DYNASTEE
NEWSLETTER ISSUE 2015/5

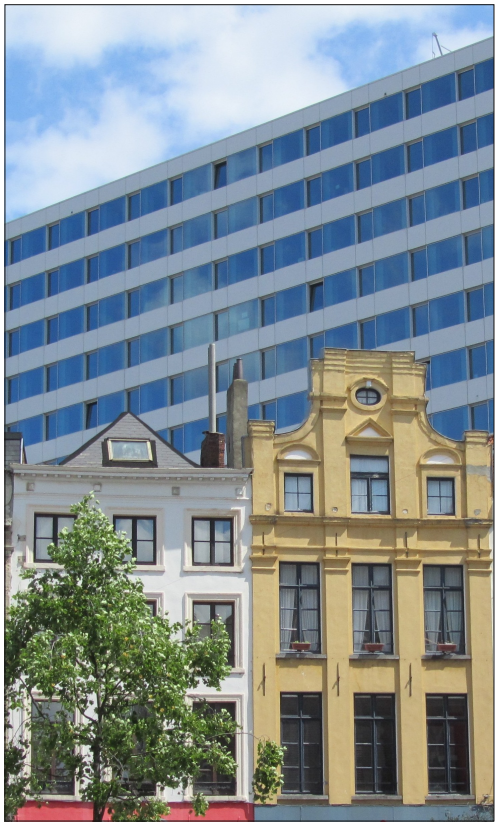
Foreword

This 5th issue presents the work that has been performed by the IEA EBC Annex 58 on some of the Tasks. Although the project enters its last year, it does not mean that DYNASTEE as a grouping comes to an end. In fact it celebrates its 10 years of existence. In 2005 it was decided to change the legal PASLINK EEIG into an informal network of outdoor test centres aiming to support outdoor experimental work with the expertise on dynamic analysis and modelling for the assessment of energy performance of buildings. It appears to be a timely right decision regarding the recently announced call for reducing the gap between design performance figures and real energy performance values of buildings.

So far DYNASTEE being responsible for Sub-Task 5 of the IEA EBC Annex 58, e.g. dissemination and communication, has produced five Newsletters. DYNASTEE will continue with the network activities and will maintain its web-site and newsletter as a channel for exchange of information between the academic and professional world on the topic of dynamic assessment methods, both by modelling as well as experimental testing. In brief it will comprise:

- An informal network of outdoor test centres for building energy performance assessment
- Dynamic analysis and modelling of time-series
- Organising training by means of a Summer School (the 4th in 2015!) and dedicated workshops
- Participation to international conferences and European projects (such as COST)

We wish you an informative reading and invite you to visit our web-site www.dynastee.info.



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Newsletter Editors

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Announcement of the Summer School 2015
Lyngby, Denmark – 22-26 June

The organisers have fixed the date and venue for the Summer School in 2015. It will be during the week 22 – 26 of June at the DTU in Lyngby, Denmark.

The focus will be on the application of methodologies for whole building energy performance assessment using dynamic mathematical and statistical tools in the software environment R.

Read more about the Summer School 2015 in the Flyer that can be downloaded from www.dynastee.info to find out more about the contents as well as the registration procedure. For registration and communication with the students, download and upload of documents, etc. the organisers are using the services of the Danish Technical University, CampusNet. The registration will close 1 June 2015.

Decision Tree Flow

Decision Tree

In order to accurately evaluate the energy performance in the built environment, it is essential that testing methods are robust and reliable. As research increases and expands across different academic and industrial sectors, it is critical that researchers and industrial practitioners use the correct procedures to ensure that a reliable test environment, experimental design and test set up are maintained when undertaking performance testing.

Subtask two within Annex 58 of the International Energy Agency 'Energy in Buildings and Communities' programme is currently aiming to address this issue through the production of a decision tree to ensure accurate testing methods and data handling. The decision tree aims to act as a guide to ensure the user has considered all possible aspects of their chosen environment prior to undertaking testing. By following the line of questioning within the decision tree they will ultimately arrive at documents which offer further information specific to their needs. These include published academic papers, ISO documents and test protocols which are determined to be of sufficient academic quality to provide useful guidance.

The decision tree began as a 26 page 'road map' document detailing the various methodologies and equipment used in in situ field tests. In order to fully capture the existing test methods, it was necessary to also include the variety of lab based test methods in both steady state and dynamic environments. The 'road map' rapidly because unmanageable in size, and the decision made to instead develop a decision tree which would aid the user to access the information relevant to their research.

The decision tree originally focussed on 5 aspects of building energy performance: Building components; building envelope; whole building energy characterisation; services and users. This format underwent several drafts which were each critiqued during Annex 58 meetings. Whilst being incredibly important, the decision was taken to remove the branches concerned with services and users in order to reduce the complexity and focus on the aims of Annex 58. Under the remaining headings, the decision tree was populated with existing standards, papers and protocols relevant to each aspect of building energy characterisation.

