Energy solution: SPIKE

Piloting in: Amsterdam & Copenhagen

Introduction

SPIKE, a scalable “plug&play” kit of devices can be installed in every building to fine-tune energy usage in real-time, allowing 20% (on average) operational savings and over 90% in-comfort time for occupants, without any drastic changes to the existing HVAC. The company's most recent solution is an all-in-one-platform, implementing the concept of “Energy as a Service”, which helps orchestrate energy loads and renewable energy production within energy communities.

SPIKE is an all-in-one, cloud-based software/hardware platform supporting data exchange with proprietary IoT-enabled devices and communication with other IoT devices/platforms, knowledge extraction for situation-aware user interaction and engagement, building performance assessments and dedicated energy management services capable of innovative and effective optimization of energy efficiency and flexibility in commercial, service and residential buildings. With these features SPIKE aims to become the world’s first enabler for easily creating a Virtual Power Plant (VPP) at urban level

The challenge

The Italian company Enerbrain has identified three megatrends in the energy sector: decentralisation, digitalisation and decarbonisation. Enerbrain also sees the sector lacking the necessary infrastructure required to switch from a traditional, centralized way of supplying energy to a more decentralized and user-centred approach. Adding to this are concerns that Europeans are faced with a critical period for energy supply. In this context, the smart management of energy consumption is crucial to make sure the European community can keep its economy and lifestyle thriving. Tot that end, Enerbrain is optimizing SPIKE (Sustainable IoT Kit for energy management), a new software (SW) and hardware (HW) solution aimed at smartly orchestrating energy consumption and comfort in a building and clusters of buildings, proposing an easy way to create energy communities at district level

The solution

Buildings are responsible for 40% of global CO2. Depending on the building type, approximately half of the energy required for building operations is consumed by HVAC systems, reducing the carbon footprint of the built environment means reducing the energy use linked to HVAC systems. With this in mind, the SPIKE solution aims at reducing CO2 emissions of buildings by improving the energy management in the existing HVAC systems through strategic and smart modifications to their regulation policies. SPIKE works on a combination of self-learning strategic control algorithms with IoT devices. It is scalable and compatible with any type of pre-existing infrastructure, enabling any kind of building to join an energy district.

SPIKE does not require the replacement of HVAC components (thus avoiding embodied carbon emissions of newly produced HVAC hardware and the time and costs associated with their installatio), but it uses IoT controllers to better steer the existing ones. These newly provided controllers operate the existing HVAC system through the commands elaborated by edge and cloud-based AI algorithms, which define optimal control strategies. The achieved CO2 reductions can be measured by using energy use as a proxy. The energy consumption of the building is measured prior to the installation of SPIKE and after its implementation. The two are compared to assess the energy consumption reduction in terms of kWh or MWh. Once the energy saving assessment is determined, the saved CO2 can be calculated by applying energy-to-CO2 conversion factors, which depend on the energy production’s source.

SPIKE is being designed to rely upon AI features for an optimal control of the energy management in clusters of buildings to create energy communities at district level. This is an emerging concept in the EU; the definition of "energy community" (EC) refers to a group of buildings/individuals/organisations that get together to optimize the production, distribution, and consumption of energy, in particular by optimizing the self-consumption of renewable energy. These are generally generated by a multitude of different generation points, creating the so-called Virtual Power Plants (VPPs). The energy consumption needs to be orchestrated in an optimized manner so as to perform peakshaving, which helps reduce the amount of energy required from the grid at a certain point in time, therefore reducing energy costs and optimizing renewable energy self-consumption.

The successful application of the optimal control depends on different factors, such as accurate measurements from sensors, highly reliable modelling, and choice of the cost function (a mathematical based optimization of competitive goals). The first two aspects are closely related, as the quality of the data will drastically affect the identified model: as a matter of fact, the algorithms employed for identifying the system model are trained on the dataset collected from the building. Moreover, it is crucial to pick the best method for each building under analysis, as each system carries its own peculiarities that can be best reproduced by different models. Finally, the cost function determines the overall performance of the system to reach the goal the user is aiming at.

SPIKE & AI4Cities

AI4Cities allowed Enerbrain to focus on three specific, and complementary targets:

- Installation of an IoT Kit in an lab-scale Energy Community (EC) to test the SPIKE infrastructure
- Algorithm development to find the best control strategies to send optimal instructions to IoT devices
- Online dashboard to manage a building's portfolio

This resulted in a number of important conclusions. The application of the prototype firstly confirmed that Enerbrain's initial estimation of CO2 emissions reduction is feasible and proved that SPIKE could achieve this goal and even do better. Whereas Enerbrain usually secures in municipality buildings an 15-20% av. of energy saving, thanks to a careful orchestration of energy loads within the EC, it proved that emissions can be cut down by an additional 12%. Furthermore, orchestration has proven that energy efficiency and CO2 reduction, due to exact monitoring of energy flows allows for precisely forecasting demand & supply, and maximising exploitation of RES (renewable energy sources). Enerbrain observed that there is room for improvement in RES optimisation and it believes that it will be able to lift the initial estimations. Testing SPIKE shows that a demand-response mechanism can be triggered, which may not lower energy consumption per-se, but definitely does decrease emissions and helps to balance the energy grid. Moreover, given enough time, SPIKE can learn the building's behavior based on weather conditions, allowing Enerbrain to predict the energy consumption per degree-day, and plan ahead for green energy production/storage/management.

AI4Cities also enabled Enerbrain to better understand its users. SPIKE is designed to be a scalable solution for public or private organisations with large real estates to manage. The main targets are buildings with large surface areas, multifunctional buildings or building portfolios which can benefit from energy usage and demand optimisation, including through aggregation and renewable energy self-consumption optimization. To do so, SPIKE is mainly aimed at energy managers, sustainability managers, mill managers, and CFOs looking to improve sustainability, energy efficiency and comfort within their premises and to reach ESG+H (Environmental, Social, Governance and Health) goals.

Additionally, in the near future, Enerbrain expects that the SPIKE solution will be particularly interesting for energy aggregators and utility companies, as it can offer energy management services

capable of innovative and effective optimization of energy efficiency and flexibility, which can help perform peak shaving and load shifting.

In summary, Enerbrain has been developing SPIKE to answer the increasing need for a smart solution that can reduce energy consumption in the buildings sector, in order to meet an ambitious, but imperative, CO2 emission reduction. The solution has been developed to be easy to implement and to be intuitive to be used by energy/facility managers and building owners, allowing them to set specific targets not only in terms of energy savings but also regarding comfort levels, demand-side flexibility and other factors. The intensive research on the algorithmic component of the solution has allowed Enerbrain to deliver innovative AI computational capabilities, able to guarantee top-notch performances. As such, AI4Cities has been a great opportunity to start developing SPIKE, which Enerbrain sees as the first step towards a more sustainable and user-centered energy management approach at district level.

The consortium

To develop and install SPIKE, the Enerbrain team consists of SW and HW developers, energy experts and energy field engineers. Enerbrain is divided into several departments which take care of the customers during the different phases of the solution implementation and application. Once the the IoT devices in the building have been deployed and SPIKE has been turned on, Enerbrain provides remote assistance and support to the facility manager of the building with a dedicated helpdesk. Such support is extended from IT support with the EB platform functionalities to a ticket management service for maintenance operations.

Enerbrain has recently closed a 5M€ investment round thanks to EDF Pulse Croissance and others, ensuring the company's financial capacity to be ahead of the curve in the upcoming market scenario. With its participation in AI4Cities and the development of SPIKE, the company was able to address the emerging market of Energy Communities, projected to become an EU-wide standard.

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