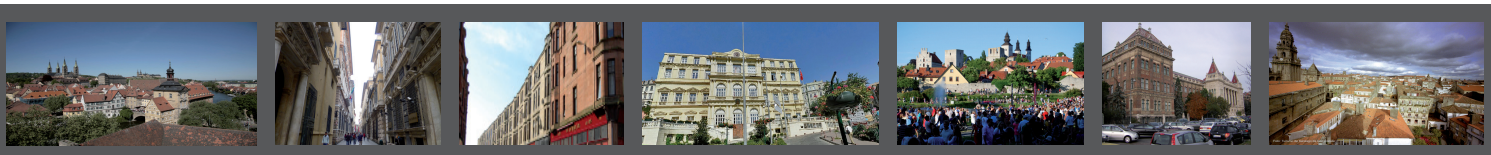

ENERGY EFFICIENCY FOR EU HISTORIC DISTRICTS SUSTAINABILITY

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NEWSLETTER NO. 2

EDITORIAL

Dear Friends,

EFFESUS has already completed one year and first results have been gathered. In this newsletter you will find an update of our activities, with special focus on integration of renewable and energy efficiency solutions and development of new materials. This issue outlines the Santiago de Compostela (Spain) case study and introduces upcoming events. We encourage all of you to enrich our newsletters with comments and ideas.

Enjoy!

Isabel Rodriguez-Maribona,
EFFESUS coordinator

Multiscale data management model developed

Historic districts are complex ecosystems that generate a large volume of data of diverse scales and nature, created by different tools and stakeholders, in different formats and for different uses. Therefore, a proper strategy for information management is crucial for the sustainability of historic districts. EFFESUS has designed and implemented a multiscale data management model that allows consolidating the geometric and semantic information into a complete and unique model, which will be used to support the decision process at urban scale. The EFFESUS data management model is based on the standard CityGML but it has been extended and tailored to meet Historic Districts´ energy management needs. The model includes data of the most representative elements at different scales from the district to constructive components. It is completed by existing sources and low cost data acquisition techniques, thus it can be easily developed at a first stage. The validation of the EFFESUS data management model has been carried out successfully in the historic district of Santiago de Compostela (Spain). For further questions please feel free to contact us: request@effesus.eu

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Case Study in Focus:

Santiago de Compostela

Fact Sheet: Case Study Santiago de Compostela

Country	Spain (Autonomous Community of Galicia)
Climate	Temperate oceanic with dry, warm summers
Selected District	Medieval city centre
Case Study Level	Urban intervention
Local coordinator	Consorcio de Santiago
Scientific advisory	Fraunhofer IBP, Department of Energy Systems and TECNALIA

Interview:

The EFFESUS case study in Santiago de Compostela focuses on the challenge of how to integrate energy efficiency policies into everyday urban regeneration. After more than 20 years dealing with heritage, the central thesis of Consorcio de Santiago is, that energy is the key to address the dilemma of conservation of a historical center declared World Heritage site, that inevitably has been and must remain in permanent transformation in order to remain a vivid city. Today we have the chance to talk to architect Angel Panero from Consorcio de Santiago and to Patrick Schumacher from Fraunhofer IBP about the ongoing activities in Santiago.

EFFESUS: What are the main objectives of this case study?

Patrick Schumacher and Angel Panero: The main objective of our case study in Santiago de Compostela is to define a management model based on energy efficiency that ensures the conservation of our heritage. Hereby, the focus lies on the use of traditional architecture passive resources and the integration of renewable energies. During the last years the Geographic Information System (GIS) implemented by the Consorcio de Santiago has become a powerful tool for achieving this goal. In the framework of EFFESUS the potential of solar energy as well as biomass from public gardens has been analyzed for the district level. Those two energy sources cannot solely meet the current energy demand. Consequently, a future heat demand was simulated that considers an increasing rehabilitation rate for this district. Another focus is on storages and energy demand potentials in buildings and districts, in order to adjust the volatility of renewable energy supply to the actual demand. Excess capacity from wind power on the coast can be used with flexible and smart heat pumps. Surplus energy can be stored in large solar thermal storages for the demand during the winter.

