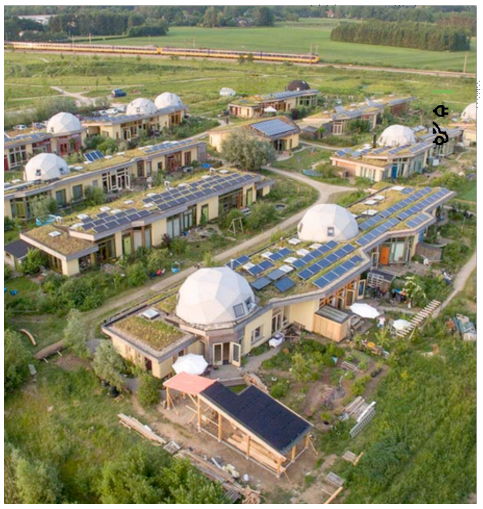
# OPEN-SOURCE EMBEDDED IOT STANDARIZED MODULAR PROTOCOL FOR SUSTAINABLE MICROGRIDS COMMUNICATIONS

## PROJECT INTRODUCTION



To accelerate the transition of the European electricity system to a more decentralized structure with local renewable power production and optimized 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 for the sustainable development of regional communities to meet their energy needs from local renewable energy sources. Some of the goals are to address all relevant technical and non-technical challenges in establishing the best combinations of local renewable energy (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 energy solutions for smaller cities, villages, and local communities. The overall project objective is to investigate how citizen involvement can be improved to create 100% renewable energy on neighbourhood level, including using heat pumps, solar PV and smart grid technology to solve load balancing problems and to stimulate self-consumption of local renewable energy. In this way, the consumption of carbon based energy sources as a heat source in existing neighbourhoods can be phased out and dependency on the national grid and problems with local, low voltage grids can be avoided.

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

Within Saxion, the research group of Ambient Intelligence (AmI) is currently involved in research topics around IoT system solutions (for data sensing, distribution, storage, and management), distributed energy management system (EMS), energy analysis tools, user dashboards and application tools, to provide the best solutions for the inhabitants in the self-management of power and energy resources to promote sustainable energy behaviors while minimizing the CO2 footprint.

As part of SUSTENANCE project, Ambient Intelligence is developing the back-end cloud infrastructure framework and IoT data collection infrastructure (named as IECON "*IoT Edge Computing for carbon neutral communities*"), as well as the interfaces for the end users (dashboards, mobile apps and generic interfaces). The IoT IECON framework is developed and optimized to run on low performance computing platforms, such as Single Board Computers, in order to provide advanced and optimized ICT services at the edge (home edge server), as well as providing a robust and resilient management system that can run local and distributed Energy Management System applications (management of local energy assets such as charging electrical vehicles, home batteries, heat pumps among many others), making it more resilient to internet disconnections or some type of cyber-security attacks (*ie.* DoS).

## ASSIGNMENT TASKS

Within the scope of microgrid communications and embedded IoT systems (sensors, devices, and actuators), we would like to research and developed a **modular software library** to provide **standardized Industrial IoT (IIoT) communications interface** for fast and efficient communications to embedded platforms and IoT devices with restricted performance (ie. power consumption, computation power or storage capacity among others), like in microcontrollers systems or single board computers.

Specifically, we are looking at the latest Eclipse Sparkplug B standardized specifications (https://sparkplug.eclipse.org) which standardizes MQTT communications, aiming for the development and integration of a C/C++ software modular library that can be used generically for embedded platforms to provide optimized microgrid communications following this specification. As for hardware platform, we are also interested at the widely used and powerful Espressif ESP32-based platform, as all the derived commercially available ESP-based devices (i.e. Shelly, BlitzWolf, LSC Smart Connect) for the integration of our custom IECON Microgrid MQTT Sparkplug B communication interface.

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

- Research, understanding and analysis of the Eclipse Sparkplug B v1.0 standardized specifications, MQTT communication protocol, Espressif ESP development platform as well as the Arduino-based framework, for the development of the embedded library. Analysis of cybersecurity features (privacy and security) of the communication standard, with emphasis on embedded platforms.
- Design and development the C/C++-based modular software library, following the MQTT Sparkplug B standard. The custom C/C++-based library must be integrated as part of the Arduino ecosystem for ESP-based platform, so it can be easily integrated and instantiated from any Arduino and ESP-based projects.
- Validation and testing the developed library as part of a IoT device system, for example a smart power plug or an environmental monitor device. The test should be performed first in a controlled laboratory environment, as well as later in home environments (H2020 SUSTENANCE project).

Our goal is to release this library as Open-Source, therefore the library should be well tested and validated as well as analysing all the requirements for open-source code. This work will be based on an already first working version of the library that was performed previously by another researcher.

## PRACTICAL INFORMATION

**Student profile:** from HBO-ICT, ACS or EE with knowledge in embedded software C/C++, IoT solutions, wireless technologies, and passion to developed embedded systems for real applications and interested in the energy transition challenges.
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