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Profiling Energy Use in Households and Office Spaces

Salman Taherian, Marcelo Pias, George Coulouris and Jon Crowcroft

Computer Laboratory

Outline

- Motivation

- CSK Energy System

- Review of energy use

- Profiling energy

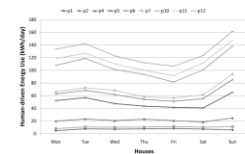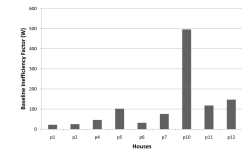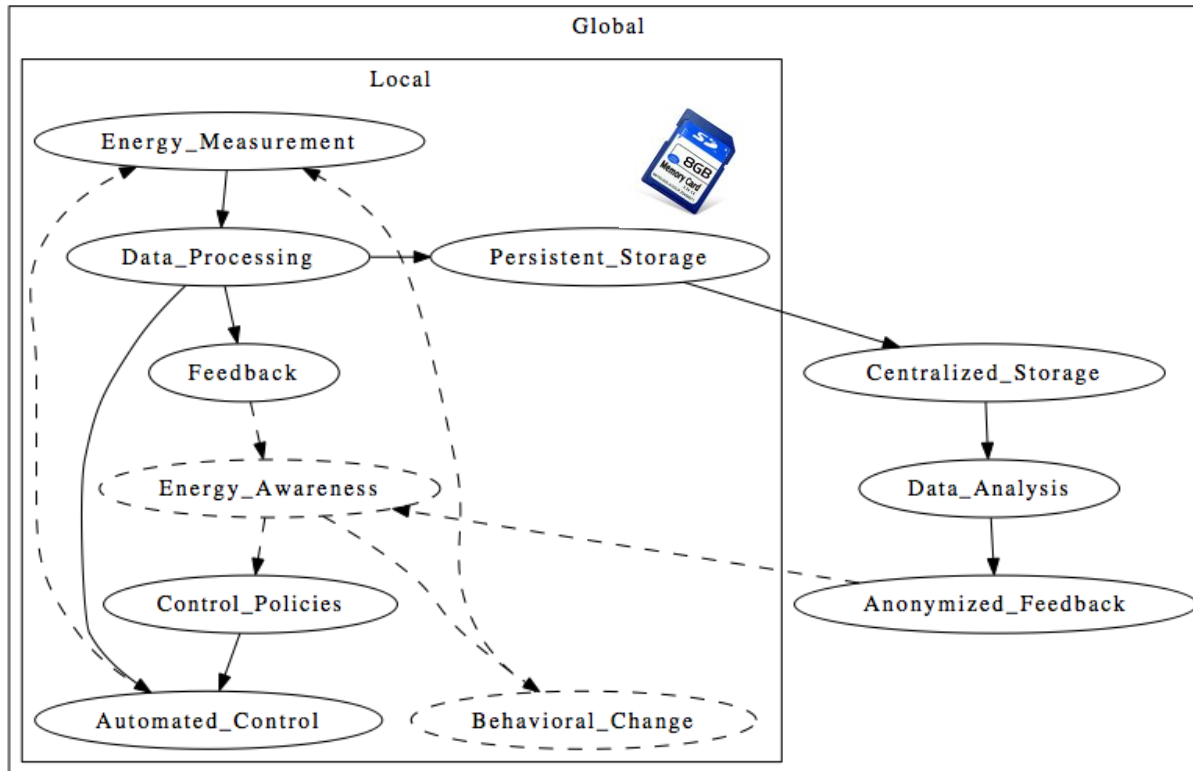- Experimentation