The decision tree will primarily be used to assist academics and industrial researchers in determining the correct test procedures required to obtain accurate results. At present these are limited to building components and whole house testing in situ. The decision tree will not provide a testing methodology outright, but the documents suggested will outline the requirements for the development of a robust methodology.

Outcome of the Summer School 2014 that took place in Leuven from 1 to 5 September 2014

Twenty-five people have participated to the Summer School 2014 at KU Leuven, Heverlee in Belgium. Most of the participants were PhD students with building physics and engineering background. Six lecturers addressed in 14 presentations, different topics on building physics, mathematics and statistics, application of modelling techniques, the use of R software environment, etc.

The main objectives of this 3rd Summer School were:

• to train a common methodology to assess thermal characteristics of building components and to assess whole building energy performance.

• to bridge the gap between expertise from both physical and mathematical/statistical analysis and modelling practice.

• To train the participants in using the software environment R

The social intermezzo has been much appreciated not only because of the lovely weather but more for the well entertaining visit to the Abbaye van Park and the diner at the old Brewery De Kroon in Neerijse.

The aim of the Summer School is not to promote a specific analysis or simulation tool but rather to transfer the knowledge on a common methodology for application to assess the energy performance of a building according to the requirements defined by the Directive on the Energy Performance of Buildings (EPBD). Therefore the students are trained in the use of R, the open software to develop their models for the exercise that were prepared by the lecturers. Roughly half of the time has been spent on exercises and has been much appreciated.

The organisers are planning the next Summer School for 2015. Follow the information on the DYNASTEE web-site to know more about the venue and dates.

Students and lecturers gathered at the 'Abbaye van Park' in Leuven

Energy performance assessment of buildings and building components.

Guidelines for data analysis from dynamic experimental campaigns.

Part 1: Physics

Guidelines for dynamic data analysis for energy performance assessment of buildings and building components have been elaborated in the framework of subtask 3 of Annex 58. These guidelines consist in two parts respectively related to physical and statistical aspects of data analysis. Both parts must be considered as complementary in a multidisciplinary context. These guidelines are based on experiences along previous EU projects developed by DYNASTEE participants and also on lessons learned from common exercises and other activities carried out recently in the framework of Annex 58.

The first part, which is mainly dealing with physical aspects, reports the minimum steps to carry out data analysis and outlines different alternative analysis approaches. It is discussed how to deal with data analysis from full size tests carried out under realistic boundary conditions. The dynamic character as well as other relevant physical issues brought by these test conditions, are taken into account. Key steps from the physical point of view, regarding application of different approaches such as steady state, linear models in transfer function form, and state space models, are discussed. Some basic concepts from general techniques which are required to carry out data analysis are briefly presented, but these techniques are more detailed discussed in the second part of these guidelines dedicated to statistical issues. Case studies that help to understand the different aspects discussed, are included along this text, and references are given for further information.

Special attention is paid to pre-processing and qualitative analysis, as well as to simplifications criteria which play an important role to obtain accurate results and design cost effective tests. The role of physical aspects and robustness of results in validation criteria is also considered.

Part 2: Statistics

This part discusses statistical aspects and may help the modeller to make a proper decision to choose a correct model and evaluate the residuals from the modelling process. The guideline for applying statistical models has been developed in Subtask 3 of the Annex 58. The core aim of the statistical guidelines is provide procedures for applying and validating statistical models in order to obtain reliable information about the energy performance and dynamics of buildings. A range of models are available: from simple linear regression models and ARX models to advanced grey-box models. The simple models are suited to static data (approximately daily values). The advanced applies to high resolution data (5-30 minutes values) and combine physics and statistics enabling detailed information about the heat dynamics of the building to be obtained. It is described how the models of different complexities should be applied depending on the properties of the data, as well as the information which is needed for the particular application. Examples using CTSM-R are provided with data and R code, thus serving as a hands-on tutorial for the reader.

CTSM-R has been successfully applied to a wide range of data-driven modelling applications: heat dynamics of walls and buildings, dynamics of heat exchangers, radiators and thermostats, solar thermal collectors, building integrated photovoltaic systems and more. Download the latest release, 7 April 2015, of the user guide from: http://ctsm.info/pdfs/userguide.pdf

Outcome of the joint workshop at LBNL

The last IEA EBC Annex 58 expert meeting took place September 17th – 19th at the Lawrence Berkeley National Laboratory (LBNL) in Berkeley, San Francisco, US. Since also Annex 60 was having their expert meeting at LBNL, the opportunity was taken to organize the morning session on Wednesday September 17th as an internal joint expert meeting with Annex 58 and Annex 60 experts. First the overall objectives and current status of both projects were presented to each other. Thereafter, the aim and results of the BES-validation exercise – launched in Subtask 4 of Annex 58 - were discussed, since also different members of Annex 60 participated in this free common exercise. The internal meeting was ended with a brainstorm session on topics of joint interest and possibilities for further collaboration.