EFFESUS: Which buildings have been chosen for the case study and what are their main characteristics?

Patrick Schumacher: The case study in Santiago focuses on a district in the heart of the historic city centre, framed by two main streets, Rúa do Vilar and Rúa Nova. It consists of very old domestic and residential buildings.

Angel Panero: The settlement density of this district is quite high, which allows to study not only the physical characteristics of traditional architecture, but also the residents´ user behaviour influencing the energy balance that ensures habitability at the lowest cost.

EFFESUS: What is the current state of the Santiago case study? What happened so far?

Patrick Schumacher: So far, the renewable energy potential and the energy demand analysis are completed. In addition, we have built a model of a typical historic building in our simulation environment. In this context, different control algorithms were examined, in order to increase the storage capacity of the building, which in turn allows raising the share of renewable energies.

Angel Panero: Now, we are about to begin with dissemination activities dedicated to the residents. The active involvement is essential to effectively promote the results.

EFFESUS: What are the major challenges of increasing the share of renewable energies in the Old Town of Santiago de Compostela and which solutions do you recommend based on your investigations?

Patrick Schumacher: First of all, it is important to decrease the energy demand for heat and electricity, because a lower energy demand of the buildings or districts can be simply achieved by an increased share of renewable energies.

Angel Panero: We believe that the historical architecture, its constructive reality, allows optimising the relation between energy consumption and comfort more easily than we imagined. After all, those houses were built when the habitability did not depend on fossil fuels.

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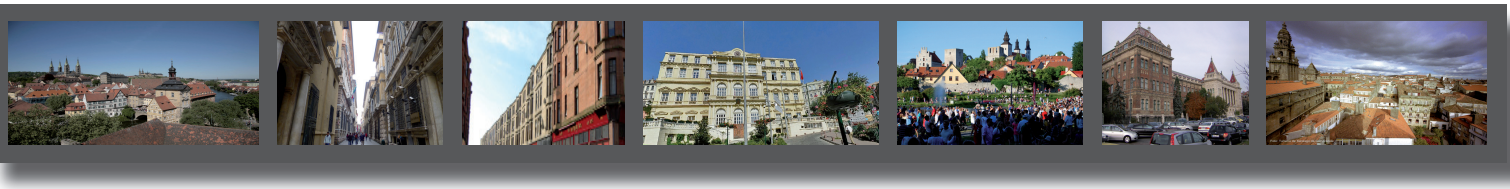

Patrick Schumacher: Another challenge is to analyze the local energy potentials of directly usable energies, like solar, biomass and waste heat. Both, energy demand and local energy potentials are analyzed with the GIS tool. In general, there is not only one answer but a mixture of energy efficiency, renewable energy and storage solutions is required.

EFFESUS: What are the most innovative and advantageous aspects of these solutions?

Patrick Schumacher: With a GIS tool the energy demand of whole districts can be analyzed relatively easy and fast. It is not necessary to consider each building individually. Districts with similar building types, local conditions and energy demand can be used to identify other supply solutions. Furthermore, the map layers provide an overview of the possible areas for storages.
Angel Panero: And we must not forget that many of the solutions are naturally present in traditional architectures. We must learn to see them and to take advantage of them by recovering an intelligent use of architecture, as it was throughout times.

EFFESUS: To which extent are these solutions transferable to other historic urban districts in Europe?

Patrick Schumacher: The solutions are definitely transferable to other historic districts and cities. Of course, regional conditions differ, like the climate that influences the solar and wind potential or special potential for storages, but for each topic you will find a similar solution like in Santiago.
Angel Panero: Depending on the special conditions, architecture has evolved over time in a process of permanent adaptation. If we are able to understand the key to this evolution, we will be able to ensure the conservation of the heritage without braking the permanent transformation and continuous change that characterizes the architecture of historic centers.

