PENTAGON
Computational Urban Sustainability Platform

Newsletter #3

October 10, 2019

PENTAGON aims to increase the electrical and thermal grid flexibility and to improve renewable energy systems penetration.

New generation district energy systems with intermittent energy resources, multi-vector energy production and distribution, dynamic energy storage and prosumer management and demand response have proved challenging to model and optimise. As a consequence, distributed solutions for real-time district energy management, such as the one developed within the Pentagon project, face a number of development and deployment challenges due to the variety and the high degree of specialisation of the software modules involved. Different modules (building management system gateways, physical simulation tools, machine learning based prediction models, optimisation algorithms etc.) must work together to provide optimal controls to the district energy system.

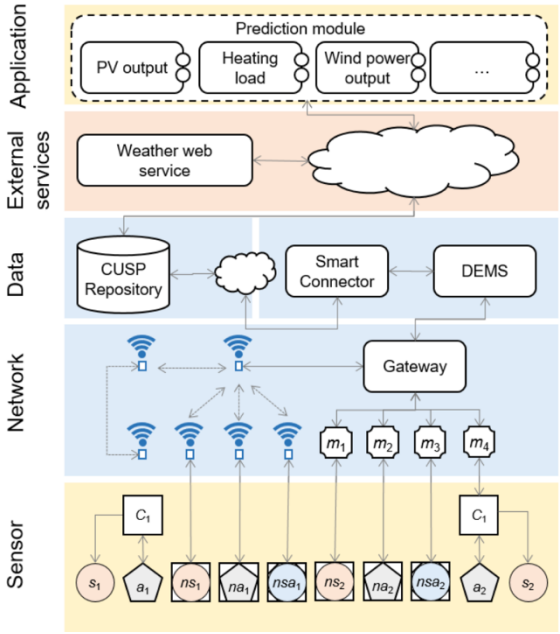

Figure 1. Prediction Model integration

Figure 1 shows how the PENTAGON solution integrates different modules in the architecture. This newsletter focusses the attention to the prediction model implemented by Cardiff University.

The Pentagon project implemented a cloud-native approach called CUSP (Computational Urban Sustainability Platform). CUSP helps with the cloud readiness of the platform in two main ways: by providing a shared semantic model and by fostering scalable practices. CUSP instances expose a common representation of domain models that conforms and builds upon the terminology and concepts defined by the standardised W3C Semantic Sensor Network ontology. The CUSP API (Application Programming Interface) is hosted in REST Web services, thus allowing the Pentagon modules to exchange structured knowledge and contextualised data relating to the targeted district energy system, while remaining independent in terms of development and deployment. Developers from separate organisations can therefore make their own development plan and keep their own intellectual property. The developed modules can rely on any bespoke/legacy framework. Having CUSP at the heart of its architecture also makes the Pentagon platform scalable. Each of the major components of CUSP (REST controller, graph database, cache, and message broker) is natively distributable on multiple server instances for performance and/or fault tolerance.

