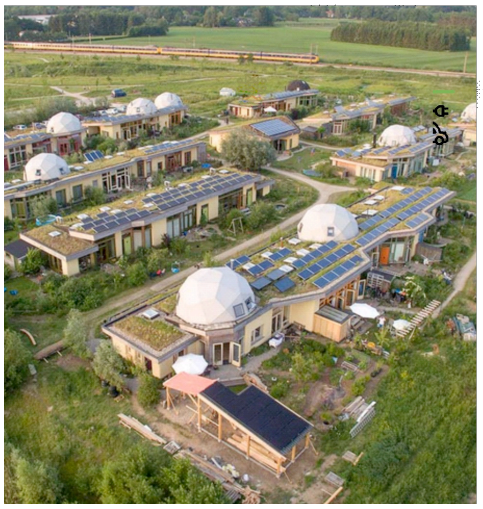
AUTOMATIC ENERGY USSAGE DETECTION ALGORITHMS FOR SUSTAINABLE ENERGY SOLUTIONS

PROJECT INTRODUCTION



To accelerate the transition of the European electricity supply to a more decentralized structure with local renewable production and sustainable consumption, the recently founded Horizon 2020 SUSTENANCE European project aim to demonstrate cost-effective and customer-centric solutions for effectively integrating different energy system carriers (electricity, heat, water) for the sustainable development of local communities to meet their energy needs from local renewable energy sources. Some of the overarching goals are to research all relevant technical and non-technical challenges in establishing the best combinations of local renewable energy production (solar PV, wind), energy storages (battery and thermal), flexible demand (heat pumps, HVAC, electric boiler, electric vehicles, wastewater pumping) and demand-response based technologies and solutions forming an integrated user-centred and community-based sustainable energy solutions for smaller cities, villages, and local communities. The overall project objective is to investigate how citizen involvement can be improved to promote as much as possible renewable energy sources to solve grid problems and to stimulate self-consumption of local renewable energy, thus minimizing the CO2 generation.

The current project demonstrator in the Netherlands involves the local community of Vriendenerf (https://www.vriendenerf.nl/) in the village of Olst, active around sustainability, renewable energy and self-sustainable communities.

Within Saxion, the research group of Ambient Intelligence (AmI) and Sustainable Energy Systems (SES) are contributing to the two projects by providing solutions for IoT monitoring and controlling systems (sensing, storage, and management), energy management system (EMS), energy analysis tools, user dashboards and applications, to provide the best solutions for the inhabitants in the self-management of power and energy resources to promote sustainable energy behaviors.

ASSIGNMENT TASKS

Within the scope of providing intelligent management tools to energy prosumers (producers and consumers), house inhabitants, we would like to research a developed intelligent algorithm that will automatically detect energy events to provide information about the local usage of energy from different energy systems. These algorithms can be based on simple and traditional

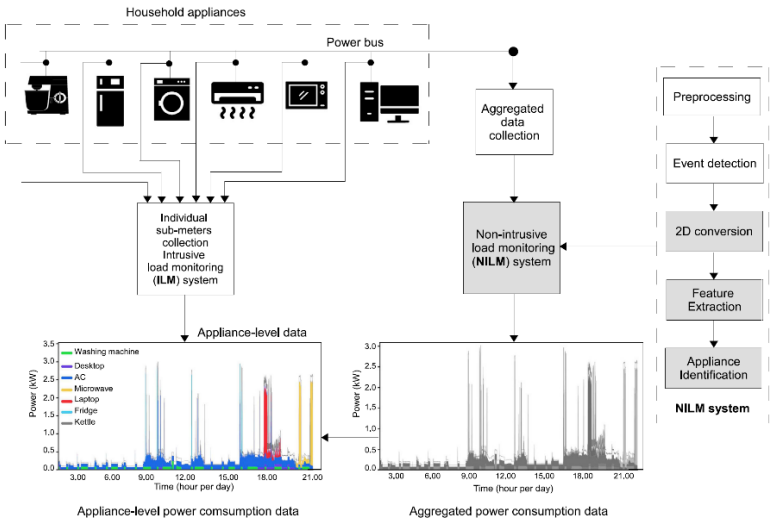
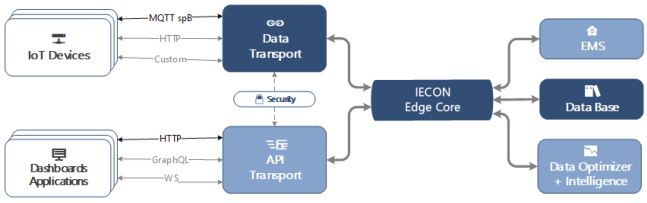


Figure 1 – Example appliance classification system. https://doi.org/10.1016/j.scs.2021.102764

detection methods, or by using more advanced techniques such power disaggregation algorithms or smart non-intrusive appliance identification methods (see example on Figure 1). The overarching goal is to integrate this energy usage detection algorithms results into the user dashboards, so the detected events can be used to provide feedback and tips to promote sustainable energy usage, as well as providing overviews of the different energy consumptions by different appliances. The system should be able to analyse and best identify the energy usage information from aggregated power profile data streams, as well as for individual power meters, which are provided by smart power meters installed in houses.



As part of the SUSTENANCE project, the Ambient Intelligence research group is researching and developing a lightweight IoT software framework for IoT data collection and management infrastructure for the energy transition. Such framework, named as IECON "IoT Edge Computing for carbon neutral communities"), provides the infrastructure for IoT data collection, data storage, interfaces for the end users (dashboards, mobile apps and generic interfaces) as well as the possibility to incorporate modular software applications for the analysis of energy data streams, like the algorithm listed in this assignment.

The envisioned assignment tasks will include, but are not limited to:

- State-of-the-art research, literature review and analysis of different algorithms for real-time power/energy usage based on traditional methods as well as latest AI ML-based algorithms, that ideally should be designed to operate on real-time bases as well as on computational lower-performance computers (edge solutions via Single Board Computers).
- Development, evaluation, and benchmarking of a sub-set of selected algorithms for power/energy activity classification, based on real un-labeled household data as well as collected labeled data obtained by the students.
- Integration of detected energy events as part of the IECON framework via standardized API's and communication interfaces. This information will be used by the user dashboards and mobile applications, to give an overview of the energy/power events.
- Software solution tests and validations based on real-time household load power data.
- (Optional) Development of a simple front-end as well as the back-end infrastructure to display a simple user interface to visualize the detected events as well as the overall energy consumption, or to label unknown events by the end users.

Energy/power data sets, that are collected real-time using the IECON framework, will be provided (un-labelled data) containing several energy devices as well as different types of events. Also, if required, a set of plug energy meters can be provided, if the students are interested to collect extra data or controlled events.

PRACTICAL INFORMATION

Student profile: HBO-ICT, ACS, EE student/s with affinity for time-series analysis and algorithms, affinity to AI and machine learning algorithms and techniques. Optional, knowledge back-end and front-end technologies. A proactive attitude capable of independent work, as well as interested in the energy transition applications.
Contact: Javier Ferreira Gonzalez (j.ferreiragonzalez@saxion.nl)