EFFESUS: Which benefits arise from the international cooperation in EFFESUS for the Santiago case study?

PatrickSchumacher: Certainly beneficial is the practical work with the data from Santiago and not only theoretically simulated data. Data about the energy demand and local potential results in a greater exchange of experiences and knowledge. Scientists learn what kind of data is generally available and local residents as well as city planners learn more about new energy solutions.
Angel Panero: The combination of our everyday experience managing the city and the scientific potential of our partners in EFFESUS, allows us to achieve the expected results by actively involving residents.

Development of conservation compatible new materials

for envelope retrofitting

One of the major objectives of EFFESUS is to develop conservation compatible new materials for envelope retrofitting especially designed for the needs of historic buildings.

Development of a new cost-effective radiant reflective coating

With regard to the development of a new radiant cost-effective reflective coating, some tests were carried out with nanoparticles at a rate of 7% and using concrete as substrate. Next steps comprise the try-out of other percentages and testing of the coating on most abundant building materials present in the Cultural Heritage buildings of Europe (clay brick, lime mortar and 3 different stones).

Development of advanced aerogel as blow-in insulation

The development of the aerogel is in progress. In January the partners APG and AST met the blowing machine producer in order to discuss solutions for reducing the dust intrusion into the cavity during the spraying process. Further trials are conducted in February and we hope for positive results leading to the answer for this problem.

Development of new mortars

BOFIMEX developed a new mortar that is called ISOCAL. It is a lime based mortar (NHL5). We still have its lambda next to 0.06. Currently it is tested under laboratory conditions.

You can find further information and the factsheet on our website soon.

Application under extreme weather conditions and assessments of properties

Laboratory and outdoor tests for mortar are going to be started within the next weeks, while other materials will be available in spring, so that tests on these can be performed soon.
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Smart management and integration

of renewable and energy efficiency solutions

One of the big challenges within the EFFESUS project is to adapt existing solutions at building and district level based on smart metering, management, control and integration strategies and technologies for improving energy efficiency in historic cities.

Development of strategies for matching supply and demand for heating, cooling and electricity

The first step to define appropriate strategies for energy saving as well as for integrating renewable energies would be an analysis of the energy demand of buildings and districts. In Santiago, this analysis has been conducted already for one district in the historic city center. It included the energy demand for heating, cooling and electricity of residential and commercial buildings.
In addition, the future energy demand according to the prognoses of roof and window renovations or by reducing the infiltration has been predicted. The graph shows the potential energy demand reduction due to the refurbishment of windows, resulting in lower air exchange rates.

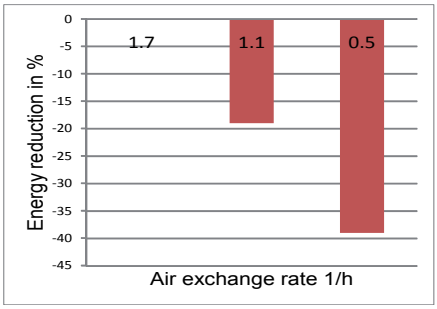

Figure 1: Reduction of energy demand in % according to air exchange rate

For example the air exchange rate of 1.1 h-1, can be reached with conventional new windows, which again can lead to an energy demand reduction of around 18%. On the supply side we have examined the possible renewable energy potential, especially of biomass and solar energy. Based on a GIS analysis, surface areas presenting different districts were investigated for green waste in public gardens and households. Figure 2 displays primarily public green spaces producing green waste.

