

# ENERGY POSITIVE NEIGHBOURHOODS - NEW TOOLS FOR THEIR COST EFFECTIVE AND INCREMENTAL IMPLEMENTATION

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## ABSTRACT

IDEAS, “Intelligent Neighbourhood Energy Allocation & Supervision”, is a R&D project, focused on the development and operation of energy positive neighbourhoods. IDEAS aims at illustrating how communities, public authorities and utility companies across the EU can be engaged in this context. In addition, IDEAS focuses on the economic and environmental benefits of doing so.

In this framework, IDEAS develops and validates different tools and business models needed for demonstrating the cost effective and incremental implementation of an energy positive neighbourhood.

Energy Positive Neighbourhoods (EPNs) are those in which the annual energy demand is lower than annual energy supply from local renewable energy sources. The project includes two pilot sites: one in Bordeaux, France and another in Porvoo, Finland.

The Finnish site makes extensive use of a local bio-CHP power plant. The CHP energy production power is, as typically, controlled according to district heat demand. IDEAS will demonstrate how the heat demand could be time shifted by interacting with the household heat controls for a residential neighbourhood, in order to function as a temporary heat buffer for the ESCo. This enables a more favourable energy production, which can be adapted to favour stochastic renewables as well, since the advantageous CHP energy is not as much bound to the real heat demand anymore. The Finnish pilot site includes a simulated wind turbine, a simulated battery and a simulated heat storage connected to the same Energy Management System (EMS).

The French site is specific in terms of occupancy and energy usages. The IDEAS tools aims at providing real time information to the facility manager related to energy consumptions both at site and building level as well as energy production predictions so that he can optimise the energy functioning of the site. Moreover awareness tools are also developed to be used at different levels: tools dedicated to end-users’ awareness as well as pedagogical tool supporting the teaching staff in explaining and disseminating concepts underpinning the energy positive neighbourhood approach to the students or to people external to the site.

The different tools have been deployed in the Finnish and French pilot sites and will be operated until autumn 2015.

The work presented is part of the IDEAS Collaborative Project which is co-funded by the European Commission, Information Society and Media Directorate-General, under the Seventh Framework Programme (FP7).

*Keywords: neighbourhood, energy positive, Energy Management System, decision support, renewable energy, predictions, simulation.*

## INTRODUCTION

The IDEAS project aims at contributing to the European Energy-Efficient Buildings Initiative by developing management and control systems, and decision-support systems addressing the dynamics of energy supply and demand in neighbourhoods and extended urban/rural communities. This project aims at demonstrating how energy positive neighbourhoods can be cost effectively and incrementally implemented. IDEAS project aims at creating, testing, demonstrating and validating a real-time optimization and decision support system for the management of energy production and consumption within a neighbourhood. The tools will be tested in two demonstration pilots: a university campus in France and a newly built residential area in Finland.

The focus of this paper is to report the different tools which have been developed as part of the IDEAS project and the objectives underlying these tools for each pilot site.

## DEMONSTRATION SITES OF THE PROJECT

The primary objective is to provide empirical evidence of the benefits of the internet based infrastructure and decision support system for control management in terms of energy positivity, total cost of operation, CO<sub>2</sub> reduction and improved services for users; provide evidence for the potential for scaling up the demonstration scenarios and test various aspects of the business models that have been identified.

### The Finnish pilot site

The Finnish demonstration site of IDEAS, Omenatarha, is part of the Skaftkärr area in Porvoo [1]. The Skaftkärr development project aims to create an energy efficient, safe, personal and cosy area that offers different living alternatives. Omenatarha is a newly built area in Skaftkärr, and is situated near the centre of the city, about 3 kilometres from the market square. Omenatarha is a residential area with predominantly single family houses and a nursery school. The city planning processes in Porvoo is being developed to improve the way energy efficiency is addressed.



Figure 1: Finnish pilot site – Omenatarha, Porvoo, FINLAND

The Finnish site makes extensive use of a local bio-CHP power plant. The CHP energy production power is, as typically, controlled according to district heat demand. One of the IDEAS objectives is to demonstrate how the heat demand could be time shifted by interacting with the household heat controls for a residential neighbourhood, in order to function as a temporary heat buffer for the ESCo.

The project also simulates heat storage for the district heating and simulates electricity battery for the power grid. The objective is to provide the ESCO with valuable information to base future investment decisions on.

Another major objective is to reduce and or time shift the energy consumption by improving the energy awareness of citizens, and by continuously providing them with relevant advices based on actual conditions.

## The French pilot site

The French pilot site selected for the demonstration of the IDEAS project is the Institute of Technology (IUT Bordeaux 1) located on the Bordeaux campus 5 km southwest of the centre of the city of Bordeaux. The institute provides teaching and office facilities for some 2000 students and 500 staff (teachers-researchers; technicians, maintenance workers and administrative staff) in 11 buildings. The total area of the site is 80000 m<sup>2</sup> with around 40000 m<sup>2</sup> of buildings [1]. Almost all of the buildings are used for teaching, although some of them also house offices, workshops, computer laboratories, research laboratories, cafeterias, but also dwellings.



