End of the Phase Report

Phase 3

The purpose of this report is to explain the progress, the achievements, and deviations of the Phase 3 implementation and the end results of the product development during the AI4Cities project.

If you have any questions or comments regarding the reporting template, please send the questions to Slack by 7.8.
Some minor adjustments or clarifications can be made if necessary.
The final version of the template will be confirmed by 12.8. (if any changes have been made).

The deadline for the submission: 16.9.2022 (via web form)

Date
16/09/2022

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a. Part 1 - The Solution

1.1. PRODUCT DESCRIPTION

White paper* (max 4 pages) - for the public use
Demo video (3 min) to present the product - for the public use

Customer perspective (The solution presented as it would be presented to a potential customer.)

Explain your solution's key elements and functionalities:

1. CO2 reduction method/logic
2. Other benefits of the solution (if any)
3. AI functionalities
4. Innovativeness of the solution
5. Maintenance and support provided after deployment
6. Main customer groups
7. Relevance for the customers and advantages for the potential customer segment(s)
8. Pricing

You're welcome to use pictures and other visual elements. The document and the video can be published.

*) An informational document issued to promote or highlight the features of a solution, product, or service that it offers or plans to offer.

We live in a historic phase where the energy sector is shaken by the three megatrends: Decentralization, Decarbonization and Digitalization. In the meantime, it lacks the necessary infrastructure required to switch from a traditional, centralized way of supplying energy to a more decentralized and user-centered approach. Moreover, as Europeans, we are facing a crucial political period for energy supply sector. In this scenario, the smart management of energy consumption is crucial to make sure the European community can keep its economy and lifestyle thriving.

Enerbrain (EB), thanks to AI4Cities, 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** (fig. 01).

Buildings are responsible for 40% of global CO_2 emissions (IEA, 2021, Global Status Report for Buildings and Construction). Considering that, depending on the building type, approximately half of the energy required for building operations is consumed by HVAC systems, a winning solution to reduce the carbon footprint of the built environment is to reduce the energy use linked to HVAC.
To this purpose, our SPIKE solution aims at reducing CO_2 emissions of buildings by improving the energy management in the existing HVAC systems through strategic and smart modifications to their regulation policies.
This solution does not require the replacement of HVAC components (thus avoiding embodied carbon footprint of newly produced HVAC hardware and the time and costs associated with its installation as well), but it uses IoT controllers to better steer the existing ones. These newly provided controllers operate the

The project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 871914.

existing HVAC system through the commands elaborated by edge and cloud-based AI algorithms, which define optimal control strategies (see "AI functionalities").
The achieved CO_2 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 CO_2 can be calculated by applying energy-to-CO_2 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 European scenario, and 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 peak-shaving, 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 (Demand Side Management-DSM).

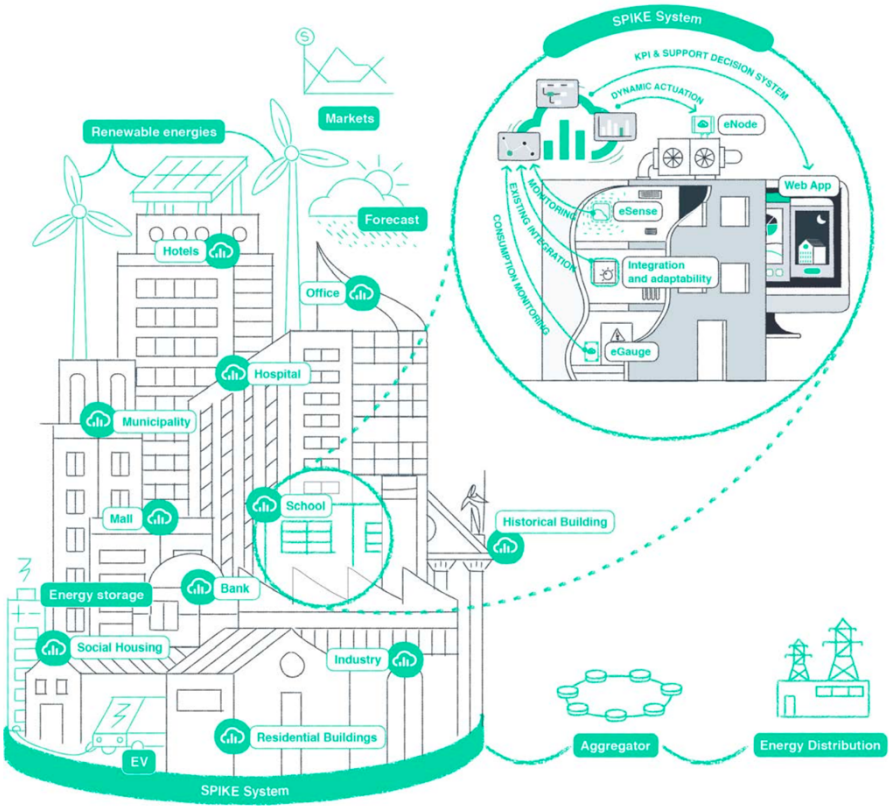

Figure 01: SPIKE System

During AI4cities, we have been focusing on experimenting predictive models at building level, a first step towards a more comprehensive, sustainable smart grid orchestration. We apply a *model-based design* method where the first step is a data-driven building modelling, created through a *System Identification* approach, which allows us to synthetize a Model Predictive Controller (MPC) based on the mathematical model of the building. With this solution, the user can express a specific target in terms of energy saving, CO_2 reduction or comfort, from which, the controller elaborates the best possible set of commands for the HVAC system to reach that chosen goal.

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The successful application of the optimal control depends on different factors: accurate measurements from sensors, highly reliable modelling, 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 in our libraries 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.

To develop and install this solution, 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. After the deployment of the IoT devices in the building and the SPIKE system is 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.

SPIKE is designed to be a scalable solution for public or private organisations with large real estates to manage. Our main targets are buildings with large surface areas, multifunctional buildings or building portfolios which can benefit from energy usage and demand optimization, also through aggregation and renewable energy self-consumption optimization. To do so, we mainly address energy managers, sustainability managers, mill managers, 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, our solution will be particularly interesting for energy aggregators and utility companies, as we 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.

Our SPIKE solution could be object of **multiple commercial arrangements**:

i. Standard purchase - client is required to pay for a capex (HW and configuration) and an annual fee (software license and data transmission);
ii. Leasing - client is required to pay a monthly fee for all the solution (SW+HW), with a 2 to 5 years contract;
iii. Energy performance contract: Enerbrain provides clients with HW and platform, by sharing its future energy savings.

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, to meet ambitious but imperative CO_2 emission reduction. We have been developing the solution 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 others. The intensive research on the algorithmic component of the solution has allowed Enerbrain to deliver innovative AI computational capabilities, able guarantee top-notch performances. AI4Cities has been a great opportunity to start developing SPIKE, the first step towards a more sustainable and user-centered energy management approach at district level.

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