The Building as the Cornerstone of our Future Energy Infrastructure
The importance of dynamic and real data for reliable assessment

The Symposium is organised around seven topics that are briefly presented below.

Measurement of building performance for validation

To analyse and compare existing methods for the assessment of the energy performance of buildings, *dynamic measured data* from metering and in-situ measurements are required. Quantifying the actual performance of buildings can only be effectively realised by optimized in-situ measurements combined with dynamic data analysis techniques. Two approaches may be distinguished: -1 Co-Heating measurements on site (CEN TC89 WG13 is developing a standard) and -2 Metering data of electricity, gas, heat, water (regular readings with intervals ranging from a few minutes up to daily values). The roll-out of new intelligent metering equipment is at full speed in most EU countries. The advantage of metering data is that a growing amount of data is coming available and hence an improved accuracy is feasible. In order to split building related energy use from occupant energy consumption a combined statistical and dynamic method is investigated for the analysis of time series. *Validation* of the selected methods with measured data from field experiments or from metering readings (e.g. electricity, heat, gas and water) is required. These collected data may be linked with different data sources (Internet of Things) and analysis tools to manage new domestic devices and building comfort in an energy efficient way.

Documentation of performance gaps and energy flexible buildings

Reliable simulation tools for building design that should deal with variable aspects in terms of energy performance and consumption as well as storage of thermal and electrical energy, have to become available. Discussions are ongoing on the issue of the *gap* between design and real performance of buildings. Questions are put on the table in order to understand and reduce this *gap*. It may lead to the important question if building simulation is ready to deal with present development in the building energy sector as well with recently reviewed standards. Since most of the reference climate data sets are created from > 10 years measured data, one may ask the question: does the climate data used for simulation reflect future conditions and does it address the particular aspects of low energy buildings? In addition, does simulation deal with optimised balancing when taking into account the self-consumption of produced energy?

Building energy related standards – CEN/ISO

The assessment of the energy performance of a building, as required by the EPBD, is related to a single building (or building unit) and requires an energy performance certificate, expressed in primary energy. The EPBD links directly to standards for calculation as well as measurements when it concerns performance assessment. The EPBD addresses new, as well as renovated buildings. The EPB Directive 2010/31/EU mentions in article 2:

*The 'energy performance of a building' means the **calculated** or **measured** amount of energy needed to meet the energy demand associated with a typical use of the building, which includes, inter alia, energy used for heating, cooling, ventilation, hot water and lighting*

Developments of a third, more ***holistic*** assessment approach are presented in several projects, based on administrative data and the application of reference buildings (which are measured on-site for that purpose).

The European Committee for Standardisation (CEN) has been working on bringing the present EPBD related energy standards in-line with these requirements. The CEN/TC 371 Energy Performance of Buildings Project Group has been responsible for the overall consistency and horizontal harmonization of the set of EPB standards. This includes the preparation and maintenance of overarching EPB standards and other EPB framework documents and the management of the overall consistency as well as other common quality and usability aspects of the subseries of EPB standards that are developed and maintained by the other CEN Technical Committees. Further work is necessary to support the development of reliable procedures that are needed to implement new standards and regulations in this field. This development will facilitate the application of the EPBD contributing towards saving energy in buildings. Associated tools should be made available to practitioners.

Renovation projects for buildings and cities

Renovation of buildings is key to meet the EU's energy efficiency targets. Recent revisions of the Energy Efficiency Directive (EED) and the Energy Performance of Buildings Directive (EPBD) address this issue. Much of the European building stock is in need of renovation (estimated about 50% of 210 million buildings) however both relevant Directives define 'renovation' in an ambiguous way. The EED defines 'deep renovations' in a very broad way, as "renovations which lead to a refurbishment that reduces both the delivered and the final energy consumption of a building by a significant percentage compared with the pre-renovation levels leading to a very high energy performance". To justify energetical and economic measures, practical and reliable methods have to be developed.

Renewable energy integration

One of the highly interesting projects is the Danish CITIES project that covers the complex issues of applying Information Technology for the Integration of Energy Systems, in particular the variable renewable resources such as solar and wind electricity. The Danish government has set an ambitious target of weaning Denmark off *fossil fuels* by 2050. District Heat is a major component that contributes to the aim of reaching a fossil free society, through renewable energy. In addition, Denmark is one of the world's most digitalised countries. The CITIES project plays an important role in activities of the International Energy Agency Annexes (e.g. Annex 58, 66, 67, and 71). Results from CITIES have been used internationally to define the concepts of flexibility for smart energy systems. The Flexibility Index implies that it will be possible to design buildings, districts and cities such that they are optimized towards the local characteristics of the renewable energy productions.

Buildings and electric vehicles integration: Towards monitoring of mobility energy with distributed sensing and edge computing

Governments have emphasised that renewable electricity resources will have a prominent part in the energy transition, in the transport as well as the building sector. In practice this may result in movable and variable sources of electrical energy that may or may not be connected to the building by means of batteries (or other solutions). The Electric Vehicle (full electric, hybrid or other types) will take a more prominent position in our society for several reasons. Future buildings may therefore be equipped with electrical storage facilities. Charging of the battery pack may double the consumption of electrical energy and increase the peak load to the grid. This may have a negative impact. However, the availability of electrical storage connected to the building may have a positive impact also. It is foreseen that, for doing so, communication between electric appliances in the building and energy providers, including urban sensing network (Array of Things) is required. For buildings that produce electricity for self-consumption (for example by photovoltaic panels), optimised management is evident.

This presentation will describe the application of the Waggle platform within the context of the Array of Things urban sensor project that provides distributed sensor data with high spatial and temporal resolution. This open source platform enables scientists and policy makers to take into account environmental air quality issues along with specific regional concerns (e.g. flooding, radiation). Initial urban and environmental applications of the Waggle platform include transportation measures (traffic flow, pedestrian counting, aircraft recognition), detection of urban flooding, and monitoring plant growth on green roofs. The opportunities for basic machine learning research with the Waggle instrument also include the potential for partnerships between computer scientists and domain scientists whose research requires analysis of imagery, sound, or of multiple sensors (e.g., adding vibration, radiation, thermal imaging) to understand particular urban or environmental phenomena. This presentation will focus on our transportation systems work to collect and analyze data that can support mobility energy monitoring.

The Urban dimension: A dynamic model for district-scale building demand simulation
Whereas the EPBD deals with *individual* buildings, buildings have to be considered as part of urban areas or cities and will have a more important place when energy demand and production is concerned. The EED addresses upon this issue also. Several international projects are studying the urban area in terms of infrastructure (roads, underground, water, etc.) as well as energy (production and load). Modelling software is developed in a very sophisticated way and uses modern techniques for planning and assessment. CityGML is regarded as a very powerful IT environment to develop the necessary software tools putting the building in the urban environment while taking advantage of innovative technological developments.

Panel discussion.
Task leaders of the IEA-EBC Annex 71 project are invited to address the speakers with dedicated questions addressing the specific topics concerning their project **"Building energy performance assessment based on in-situ measurements (IEA-EBC Annex 71)".**