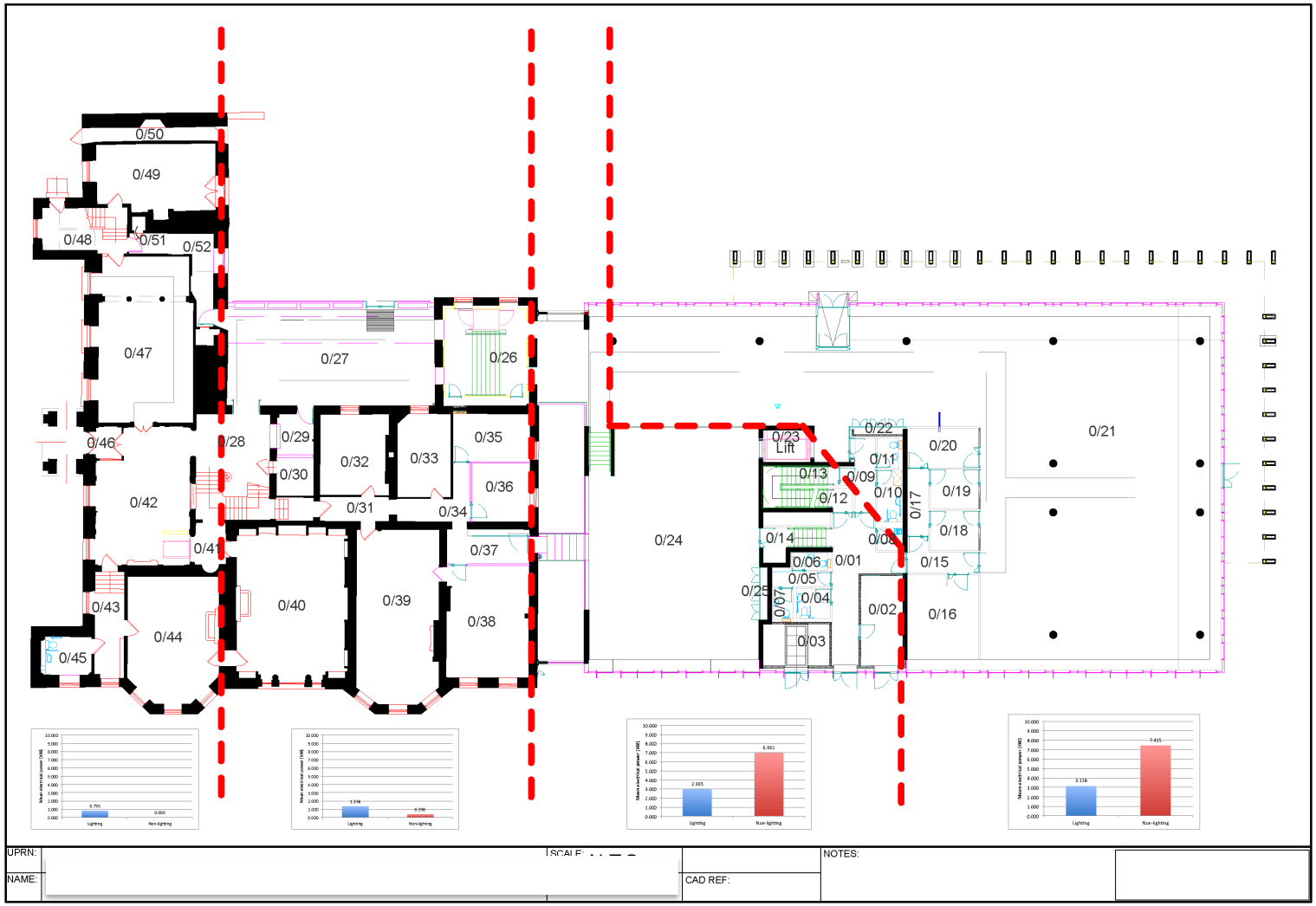
Study

Data workshop with strategic decision makers

- Facilities manager, energy strategy team, human resources managers, procurement managers, IT managers, building architects …

- To focus discussion: visualisations of building energy data
  - Longitudinal
    - How is energy used over time?
  - Topological
    - How is energy used across the workspace?
  - “Best” and “worst” periods


External Air Temperature
Internal Temperature (RBS_01_WE)
Total Gas Consumption
Temperature (degrees C)
Gas consumption (KWh)
30
25
20
15
10
5
0
-5
300
250
200
150
100
50
0
Mar 06
Mar 08
Mar 10
Mar 12
Mar 14
Mar 16
04-04 (Weekday, Good)
Total
Power (kW)
120
100
80
60
40
20
0
03:00:00
06:00:00
09:00:00
12:00:00
15:00:00
18:00:00
21:00:00
20-05 (Weekday, Bad)
Total
Power (kW)
120
100
80
60
40
20
0
03:00:00
06:00:00
09:00:00
12:00:00
15:00:00
18:00:00
21:00:00


0/50
0/49
0/48
0/51
0/52
0/47
0/27
0/26
0/46
0/28
0/29
0/32
0/33
0/35
0/30
0/36
0/42
0/31
0/34
0/41
0/37
0/24
0/23
Lift
0/22
0/20
0/11
0/13
0/09
0/10
0/12
0/17
0/19
0/21
0/14
0/08
0/18
0/06
0/01
0/15
0/05
0/25
0/07
0/04
0/02
0/16
0/03
0/43
0/40
0/39
0/38
0/44
0/45
UPRN:
NAME:
SCALE:
CAD REF:
NOTES:

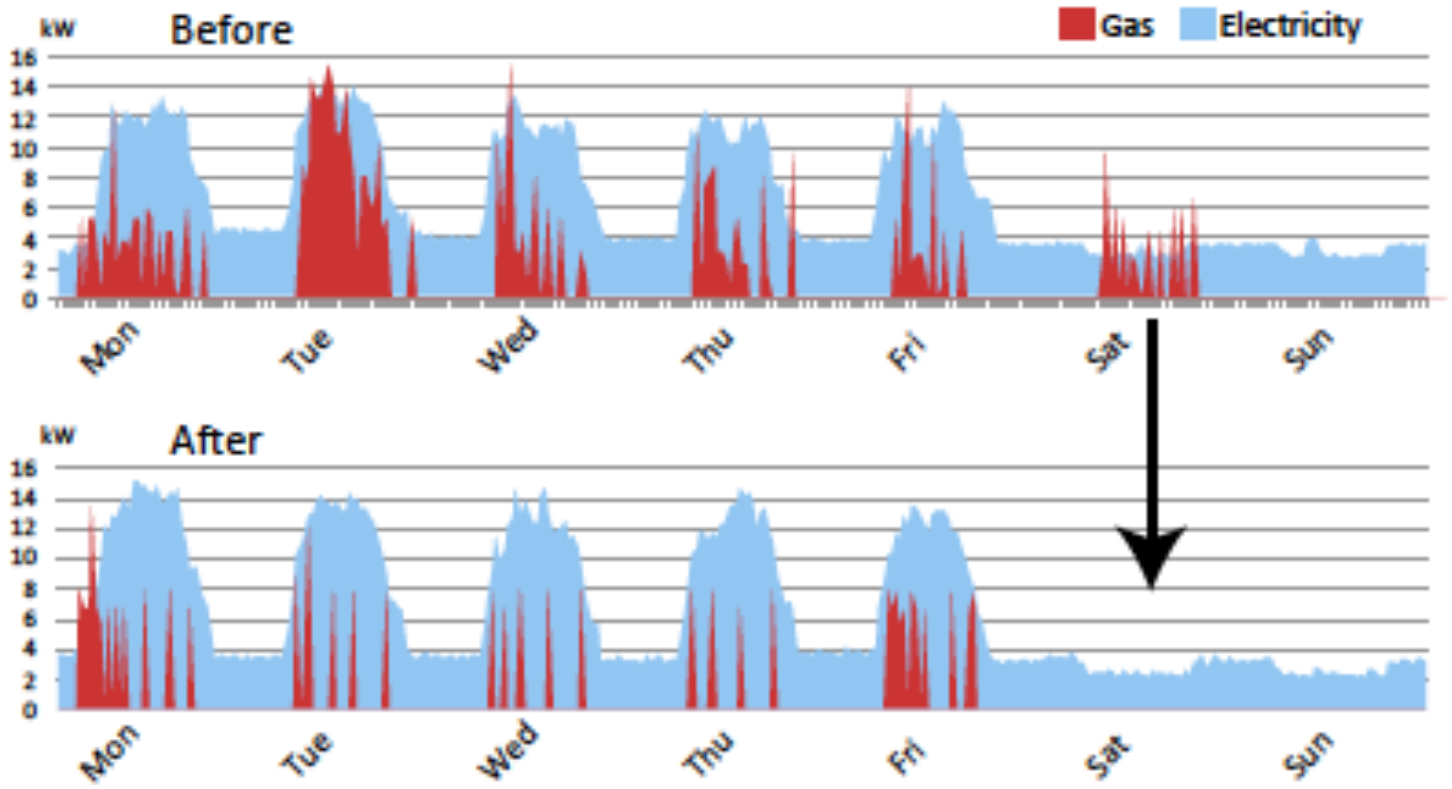

Total electricity consumption per day (KWh)

“You just believe that? You know it makes no sense …”

Making Building Operation Visible

Errors

- “Errors” arise from misunderstanding of the building operation and use
- Errors can lead to significant energy costs
- Errors can be invisible, perpetuating their impact


kw
Before
Gas
Electricity
16
14
12
10
8
6
4
2
0
Mon
Tue
Wed
Thu
Fri
Sat
Sun
kw
After
16
14
12
10
8
6
4
2
0
Mon
Tue
Wed
Thu
Fri
Sat
Sun

Making Building Operation Visible

Errors

- “Errors” arise from misunderstanding of the building operation and use
- Errors can lead to significant energy costs
- Errors can be invisible, perpetuating their impact

Data-driven communal activities can make errors visible

- Errors spotted when different perspectives are brought together
  - Alien and mundane routines are questioned
  - Evidence is expected
- Questioning should follow through to testing (not storytelling!)

"If we stick to [the policy], we know everything's working"

"My job? Firefighting …"

"The policy makes no sense – one person is freezing, the other is boiling"

Caught in the middle: The role of the Facilities Manager in organisational energy use

- ***M. Goulden & A. Spence*** *Energy Policy (85), 2015*

Issues: practical & ethical

Revealing cross-community data can exacerbate issues for people "in-the-middle"

- In organised systems there may already be an actor "papering over the cracks" or devising solutions that appease all parties
  - Interventions can put this actor at risk of …
    - More work
    - Being made responsible for the errors
    - Being made redundant by solutions
  - Solutions must cater to this actor as much as any other

Questions?

1. C-AWARE – using data to improve awareness of personal day-long energy consumption
2. Datawear – exploring use of personal ICT at work through wearable cameras
3. PAWS – embedding experimental technology in a digitally-excluded community
4. C-tech – dividing up and representing energy use in workplaces to facilitate internal sustainability

Ben Bedwell

- Horizon Digital Economy Research & Mixed Reality Lab (University of Nottingham, UK)
- benjamin.bedwell@nottingham.ac.uk