



UK-DALE: A dataset recording UK Domestic Appliance-Level Electricity demand and whole-house demand



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1) INTRODUCTION

Motivation

- Smart meters measure whole-house aggregate power consumption.
- Disaggregated, appliance-by-appliance information enables consumers to manage their electricity consumption most effectively.
- In order to develop disaggregation algorithms, researchers require as much 'real' data as possible.
- Hence we designed a low-cost open-source data collection system and recorded an energy demand dataset.

Contributions described this poster

1. Low-cost, open-source data collection system.
2. Presentation of open-access dataset & analysis.

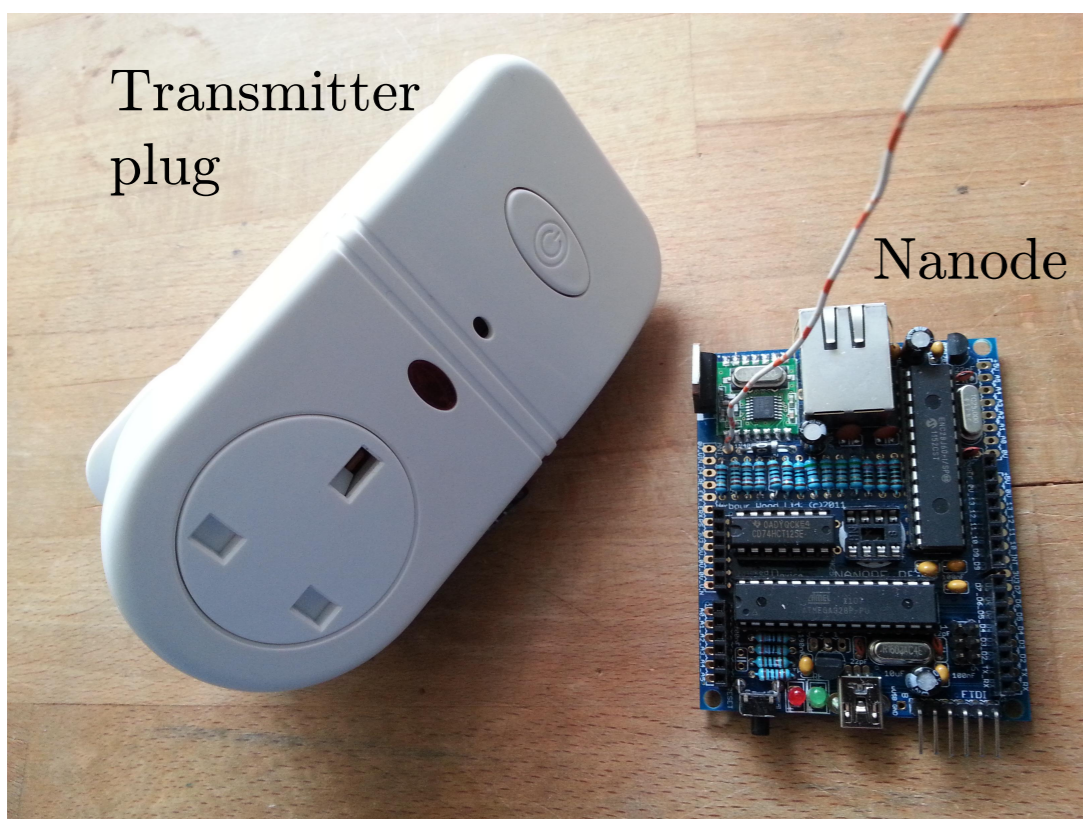
A longer paper describing UK-DALE is available [1].

2) RECORDING SYSTEM

- We present a low-cost, open-source, wireless system for collecting 'ground truth' power data from multiple appliances per home as well as recording whole-house voltage and current waveforms at 44.1 kHz.
- Our code is open source on github. Visit jack-kelly.com/energycode