- Conclusions

Motivation

- Climate change

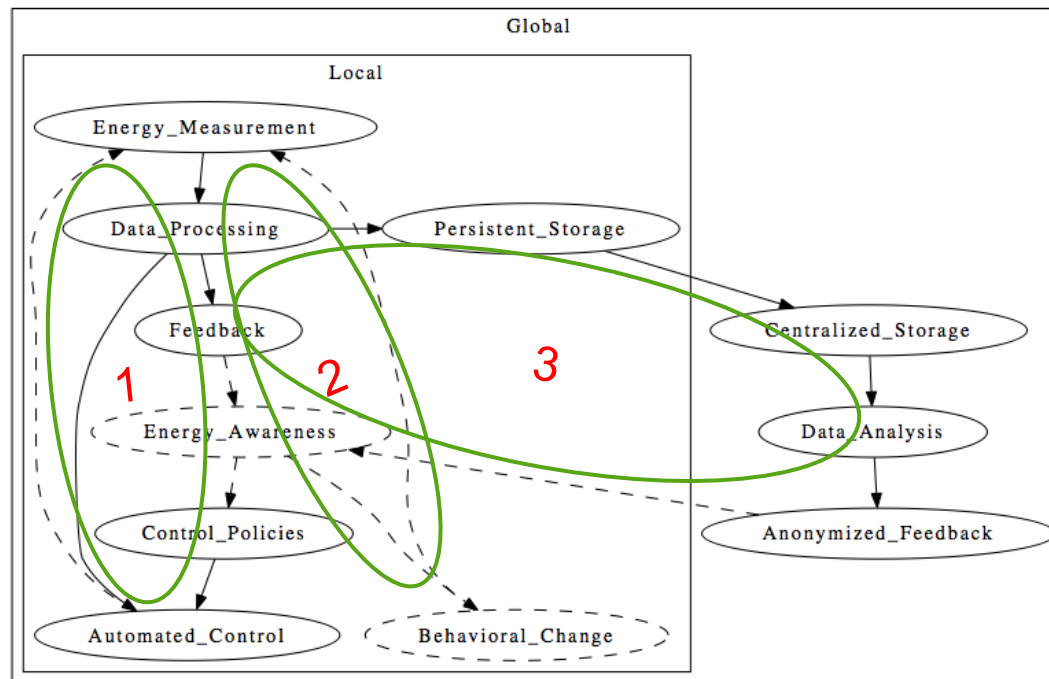- Reducing energy consumption (behavioral dimension ⟷ *awareness*)

Aggregate energy use (homes and offices)

CSK (Cambridge Sensor Kit) Energy System

Reducing energy consumption (awareness & action)