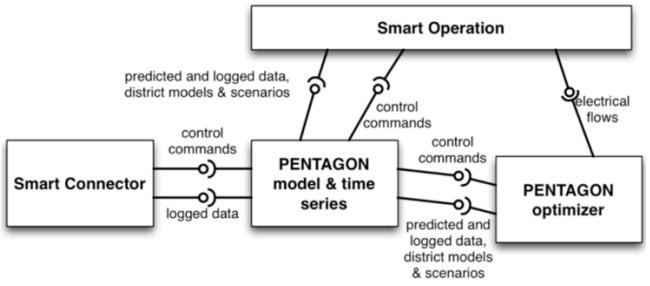

Figure 2 - PENTAGON functional architecture

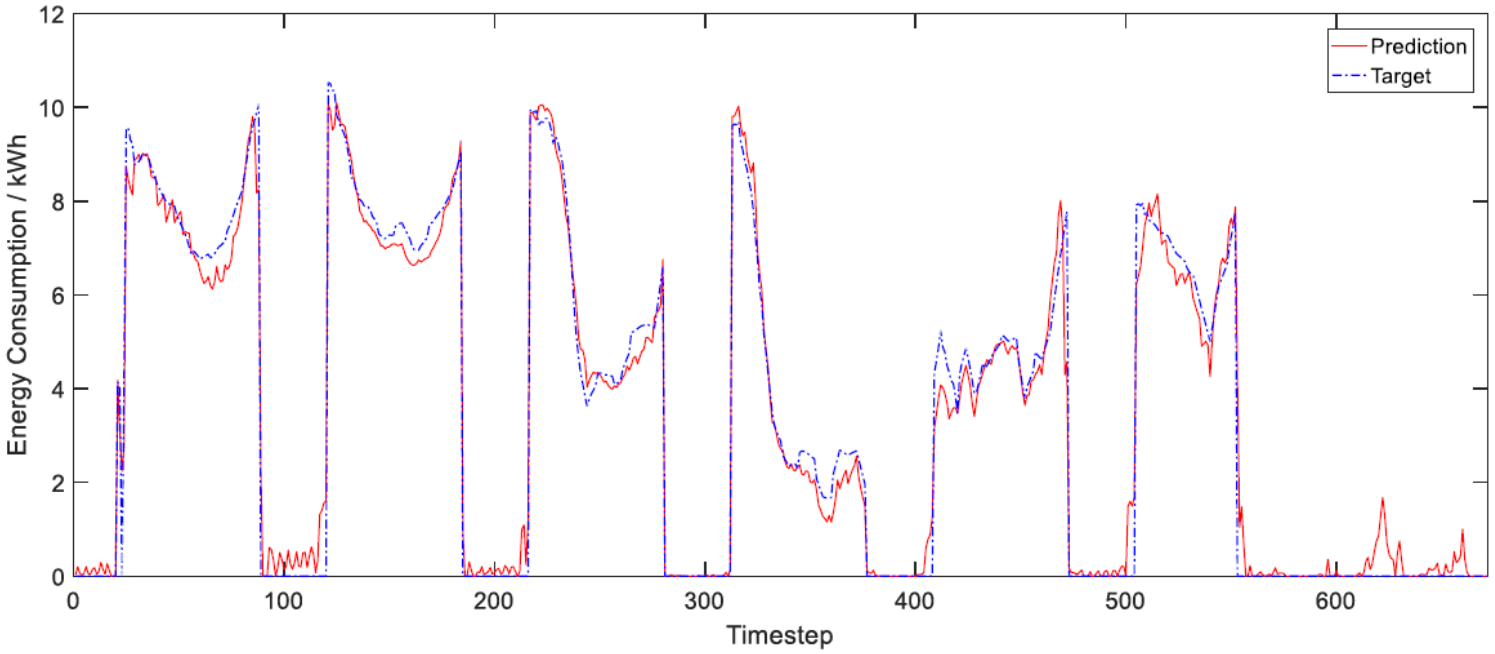

Figure 3. Example of energy prediction compared to the target.

Pentagon also draws on the adoption of predictive models with the scope of extracting relevant information from measured energy-related data and to inform the development of a real-time management platform. Additionally, the integration of predictive analyses favors the comfort of the users, leading to lower operational costs and preventing peak demand. In order to provide the machine learning algorithm with a suitable level of generalization, long-term historical data are needed to perform its training. The scope of the proposed model is to predict energy consumption at the district level based on historical data regarding measure and simulated energy usage but also weather forecast. In detail, both heating and electricity consumptions are considered as well as weather-related data over a period of more than a year. The considered variables as an input for the algorithm need to be known at least 24 in advance respect to the prediction and they include for instance: occupancy, solar radiation, heating consumption and day of the week. The prediction model is deployed by means of artificial neural networks, which consist in a machine learning approach emulating the way human brain operates.

Contacts:

Marco Rocchetti (R2M): marco.rocchetti@r2msolution.com
Muhammad Ahmad (Cardiff University): AhmadM3@cardiff.ac.uk
Giulia Cere (Cardiff University) CereG@cardiff.ac.uk

http://www.pentagon-project.eu