Recording appliance power

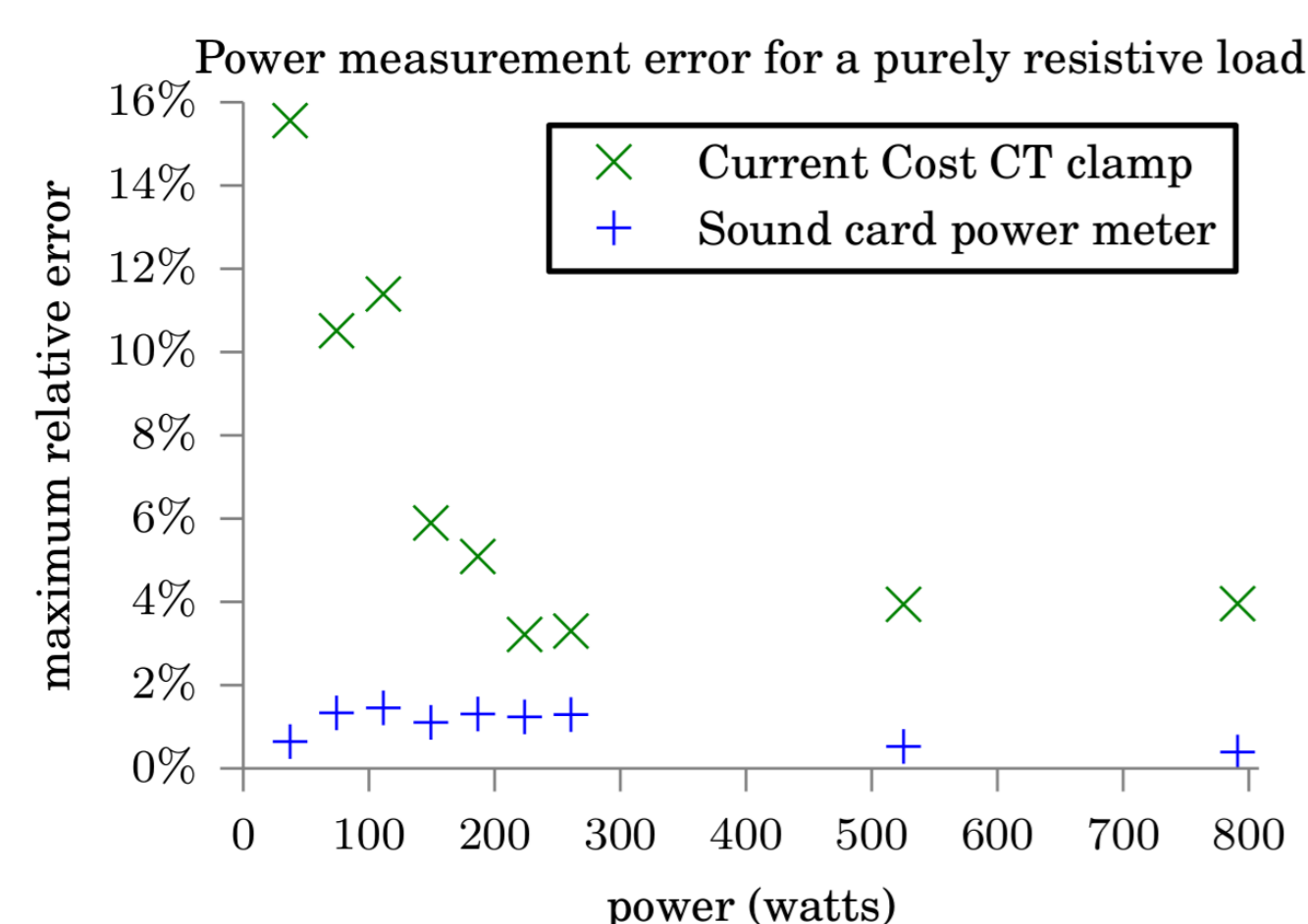
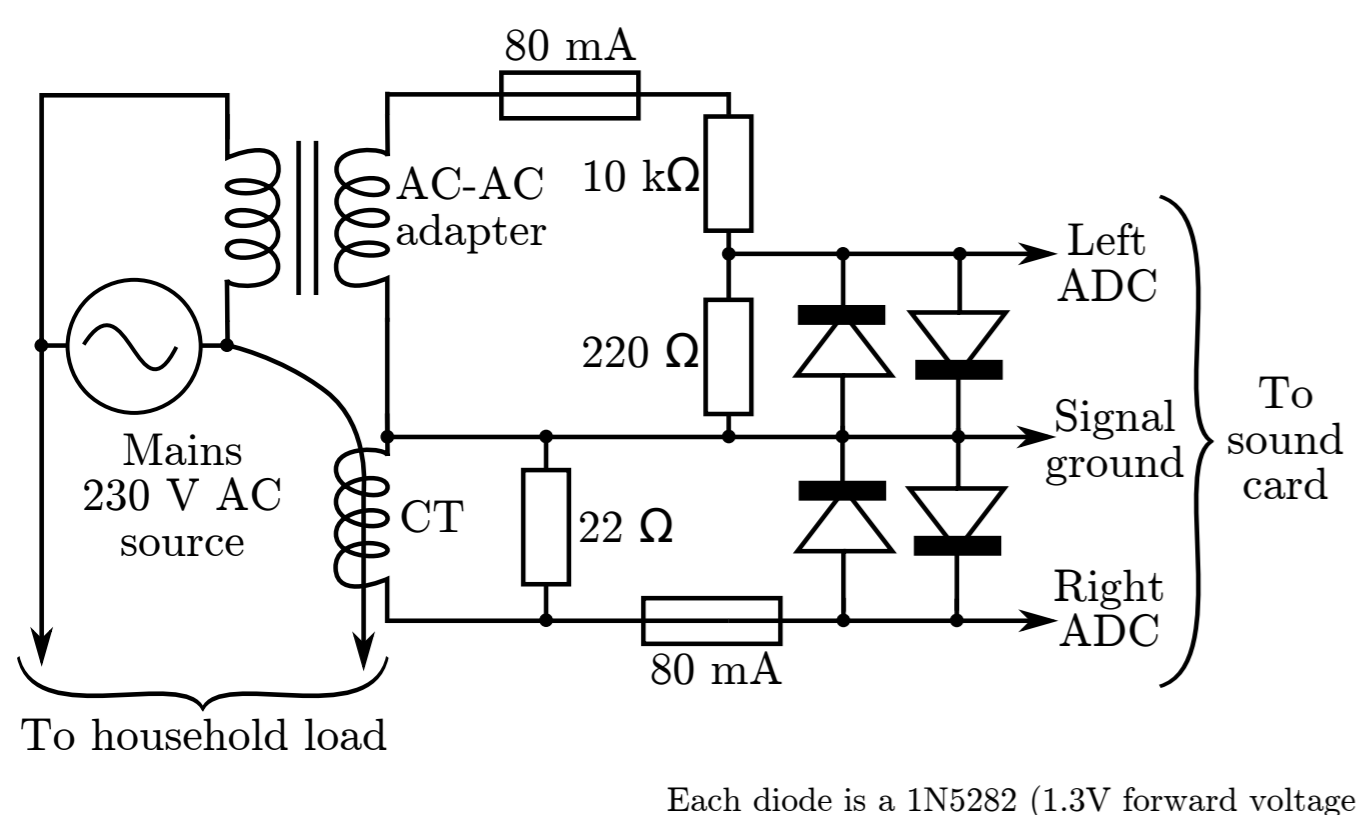
- Low-cost "EDF EcoManager Transmitter Plugs" on each appliance.
- Wirelessly reports active power once every six seconds.
- Off-the-shelf base station is not suitable for our purposes.
- Built our own wireless base station on a Nanode. Nanodes include an ATmega 328P microcontroller & a HopeRF RFM12b RF module.