1. Local feedback and assisted control (easy)

2. Local feedback and behavioral change (difficult)

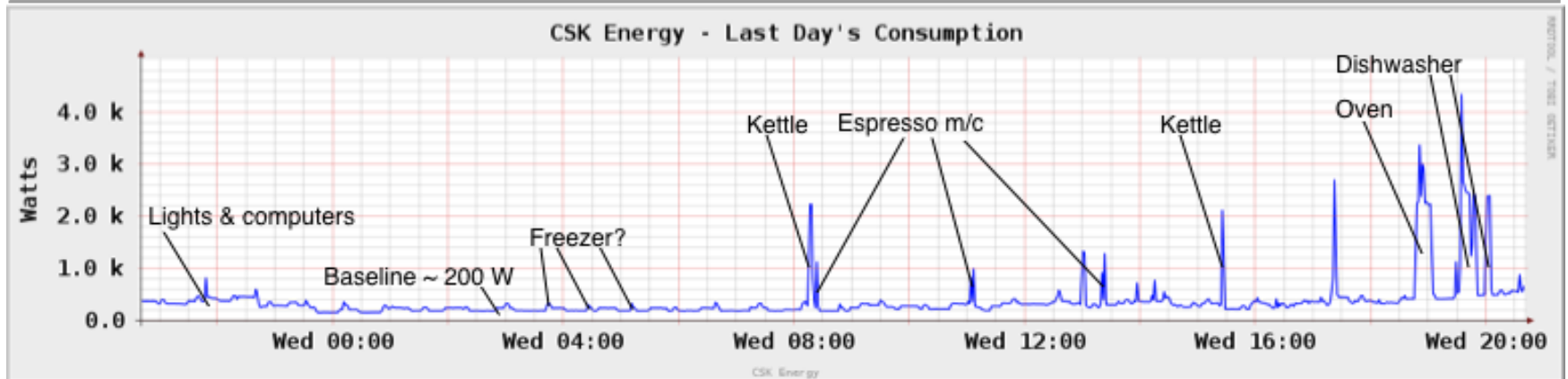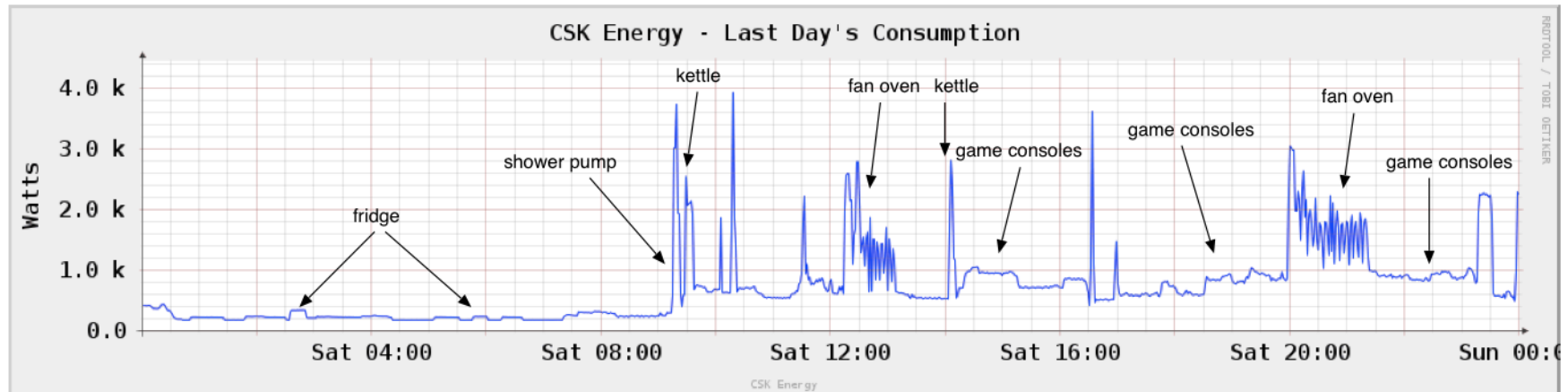3. Information sharing and comparison

Local feedback…

- Real-time displays (RD)

  - Spatially confined

  - Temporally confined

- Complementary feedback systems

  - Real-time LED Globe (RLG)

