How do we know that we make good buildings? The benefits of Building Performance Monitoring

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Deep retrofitting of 6 bungalows in Swansea. LCBE team from Cardiff University and Swansea Council won a 2021 Welsh Housing Award in the Excellence in Housing Innovation category. 3D drawing created for LCBE project, Welsh School of Architecture, Cardiff University.

Building a house involves the process of separating the external from internal to ensure independency and security and create comfortable controlled indoor conditions. In recent years, this definition is accompanied by low carbon criteria, and a series of government schemes are pushing for green new build homes and retrofits. Registered Social Landlords and Local Authorities are keen to make the change, creating quality places to live to achieve climate change ambitions whilst reducing or eliminating fuel poverty. All these aims and objectives create a variety of challenges as making a good home is now a multivariable exercise that demands quantifiable priorities and outcomes.

How do we make sure that we deliver high quality low carbon housing in a changing world? Monitoring is a powerful tool to evaluate the performance of a building and reveal its identity and characteristics. To monitor is to measure the progress or quality over a period of time; this process gives confidence that what is designed/promised matches the reality. In addition, monitoring is a building diagnostics instrument that supports proactive and responsive maintenance. Choosing the right monitoring tools allow the in-depth study of building performance and to identify and rectify potential failures. Whole house monitoring enables a holistic approach that quantifies changes in the environment, building fabric, building systems and occupant behaviour. If, for example, an energy bill is high, appropriate monitoring will assist to identify the reason/s and solution/s to try to solve the problem.

Monitoring can also be part of a control system, such as a smart thermostat that would learn from the occupants' patterns, or part of the commissioning process to make sure that a system works. It could also be a prerequisite to participate in an energy scheme (FIT) or part of public/occupants' awareness, for example by visualising renewables generation is a school. Monitoring is the medium that helps us to enumerate performance indicators; but which are the indicators? Different building stakeholders have different ideas on what a good building or an effective system is. The architect/designer would primarily want to make sure that the building complies with the Building Regulations and would use modelling processes to ensure compliance and good performance. The priority for a registered social landlord could be to know if the installation of a solar panel is affordable and replicable. Governments have targets on carbon emission reductions and economy stimulation that they need to achieve. The market cares about selling their product and a business that works whereas the tenants' focus would be to reduce cost to live and have a comfortable home. A different monitoring approach applies to each performance target-indicator.

At the Welsh School of Architecture at Cardiff University, we are developing and trialling a whole systems-based approach combining renewable energy supply, storage and demand reduction solutions in different types of buildings. Our approach combines modelling and monitoring the energy and environmental performance to propose affordable and replicable suite of solutions to provide evidence of carbon savings, cost of technologies and associated cost savings together with more broader challenges faced. Modelling and monitoring outcomes are used to inform the decision-making process on a set of solutions that have been demonstrated in a range of buildings including groups of social and owner-occupied housing. Once the technologies are implemented in practice, monitoring continues to provide evidence of energy and environmental performance.

The Welsh School of Architecture have an established research track-record and state-of-art equipment to evaluate building performance. We engage the public, drive policies and enhance the market through the evidence that we have generated. Researchers in the school are collecting data from thousands of sensors by using high-end tools and combining in-situ testing with remote monitoring and wireless sensor systems that allow real time data gathering, analysis and visualisation.

The Low Carbon Built Environment (LCBE) team at the Welsh School of Architecture, Cardiff University, led by Dr. Joanne Patterson have recently worked together with Swansea County Council to significantly reduce energy bills and carbon emissions, whilst improving the condition of some of their homes. The project won a 2021 Welsh Housing Award in the Excellence in Housing Innovation category. Six off mains gas bungalows in Swansea have been transformed into highly energy efficient 'Homes as Power Stations' generating and storing their own energy and providing substantial energy savings for the residents. The homes are now more comfortable and attractive, and the lessons learned are informing a wider debate around stock retrofitting challenges, vital to meet net zero carbon targets. We have gathered information on the built environment, energy use and the technologies before and after the work has been carried out. This information is essential to quantify how low carbon the buildings really are and helps to give confidence to other organisations who are looking to invest in low carbon solutions. •

Emmanouil gave a presentation on this topic at the APSE Housing and Building Maintenance Seminar 2021. You can download the presentation from the APSE website.