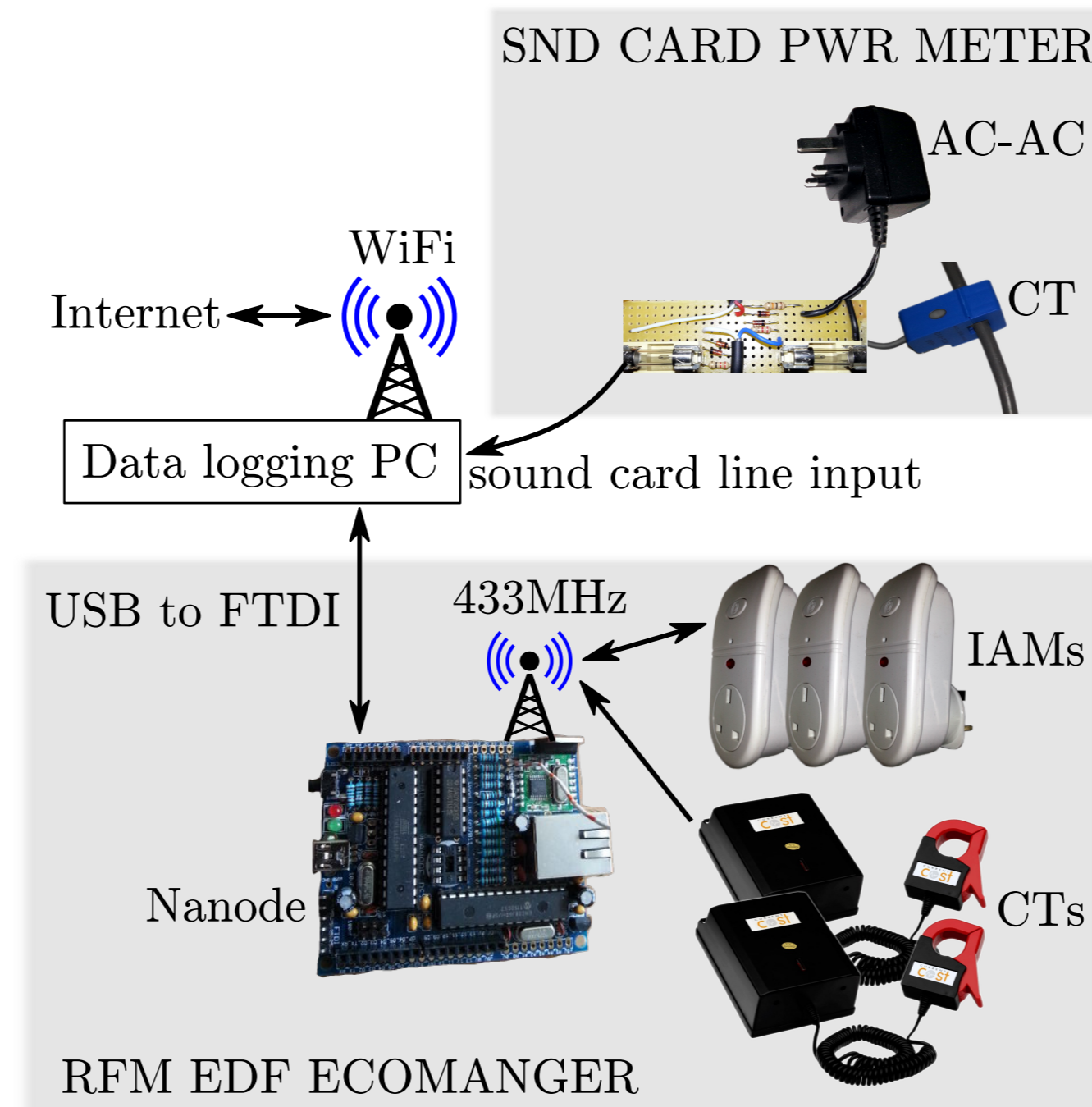
Recording whole-house power

- Home energy monitors do not measure active power or reactive power or voltage. (OpenEnergyMonitor does but its resolution is ~14W)
- 'Proper' (SMETS2) UK smart meters are not yet available.
- We built our own meter using a PC sound card as an analogue to digital converter, a 'current transformer' (CT) clamp to measure mains current & an AC-AC adaptor ('wall wart') to measure mains voltage.
- Records V and I at 44.1kHz and calculates active & apparent power.

Circuit for measuring mains power using sound card:



Our complete data collection system:



The three major components of the system are: (top left) the data logging PC; (top right) the sound card power meter (which uses the sound card on the data logging PC to record the output from an AC-AC adaptor and a current transformer (CT)) and (bottom) the 'RFM EDF ecomanager' which uses a Nanode to communicate over the air with a set of individual appliance monitors (IAMs) and current transformer (CT) sensors.

3) DATASET

- We recorded electricity demand from four UK houses.
- Available from jack-kelly.com/uk-dale
- UK-DALE is also mirrored on the UKERC's Energy Data Centre.
- First public UK dataset with temporal resolution less than 2 minutes.
- Includes detailed metadata using the NILM Metadata schema [2,3].
- We present an analysis of this dataset, focusing on patterns and correlations which could be learnt by a disaggregation system.

SUMMARY OF THE DATA AVAILABLE FOR EACH HOUSE.

| ID | Number of meters ^a | Mains ^b sample rate | Time span ^c (days) | Uptime ^d (days) |
|----|-------------------------------|--------------------------------|-------------------------------|----------------------------|
| 1 | 54 | 16 kHz & 6 sec | 499 | 470 |
| 2 | 20 | 16 kHz & 6 sec | 234 | 199 |
| 3 | 5 | 6 sec | 39 | 36 |
| 4 | 6 | 6 sec | 205 | 205 |