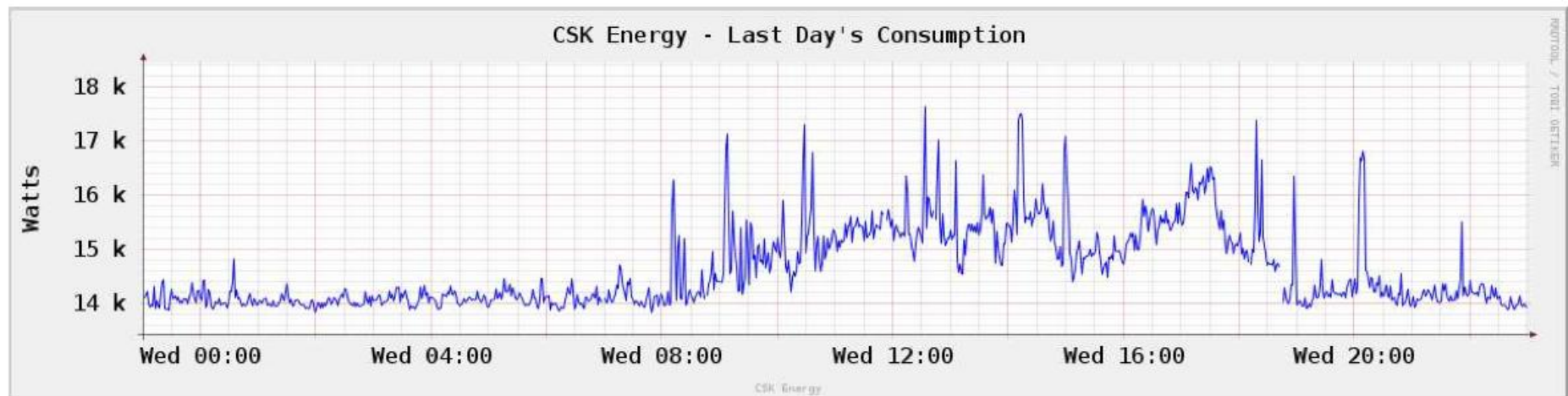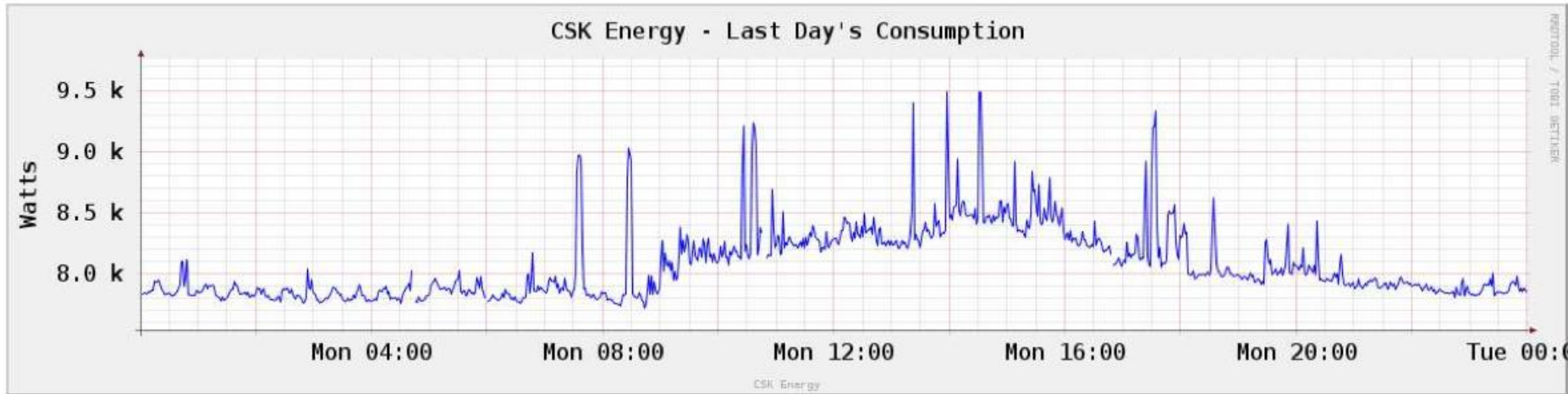 - Digital Photo Frame (DPF)

  - Webpage (Web)
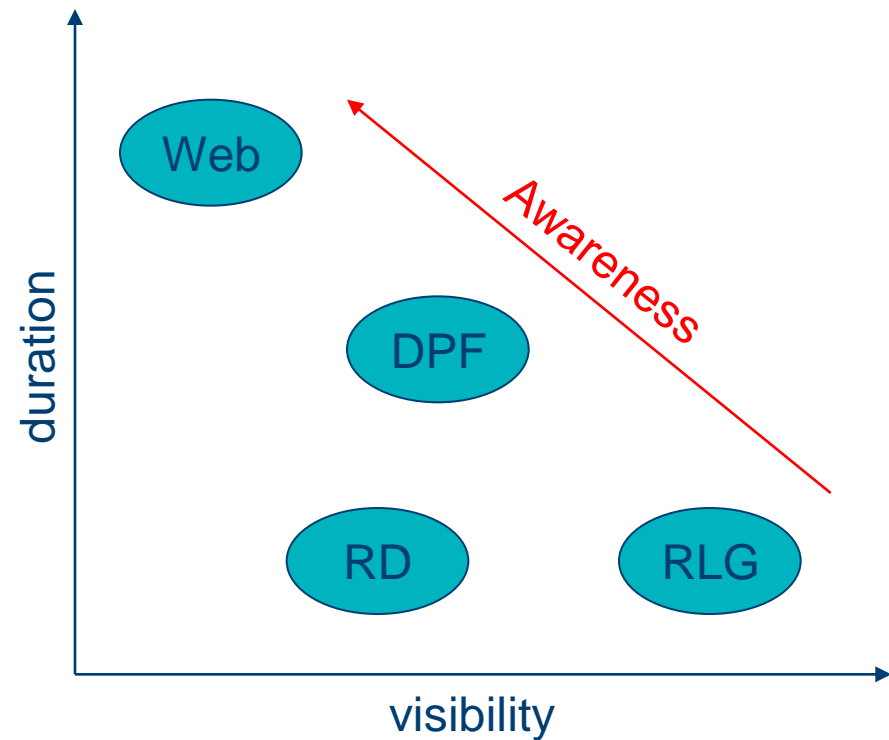
Feedback, awareness, and action….