Figure 2: Biomass analysis in Santiago de Compostela, Fraunhofer IBP

Furthermore, a solar thermal and PV technical analysis was conducted on suitable historic buildings. Standard demand curves were used to evaluate the integration capacity of photovoltaic systems and their potential share on the electricity consumption of the buildings.
Both, information on energy generation and energy consumption are based on data available from the case studies and have been entered into a historic district geographical information system (HISD-GIS). It combines this information with the restrictions and requirements regarding the alteration of the historic building stock, in order to evaluate areas that are available for the generation of renewable energies.

Adaptation of smart grid solutions to historic districts

Due to the fluctuation of the renewable energy supply the energy systems have to be transformed from demand-oriented energy generation to a generation-oriented energy consumption. This requires demand side management (DSM) and intelligent storage technologies. In this context, the building sector has huge potential.
Therefore, the objective is to evaluate the fraction of residential heat demand, which can be expected to be covered by using electric heat pumps coupled with a heating system for variable loads. Furthermore, the aim is to improve the utilisation of surplus electricity from renewable energy sources in space heating and to stabilise the indoor temperature within a given comfort interval.

Adaptation of energy storage technology

The importance of energy storage technologies is increasing with the implementation of volatile energy sources. There are different ways to classify energy storage technologies. Lead-acid and lithium-ion batteries cover horizons between hours and

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days. They are used in residential buildings when a renewable energy source (PV, wind) and an electricity user (heat pump) are present. Packaged systems with inverter and controls are nowadays commercially available and receive financial support in countries, like Germany. Also Vanadium-Redox flow batteries are becoming more attractive. However, the rooms in which these systems are placed need to be sufficiently ventilated and in case of flow batteries the temperature has to be controlled.

Seasonal storage is generally realised with thermal storage systems like large water pits, borehole heat exchanger fields or aquifers. They do not need to be adapted for the use in historic districts but they do require a district heating network with large surfaces and/or appropriate underground conditions. This is usually not given in historic districts, which complicates the application of these technologies.

In summary, energy storage technologies can be applied without major adaptations. However, the buildings or districts need to be adapted to the spacial boundary conditions for implementing renewable energy sources and district heating/cooling networks.

Improvement of moisture and thermal properties of original windows

Windows are an important component of all buildings. Studies show that windows have a significant influence on the indoor environment including air quality, day lighting and thermal comfort, which influences the energy use. Consequently, it is important to improve the thermal performance of windows.

On top of that, windows have an aesthetic value, because the age of buildings can be precisely defined by looking on the original window construction. Many historic windows were custom designed for each building, thus there are many unique windows which are hard to copy. Within the design process for improved windows, the aesthetic appearance, energy efficiency, cost and durability are important assessment criteria. It is planned to develop a spectrum of different solutions, which can be applicable for a wide range of buildings that require window improvements.

Figure 3: Rúa Nova, 42, Santiago de Compostela, Spain (Source: Google Maps 2014)

Currently, the following products can be found among the considered: ultra-thin and light insulating glazing units, shades with thermal resistance, and low-emissivity adhesive plastic films. In addition, constructions are preferred that allow the air exchange with the outside – in order to provide sufficient ventilation without mechanical support. If properly designed, the above mentioned window systems can also contribute to energy savings by reducing heat losses through the glazing area and enhance the solar heat gains when needed. It can be observed that in some cases the replacement of windows is chosen to improve the energy performance. This might be caused by insufficient knowledge of available techniques and cost efficiency. In order to address that, we are working on solutions which might be directly applied on the sites, in order to improve glazing thermal performance. Such techniques will hopefully increase the number of energy retrofittings and help preserving historic windows.