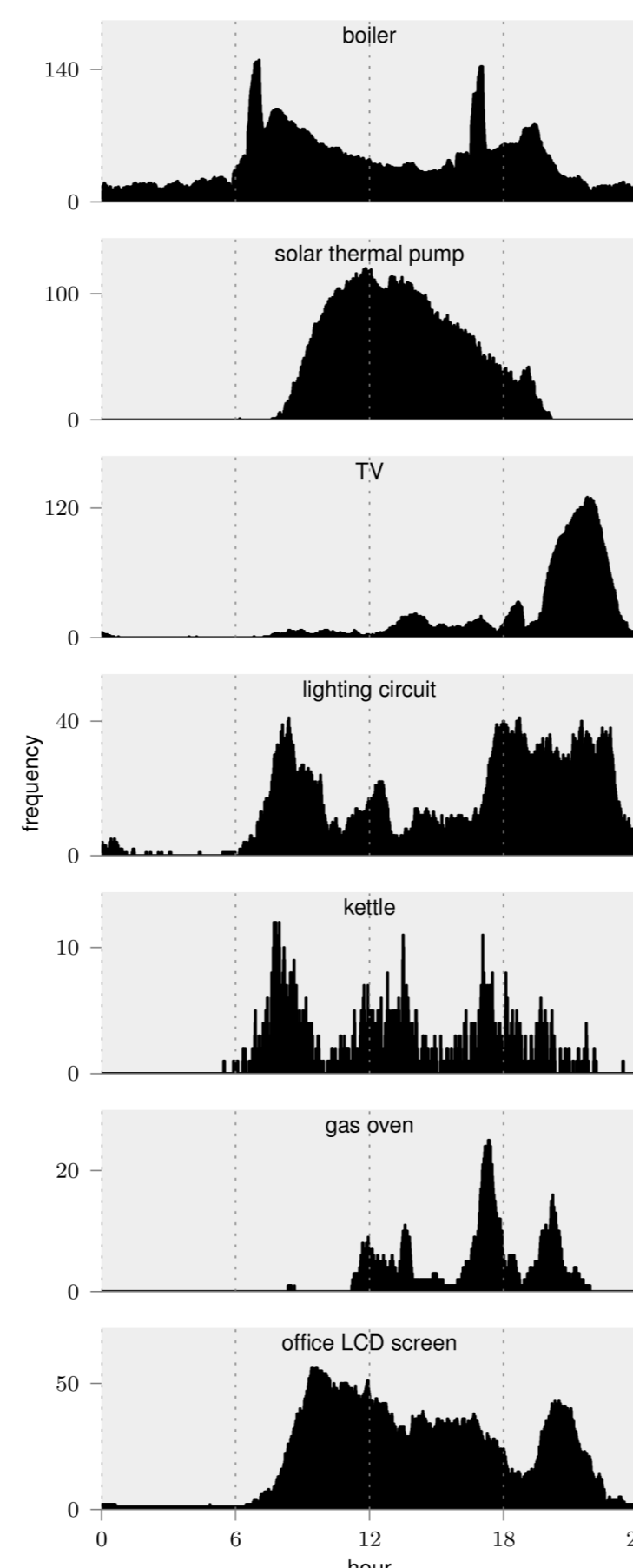
^a The maximum number of meters used (including mains meters). Some houses started with a small number of meters to test the system and then added more.

^b Indicates whether we recorded the mains current and voltage waveform at 16 kHz using our sound card power meter (as well as at 6-second intervals using the Current Cost CT clamp).

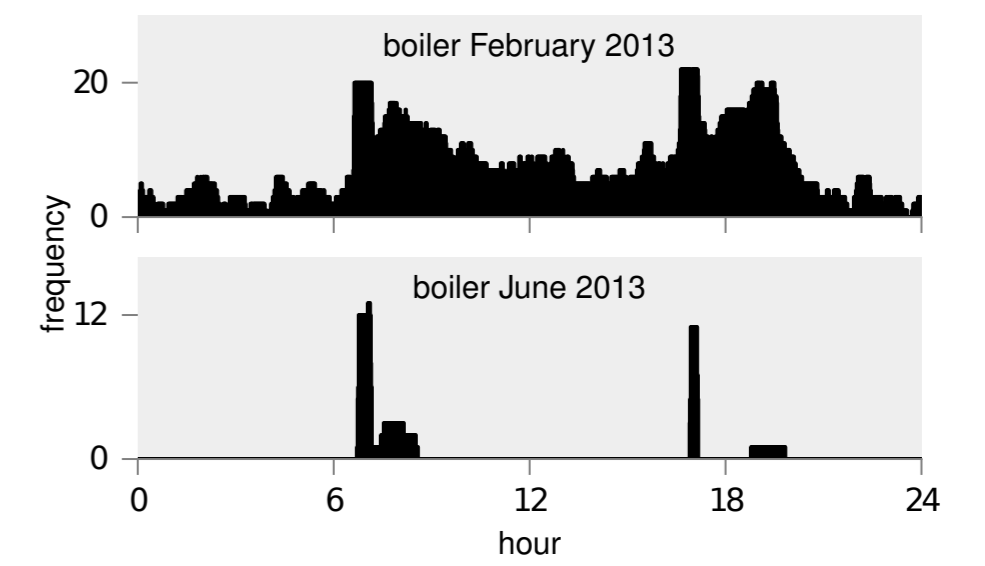
^c Difference between the first and last timestamps.