- Personal experience and practice helps

Feedback for office environment

# Global feedback…

- Beyond one man's knowledge & expert advice

    - *Information* sharing and comparison

    - User-level discussions

    - Co-operative solution discovery

- Energy profiling: *what* to discuss?

    - Simple, personal, safe (secure & anonymous)

        - Baseline energy use (level of commitment/effort)

        - Personal energy demand (lifestyle efficiency)

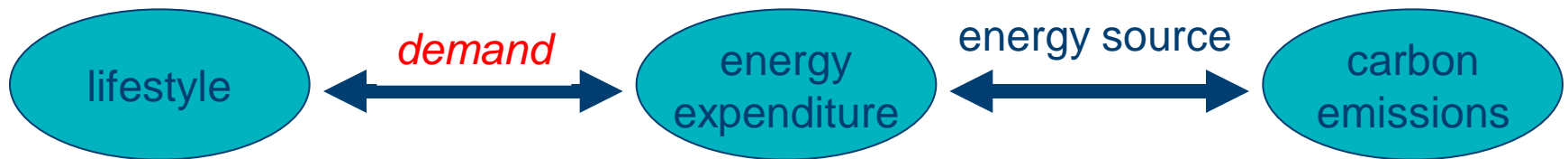# What's always on? (baseline energy use)

$$\Delta_{bl} = b_{observed} - b_{correct}$$

- *b_correct* ~ 30 *watt* for homes (electric timers, smoke alarm/detector,…)

- e.g., http://www.cambridgesensorkit.org/cskenergyP2 !
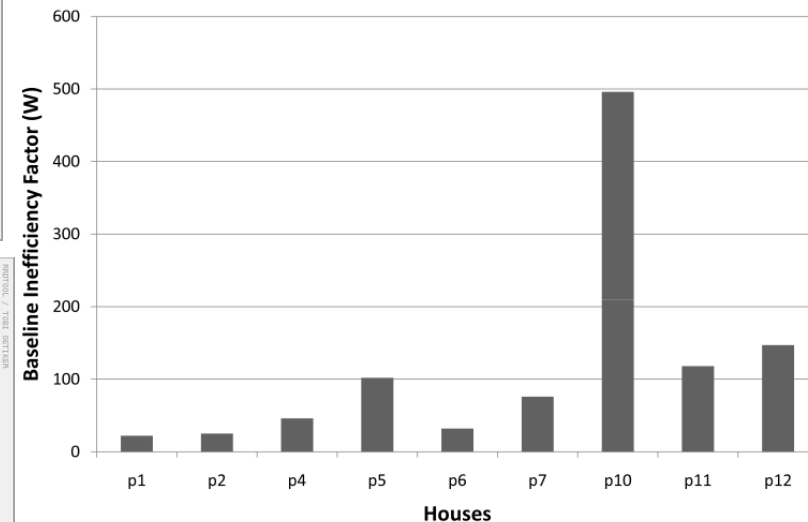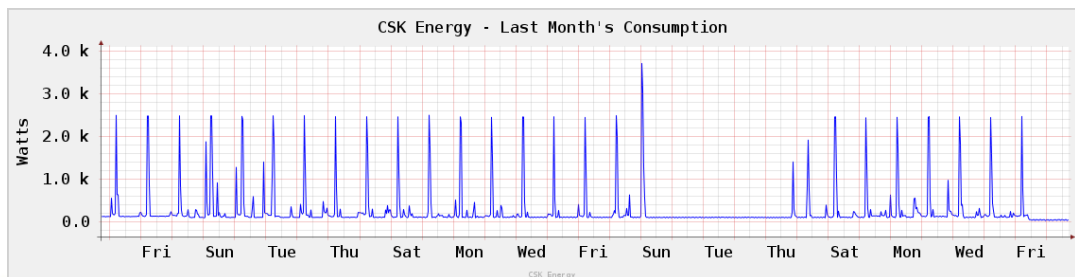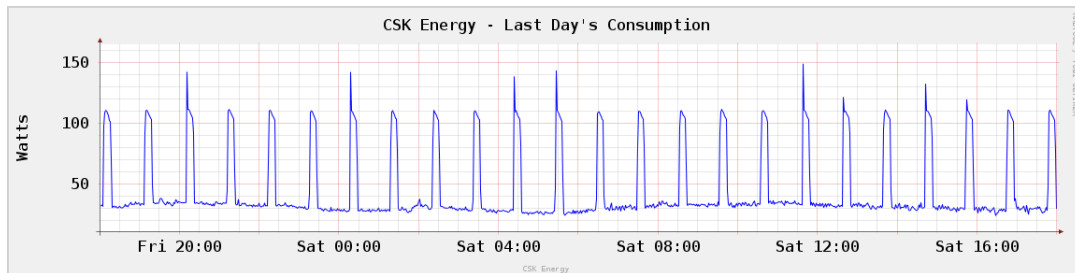
Who's green? BMI for energy?!