Development of optimised and intelligent indoor climate solutions

Building management systems are widely available nowadays. Sensors are becoming less costly and their use more widespread. Controllers and software of the management systems are becoming more sophisticated and powerful. This creates new opportunities for the smart indoor climate management. Indoor climate encompasses thermal comfort, indoor air quality, illumination and HVAC systems. In each of these fields, performance parameters, sensor technologies and control strategies have been studied. An extensive state of the art review has been realised. Since all of these systems interact with each other, control algorithms need to be developed that take into account these interdependencies. Such developments are totally dependent on the configuration of the rooms or buildings, the installed management system and the type of illumination and HVAC plants. Hence, generic control algorithms do not make sense. Consequently, a lecture room in the historic building of the University of Budapest has been chosen for a case study. The windows developed in EFFESUS replace the existing windows. Additional modifications of the heating, ventilation and illumination systems have been defined to enable the implementation of the newly developed control algorithms.The adjacent lecture room serves as reference room to evaluate the impact of the new windows and the indoor climate control algorithms on the indoor air quality and the energy consumption.

Month 15

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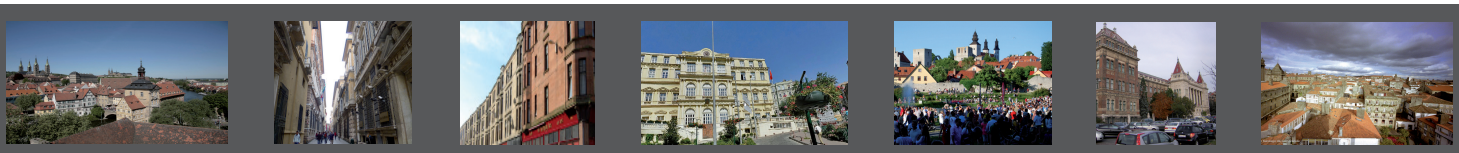

Partners in Focus:

R.E.D. S.r.l. is an Italian SME active in the renewable energy field with installations of geothermal coaxial heat exchangers coupled to heat pumps. The company also develops and installs innovative sensors built ad hoc and integrated in monitoring systems for thermal comfort, visual comfort monitoring, climatology, microclimatology, particularly applied to Cultural Heritage. RED leads the activities concerning energy storage technologies and indoor climate solutions. Moreover it participates in the demonstration case studies by implementing a monitoring system in order to evaluate the impact of the applied technologies.

I2S is a high-tech information technology company specializing in asset management. The company aim is to use knowledge and expertise to assist companies and organizations to effectively manage physical assets, improve operations and therefore reduce costs and improve energy conservation. I2S is the developer of the iMaint system, which is a registered trademark in the European Union. It leads the development of the Decision Support System and participates in conceptualisation, results integration and strategies for decision making.

SNEKKERIET AS is a small window production company in Mid-Norway specialising on traditional wooden window types. The company focuses on meeting the strict requirements from the building conservation market. Only 100% heartwood is used in the production for obtaining the longest possible durability of the components and the window as a whole. It is responsible for the development and production of prototypes for non-destructive and aesthetical acceptable components and solutions for reduction of energy loss from different types of original windows.

Upcoming Events

49th AICARR International Conference on the 26th – 28th February 2014 (Rome, Italy)
The conference is devoted to providing an overview of the retrofit design of historical and existing buildings.
For further information about recent and upcoming events, please visit our website: www.effesus.eu/events

Project Partners:

TECNALIA Research & Innovation / Fraunhofer-Gesellschaft / R.E.D. SRL / Integrated Information Systems / SNEKKERIET VERDAL AS / SAMPAŞ Nanotechnology / D'APPOLONIA SPA / Consortium of the City of Santiago de Compostela / ACCIONA Infrastructures S.A./ Uppsala University / EURAC RESEARCH / Delap & Waller EcoCo Ltd. / Active Space Technologies S.A. / Dennis Rodwell / National Research Council – Institute of Atmospheric Sciences and Climate / University of Stuttgart – Institute of Materials Testing / Norwegian University of Science and Technology / BOFIMEX BOUWSTOFFEN BV / Historic Scotland / A. Proctor Group Ltd. / HOR-BER Ltd. / SAS GOUAS / Advanced Management Solutions Ltd. / Active Aerogels Lda

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