Politecnico di Torino
Dipartimento di Automatica e Informatica

PhD in Computer and Control Engineering
XXXVI cycle

Fondazione CRT

Supervisor
Prof. Enrico Macii

Machine learning for the analysis of energy consumption and production

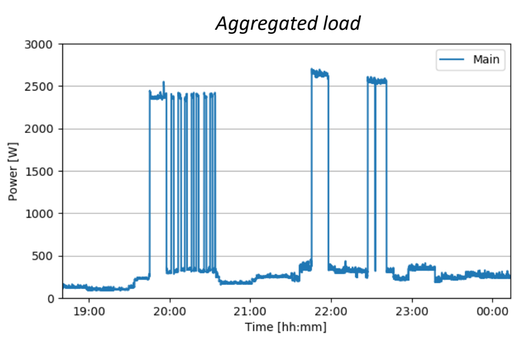
PhD Candidate: *Marco Castangia*

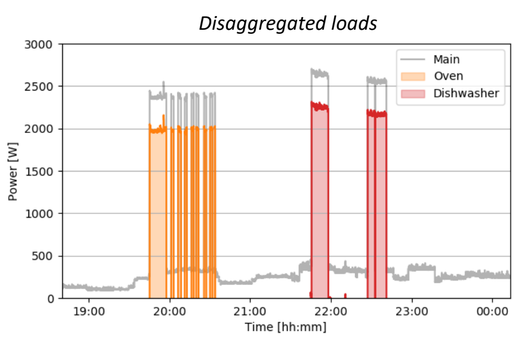
1. Introduction

Load monitoring has proven to be an effective technique for reducing the energy consumption of end users through greater awareness of their energy use. Specifically, the researchers found that real-time energy feedback down to the appliance level can be much more effective than simply providing whole-house information on energy consumption. Intrusive load monitoring solutions such as smart plugs are impractical due to the high costs of their distribution and maintenance. For this reason, non-intrusive load monitoring solutions based on software programs are generally preferred.

2. Non-Intrusive Load Monitoring

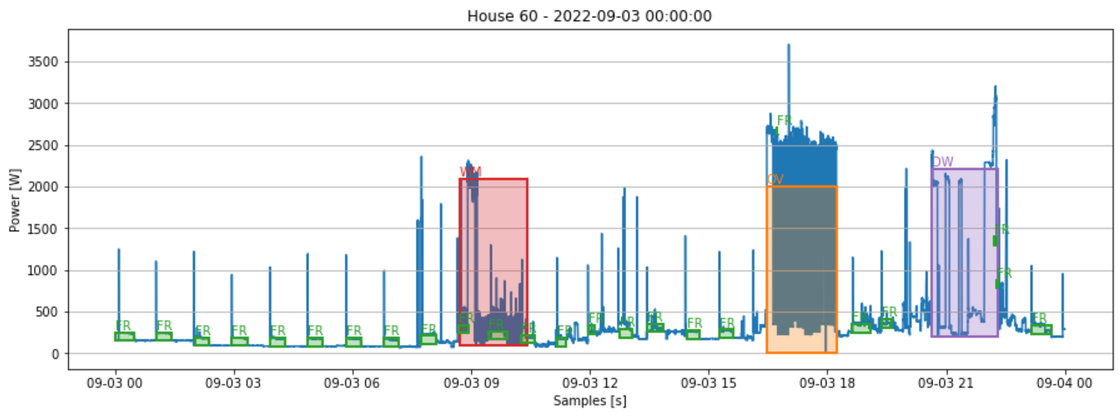
Non-Intrusive Load Monitoring (NILM) aims at estimating the energy consumption of electrical devices by analysing the aggregated load measured at the main meter of the house. The whole-house power consumption is monitored by a single meter connected to the main electrical counter of the house. The NILM algorithms running on the cloud analyze this data in real-time and provide the energy consumption of the individual devices operating in the house.





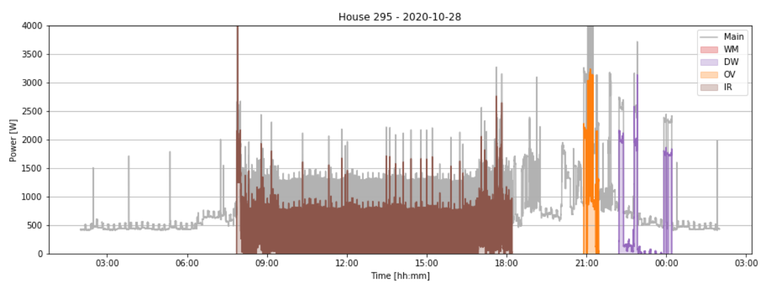
3. Methodology

Typical appliances present specific power signatures that allow us to recognize them within the aggregated load of the house. A library of deep learning models is in charge of detecting the operations of the different electrical devices. Eventually, a software module processes the aggregated load to estimate the energy consumption of the specific appliance operations.