*Figure 2: French pilot site – IUT Bordeaux1, Gradignan, FRANCE*

The use of the site is highly variable with many parts of the buildings occupied only occasionally. Some researchers-teachers working on energy and ICT issues are key contacts for pedagogical purposes and for getting in touch with students. Similarly, the facilities energy management team on the site is really committed to improving energy efficiency and they constitute key actors for the IDEAS demonstration.

The IDEAS project aims at providing tools enabling the end-users and Energy Manager of the IUT site to better understand how the site consumes and can produce energy and to visualise the output of the energy optimization process. The purpose of these tools is to increase occupants' awareness about energy and induce changings in occupants' behaviours. The major objective is to reduce and optimise the energy consumption by improving and raising the energy awareness of students and IUT staff inducing reactions at the occupants' level. Another major objective is to take into account the occupancy of the site in the energy optimisation process.

The project also aims at simulating PV production based on real irradiation conditions on site and simulates electricity storage so that optimisation of the use of electricity energy can be done by the Energy Manager of the site.

## OVERVIEW OF THE GENERAL ARCHITECTURE OF THE ENERGY MANAGEMENT SYSTEM DEVELOPED WITHIN IDEAS

In order to comply with the objectives mentioned above, an Internet based ICT infrastructure has been developed to support all the required functionalities. A high-level overview of the inter-relationships and functionalities of the two main demonstration sites has been specified and is shown on the following figure along with the wider contextual domains of a smarter energy grid and smarter city. Within this global infrastructure, the IOC (IBM®Intelligent Operations Centre), a software solution that is designed to facilitate effective supervision and coordination of operations, is used in IDEAS to provide a central control centre to implement the Energy Management System (EMS) of IDEAS including database and data management, geographical information systems, web hosting and internet interfaces, performance metrics/analytical engines and optimization tools.

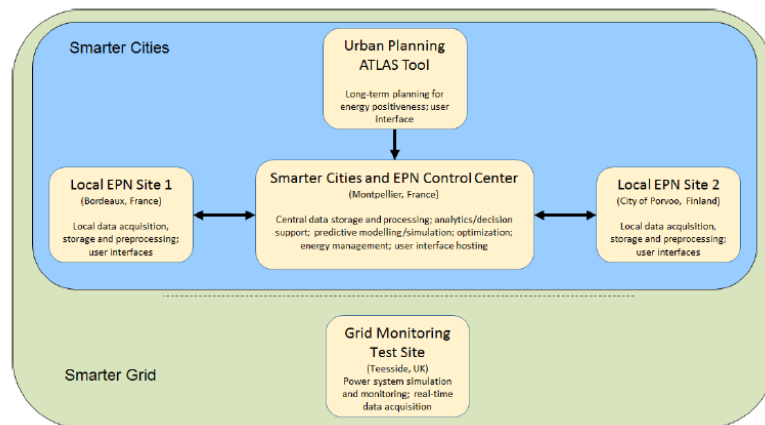


Figure 3: High-level overview of demonstration sites, IT tools and functionalities in the IDEAS project

The IT systems in Finland and France are described in figure 4 and are based on a metering system installed in each pilot site, on an EMS including optimisation algorithms and collecting also external information such as weather forecast and real-time energy prices.

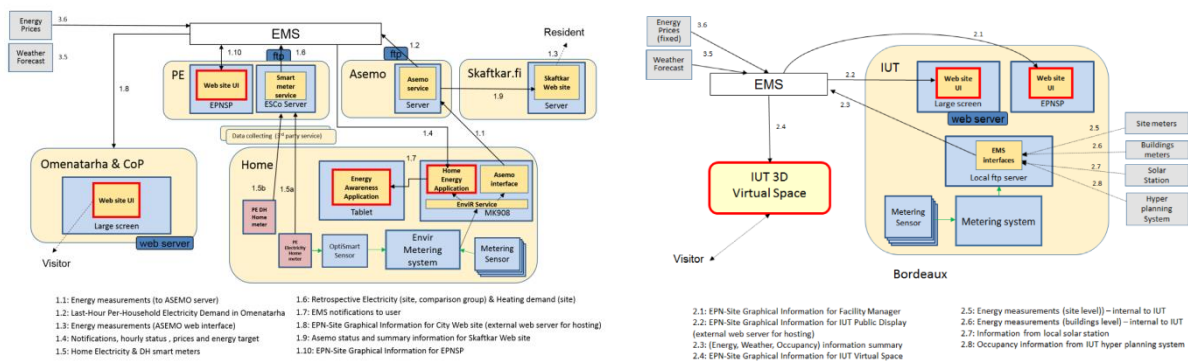


Figure 4: IT systems in Finland (left) and in France (right)

## TOOLS DEVELOPED FOR END-USERS' AWARENESS AND NEIGHBOURHOOD ENERGY MANAGEMENT

### End-users awareness tools

- **Advising the residents – HEAA (Home Energy Awareness Application)**

The IDEAS project has developed a Home Energy Awareness Application, in order to both improve the energy awareness of the residents by making the consumption visible, but also in order to send energy related advises or co-operation requests based on measured or forecasted data that typically is invisible for the users.