Individuals	PI_{home}	PI_{office}	$API_{\{home,office\}}$
Subject A	137.38W	176.34W	**313.72W**
Subject B	156.17W	176.34W	**332.51W**
Subject C	193.37W	50.38W	**243.75W**

- Individualized energy metric (aggregated power index, API)

- $A^x = \sum_V P_v^x$ (sum of power indices, PIs, at different environments V)

  - User must have _control_ (ownership)

  - Change must be _noticeable_ (effective feedback)

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Experiment (office space)

- How much energy use is at users' control?

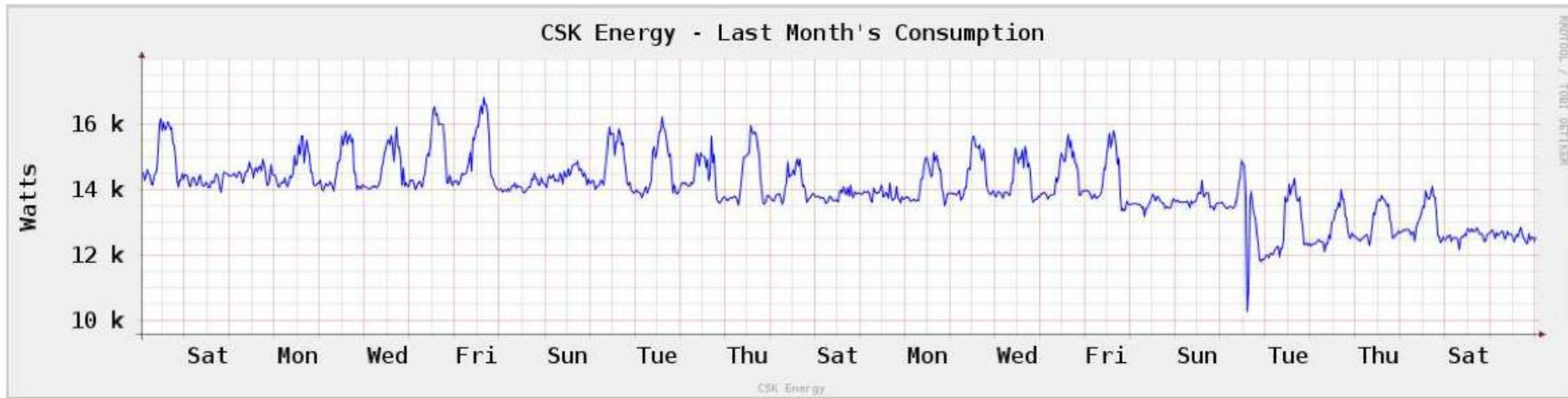- How noticeable is a simple change/action?