^d Total duration that the system was recording.

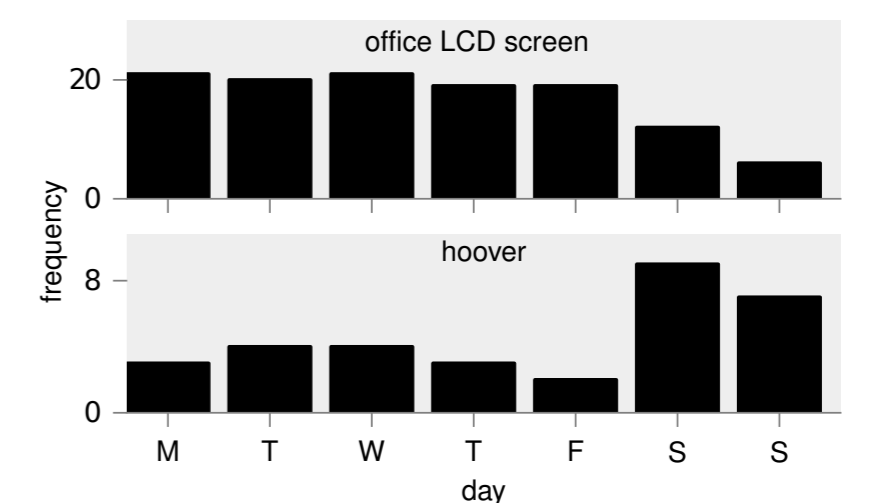
Histograms of appliance usage over average day:



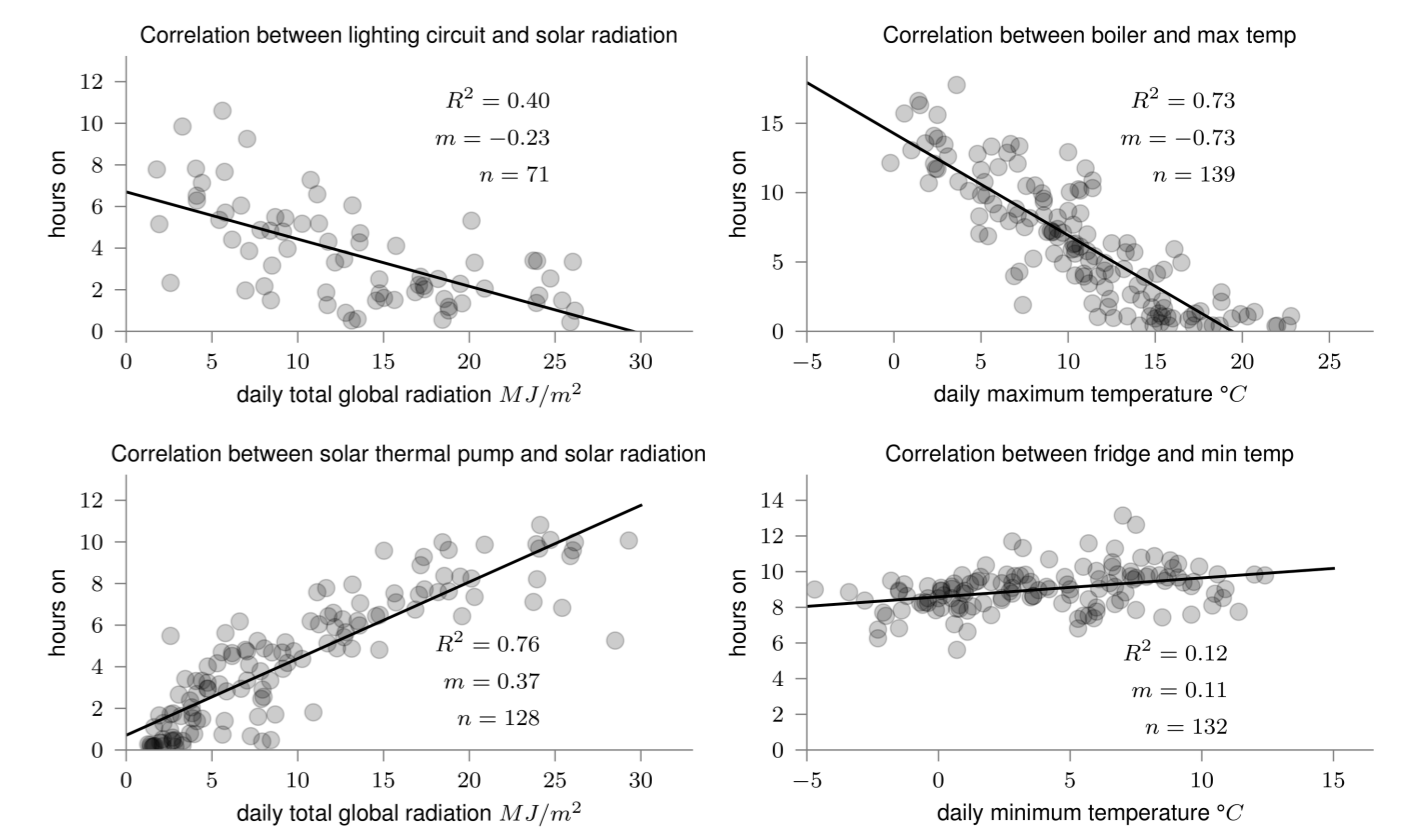
Histograms showing seasonal variation in daily boiler usage:



Histograms showing weekly appliance usage:

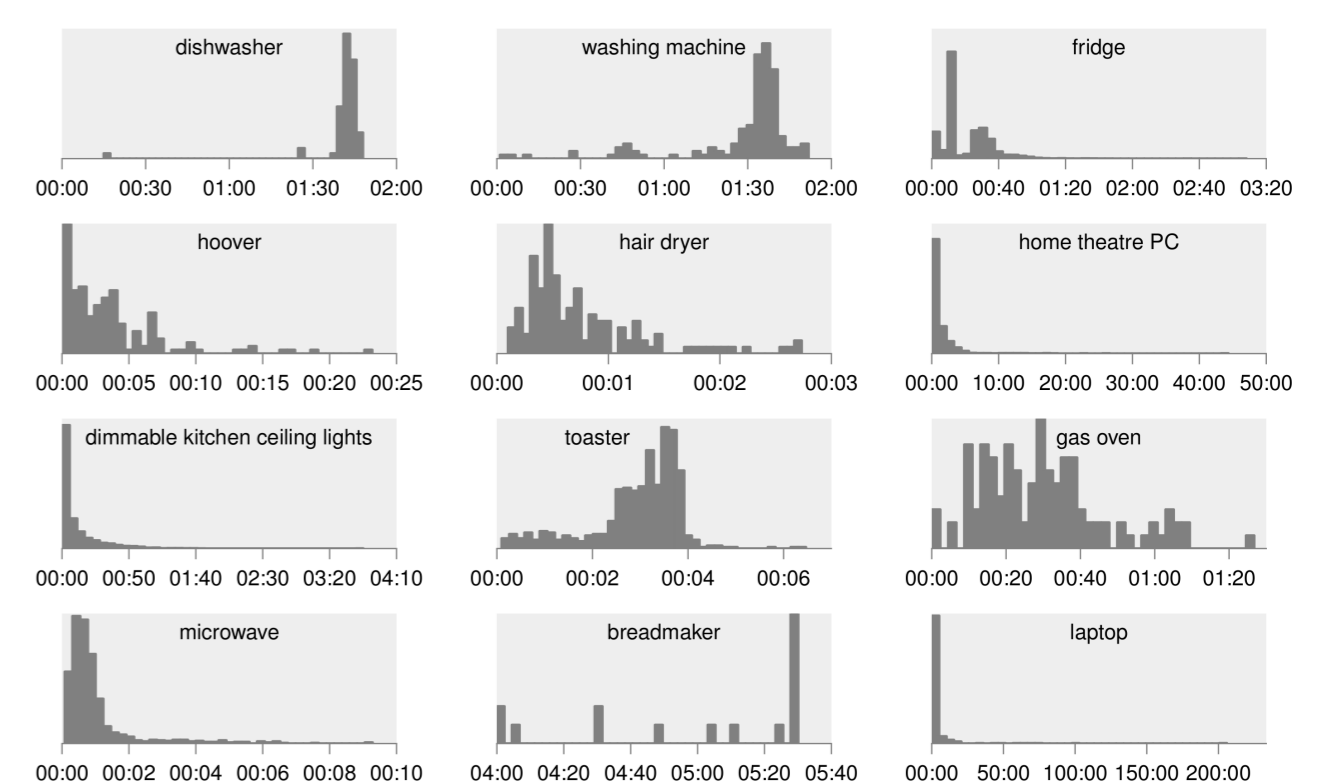


Correlations between appliance usage and weather:



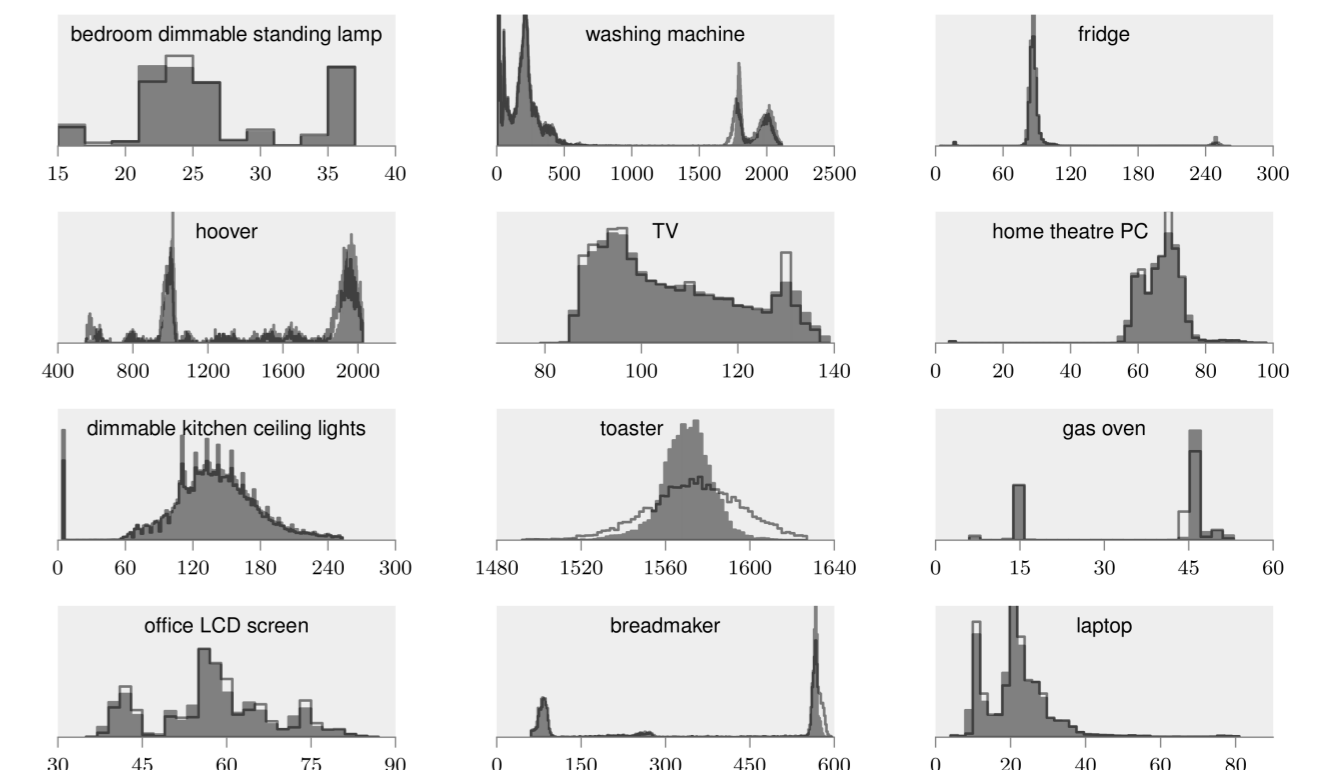
Each data-point represents one day. Historical daily weather data from Heathrow weather station (20 miles west of the premises under consideration) were obtained from the UK Met Office under their Educational program. Days for which the appliance usage was zero were ignored because we assume that the house was unoccupied on these days.

Histograms of appliance on-durations:



Horizontal axis denotes duration formatted as HH:MM. Vertical axis indicates frequency.

Histograms of appliance power consumption:



Horizontal axis denotes appliance power in watts. Vertical axis indicates frequency. The filled grey plots show histograms of "normalised power". The thin, grey, semi-transparent lines drawn over the filled plots show histograms of un-normalised power. Normalisation is calculated using the following formula: $P_{Norm}(t) = \left(\frac{230}{V(t)}\right)^2 \times P(t)$

REFERENCES

- [1] Jack Kelly and William Knottenbelt (2014). UK-DALE: A dataset recording UK Domestic Appliance-Level Electricity demand and whole-house demand. ArXiv e-prints, arXiv:1404.0284
- [2] Jack Kelly and William Knottenbelt (2014). Metadata for Energy Disaggregation. In The 2nd IEEE International Workshop on Consumer Devices and Systems (CDS) in Västerås, Sweden. arXiv:1403.5946
- [3] github.com/nilmk/nilm_metadata

ACKNOWLEDGEMENTS

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