The bleeding edge image recognition technology from IBM has been included to regular Android tablets. The augmented reality is displaying an overlay with the real time consumption of a device that has been recognized by the tablet camera. The Finnish pilot is demonstrating this in 23 private single family households, with at least 6 measured devices in each household (z-wave based solution).

Instead of having automated control over the household electrical equipment and heating system, the impact is supposed to be achieved by sending notifications to the residents, who is requested to act upon the received notification (triggered by the decision support system of the neighbourhood level Energy Management System).

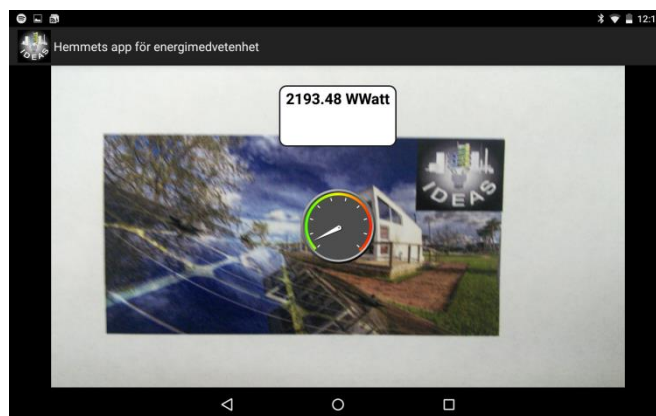


Figure 5: HEAA (Home Energy Awareness Application) interface

- **Raising end-users’ awareness - Public screens interface**

The IDEAS project has also developed an “energy awareness” user interface (figure 6) which has been installed on wide screens in public spaces within the French pilot site (5 large screens have been installed in relevant locations) and the Finnish pilot site (3 interactive screens have been installed in the nursery school of Omenatarha and one in the City of Porvoo citizen service point, in the city centre). This interface is displaying general information related to energy efficiency of the surrounding environment and related to the impact the neighbourhood occupants have on their own neighbourhood. The interface zooms from the big picture of the national level down to the neighbourhood detail level, including measured data of energy consumption of the whole site.

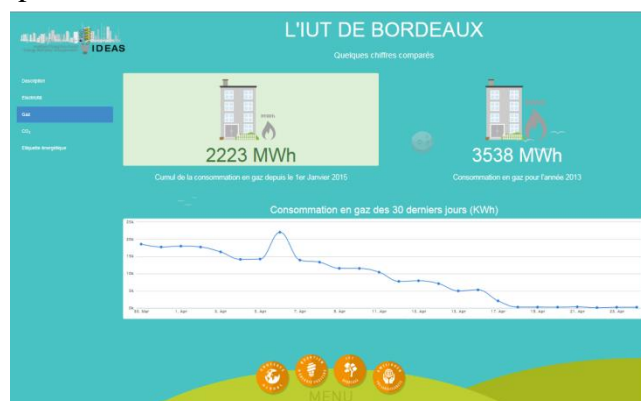


Figure 6: Public screens interface – Electrical consumptions at the French site

### Energy manager interface

The Energy Manager interface provides energy related professional information that enables managing the EPN. The primary intended user of the tools developed in the IDEAS project is a new type of actor, the Energy Positive Neighborhood Service Provider (EPNSP, described in [2]). The developed interfaces are hosted by the IBM® WebSphere Portal embedded by the Intelligent Operations Center ® (IBM® IOC) as part of the EMS. The main view of the EPNSP interface is a manager dashboard (Figure 7) which summarizes most relevant data in real time: for instance, the current solar irradiation measured on site and the associated simulated energy production, the energy consumption of the whole site but also at building level.



Figure 7: Energy Manager interface – Dashboard for the French site

This tool constitutes a decision support interface for the energy service company (ESCO) which is involved in the project (Porvoon Energia, Finland). This interface includes abilities for (i) visualization of estimated future energy supply, demand and pricing, plus the optimal plan for buying, selling and/or storing energy and (ii) functionality for configuring the optimization and decision support tools. This tool can help the Energy Manager in the coordination and optimization of demand side management (DSM) and supply side management (SSM) which are the two key goals of the EPN service provider.

## CONCLUSION

In order to support the development of EPNs, ICT tools are required for energy awareness and management. This includes user interfaces that raise awareness and enable the visualisation of all the energy aspects within the neighbourhoods.

The pilots are currently running and will be operated until autumn 2015. Some promising results are already visible in the French pilot site in which energy savings opportunities have already been detected thanks to the IDEAS tools.

## ACKNOWLEDGEMENTS

This work is part of the “IDEAS - Intelligent Neighbourhood Energy Allocation & Supervision” project (Grant Agreement No. 600071) which is co-funded by the European Commission, Information Society and Media Directorate General, under the Seventh Framework Programme (FP7), Cooperation theme three, “Information and Communication Technologies”. Project partners are acknowledged.

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