- Methodology

- *"everyone should shut down their machine prior to attending weekly meeting"*
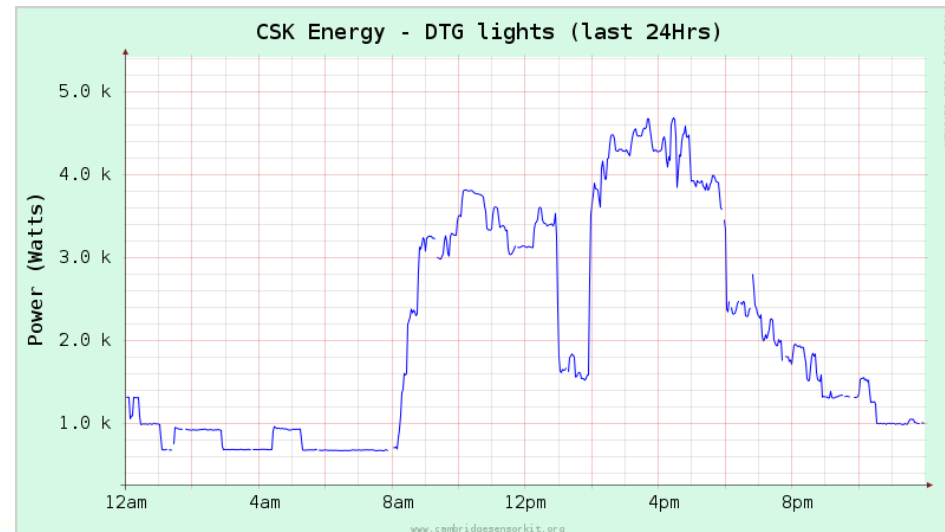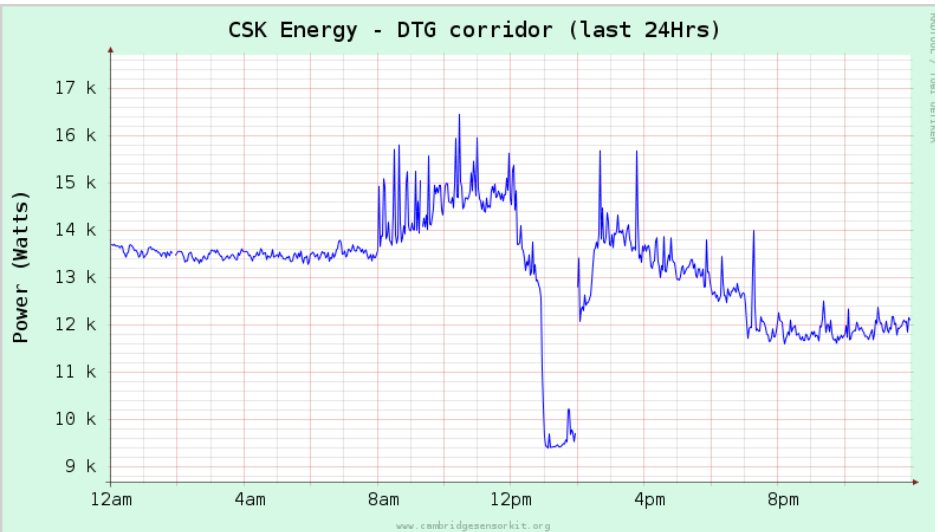
Post experimentation

- Compulsory vs Voluntary

- Technology's role

  - duty cycling (> 55% savings

on machines, 4kW)

State	Power	Current Cycle	Proposed Cycle
Disconnected from mains	0W	0%	67%
Switched off	12W	0%	0%
Stand-by	60W	75%	8%
Switched on	110W	25%	25%
Total power		72.5W	32.3W

Conclusions

- Smart system in co-operation with the user

  - User as valuable source of info.

  - Human in the control loop

- User engagement

  - Awareness + Personalization + Ownership

  - High-level data to assist engagement

- Sustainable behavior change is difficult

  - Re-enforce acceptance through automated control

Thank you!

Salman Taherian

st344@cl.cam.ac.uk