Smart and efficient buildings

A short overview of key technologies, challenges and future opportunities

Foreword

Work package 2 of the INCASE European project (towards INdustry 4.0 via Networked Control Applications and Sustainable Engineering) aims at designing and implementing sustainable engineering pilots, using the new and emerging key automation technologies covered in INCASE for the future factories and buildings, in order to increase market introduction, and thus resulting in decreased energy consumption. The rationale behind having two quite different domains, factories and buildings in the same work package is that cross-fertilization could bring up new ideas and solutions.

As an early step toward this goal, INCASE involved partners worked on a series of reports covering essential aspects and technologies for smart buildings.

This document will give the reader a quick overview of smart buildings, the key technologies involved, the challenges and the future opportunities and it will finally introduce the more in-depth technical reports authored by INCASE partners.

Smart buildings

Buildings in general (residential / commercial / offices / industrial buildings and healthcare facilities) are the largest contributors to global carbon emissions. They account for about 40% of the world's total footprint. Reducing the impact of buildings on global carbon emissions is of course important to help fight against climate change, but for building owners it is not the only driver. In organizations, after salaries, buildings are one of the biggest operational expenses and energy amounts for a significant part in this.

New buildings can be of course designed to be more efficient, but obviously most gains will come from retrofitting existing buildings and infrastructures. In recent decades, most buildings (however mainly non-residential) have been equipped with an increasing number of sensors, control systems (building management systems – BMS -, building automation systems – BAS), panels, and other devices and significant energy savings can arise from the use of analytical tools that will help achieve a better integration and orchestration of

these quite often disparate building systems.

The rise of the Internet of Things (IoT) opens up opportunities to further enhance these systems by combining them with a very wide variety of brand new kinds of devices ranging from smart appliances to plug energy meters, smart locks, air quality monitors, smart thermostatic valves and so on. Often, these “things” may not have been designed primarily to help save energy: they may for instance be part of some other system dedicated to the safety (air quality monitoring, elderly care alerts, ...), the security (access control, window opening detectors, ...), the welfare (smart locks, smart fridge, …) or anything else. But these things tend to be:

- rather cheap (ready for residential market),
- quite versatile,
- easy to deploy (running on battery and using wireless technologies)
- easy to integrate (Internet ready, able to connect to the cloud)
- and the additional data they produce are often very helpful to the analytical tools that continuously monitor, orchestrate and control the building management systems.

Challenges

Several challenges must however be overcome. A first one relates to connectivity and integration. Data from existing equipments and building systems (HVAC, lighting, meters, sensors, access control, elevators, BMS, ...) must be remotely accessed, yet these systems tend to be quite disparate (kind, manufacturer, age), use different communication protocols and often are not designed to connect to IT networks.

Another challenge relates to the cost of retro-fitting an existing building, a cost that may be significant compared to the expected savings for certain classes of buildings: mainly older, smaller scale or residential buildings, school buildings, buildings lacking proper building systems or technical ceilings, ...

No retro-fitting project will however deliver expected savings without the proper involvement of users, occupants, building managers. Usability is thus another major challenge for smart building solutions. These tools tend to produce very large volumes of data and it is critical to present only appropriate subsets of it and moreover in a consumable and actionable form (e.g. it has to be easy to understand and one should easily figure out what to do with it and how to do it). This is of course an HMI issue, dashboards may be used as interfaces, but multi-modal approaches with the addition of text to speech and command or gesture recognition may be in some case more appropriate.

Future opportunities

Some key technologies may have a significant impact on the rate of adoption of Smart Building solutions by addressing several challenges and mitigating common barriers. As

an example, all technologies related to the Internet of Things and in particular standard low power wireless communication will have a deep impact on Smart Buildings, because they have the potential to significantly lower the costs of retro-fitting older and also residential buildings (thus addressing more effectively the B2C market).

Other technologies may as well have the potential to bring disruptive innovations to next generation smart building solutions. Artificial intelligence / machine learning belong to that category, as a result of their ability to combine, correlate, predict and in the end bring value to the vast amount of data produced by smart buildings every day

Smart buildings are not islands, they will be part of the so-called smart cities and smart grids and as such will have to integrate bigger systems. Smart building will become individual nodes of the smart grid, they actively participate in managing demand and supply in an environment that will include power plants, transmission networks, renewable energy, electric vehicles, ...

The reports series

The report series consist of four documents

- A mind map organizing key concepts around the “Smart Building”, with technologies, traditional use cases, definition, vertical domains, …
- A report on “Wireless communication for the smart buildings”
- An overview of “Machine learning perspectives for smart buildings”
- Smart buildings: economic impact and user acceptance