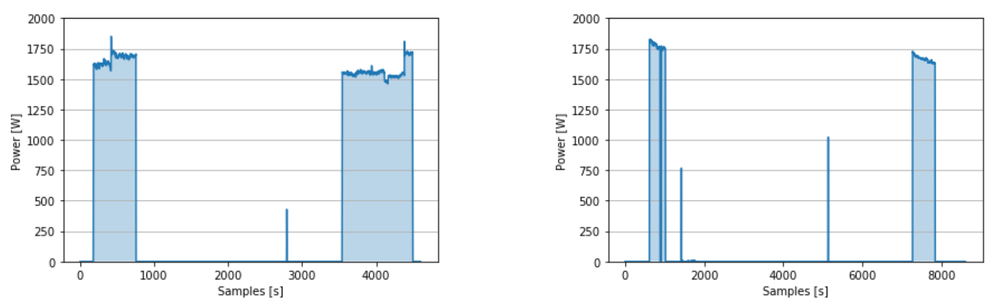


4. Applications

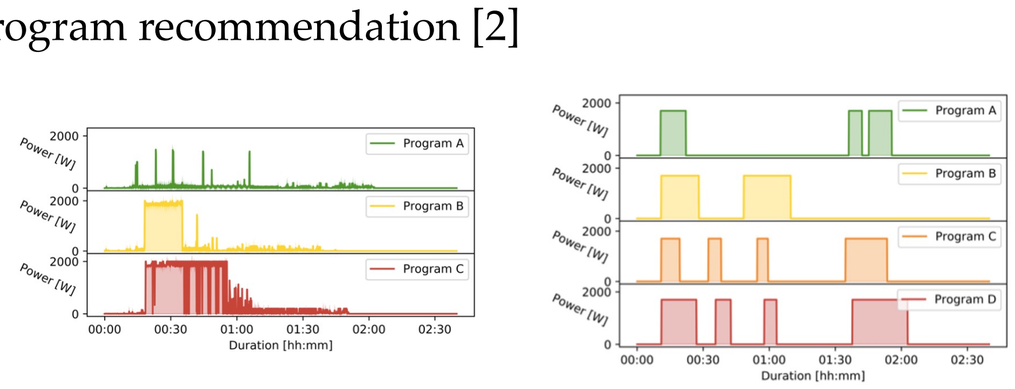
Anomaly detection [1]



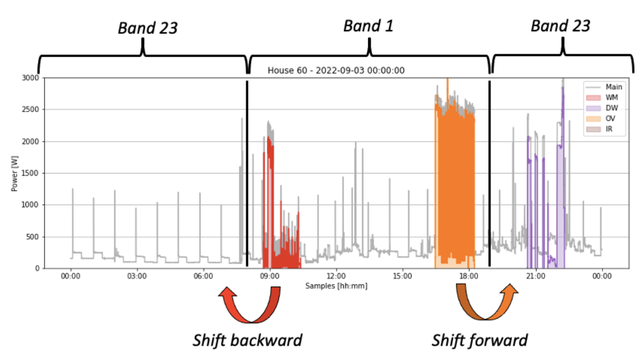
Detect inefficient appliances



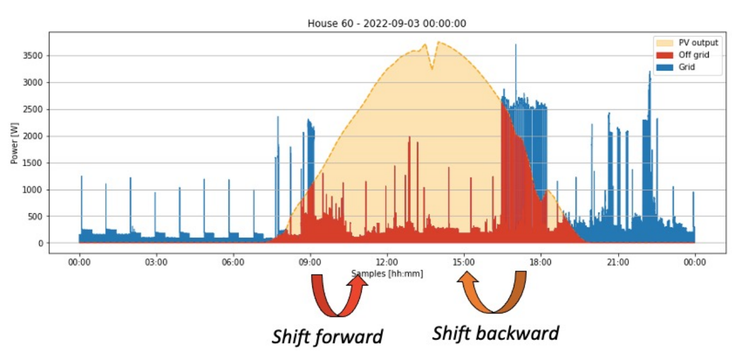
Program recommendation [2]



Demand response



PV integration



5. References

[1] Castangia, M., Sappa, R., Girmay, A. A., Camarda, C., Macii, E., & Patti, E. (2022). ***Anomaly detection on household appliances based on variational autoencoders.*** *Sustainable Energy, Grids and Networks*, *32*, 100823.

[2] Castangia M., Barletta N., Camarda C., Quer S., Macii E., Patti E.(2022); ***Unsupervised deep learning techniques for clustering appliance operation modes.*** IEEE Transactions on Industrial Informatics.