Annex 58- participants visiting the test sites at Lawrence Berkeley National Laboratory during the last expert meeting in September 2014.

In the afternoon, an open workshop was organized by LBNL in collaboration with Annex 58, Annex 60 and DYNASTEE. The workshop was opened by Mary Ann Piette from LBNL, followed by a talk by Steve Selkowitz (LBNL) on typical gaps in building performance. Thereafter, an overview of ongoing work in IEA EBC Annex 58, Annex 60 and Annex 66 was presented by the operating agents. Henrik Madsen (DTU) closed the first part of the workshop with his talk entitled 'What can we learn from data'. He elaborated further on ongoing research in Annex 58 and presented some current research at DTU on data analysis applied to building characterization and smart grid optimisation.

After the coffee break Hans Bloem (JRC) and Paula Gruendling (CPUC) compared the energy policies and standardisation in Europe and California. This was followed by a view from Eric Soladay (Integral Group, Oakland, CA) on energy policy and use of computational tools in practice. Steve Selkowitz (LBNL) had the honour to close the workshop in a final talk wrapping up the different presentations and discussions of the afternoon.

IEA EBC Annex 58
SubTask 1. Inventory of full scale test facilities

The first subtask of IEA EBC Annex 58 aimed to give an overview and evaluation of previous and ongoing in situ test activities. The report which gives an inventory of full scale test activities for the evaluation of energy performances of building components and whole buildings is ready now. It contains descriptions of 25 existing test facilities or test sites available at different institutes all over the world, according to their main functionalities: objectives, lay-out of the infrastructure, typical equipment and operation, examples of measuring campaigns and analysis methods. The descriptions were provided by the participants of IEA-Annex 58, and complemented by descriptions which were previously published in the book on 'Full scale test facilities', also available on the DYNASTEE website. The inventory may provide examples and background to building researchers responsible for the design and construction of new test facilities or for the management of existing ones.

Full scale test facilities may be defined as facilities, specifically constructed for experimental use, where the energy related performances of building components, systems or whole buildings are studied in full scale in response to realistic boundary conditions. To achieve this, the facility requires a high degree of control of the indoor environment, well-specified constructions, and high levels of instrumentation. As this type of facilities can fill the gap between precise laboratory experiments and energy monitoring in real buildings in use, also the test approaches applied in these facilities range between both extremes. The report is subdivided in two parts, related to the scale at which building energy performances are analysed.

A large group of facilities is designed to study and quantify the performance of full scale building components in realistic climatic conditions. In these facilities this is achieved by means of a well-controlled indoor environment and by exposing components to the real climate in the field. Building components may include opaque walls, advanced glazed façades, sloped and flat roofs, etc…, while the performances under investigation range from thermal and solar to moisture performance. The test results are used to evaluate the validity of model predictions, or to characterise component performances related to their behaviour in real climatic conditions.

Another group of facilities is designed to study energy use and indoor environmental quality under realistic dynamic conditions at building level, in relation to the building services and building envelope solutions installed in the test buildings. The geometry and construction of this type of facilities is usually simplified and more precisely defined compared to 'real' buildings. As a result, it is easier to obtain high levels of instrumentation and control which allows for a more accurate and straightforward analysis of measuring data. To further reduce uncertainties, facilities for energy use analysis are typically unoccupied (although user schedules may be emulated). However, a smaller number of more recent test buildings are specifically designed for in-use testing and are occupied during monitoring. In-use testing of dedicated test buildings helps to investigate the relation between user behaviour, building and system design, indoor environmental quality and building energy use.

Top: FlexHouse

Bottom: rotatable test cell

ABOUT DYNASTEE

DYNASTEE is an informal grouping of organisations involved in research and application of tools and methodologies for DYNAmic Simulation, Testing and Analysis of Energy and Environmental performances of buildings. DYNASTEE provides a multidisciplinary environment for a cohesive approach to the research work related to the energy performance assessment of buildings in relation to the Energy Performance for Buildings Directive (EPBD). DYNASTEE, being a network of competence in the field of outdoor testing, dynamic analysis and simulation, has over 25 years of experience through a series of EU research projects. DYNASTEE is an open platform for sharing knowledge with industry, decision makers and researchers. DYNASTEE has the expertise needed to support the developments and design of Nearly-Zero Energy Buildings as required by the EPBD. Specific outdoor experimental work needs knowledge of the analysis process in order to optimise the dynamic information in the measurement data. Simulation requires results from analysis in order to be able to scale and replicate the results from analysis and testing to real buildings in different climates. DYNASTEE functions under the auspices of the INIVE EEIG. For more information visit the DYNASTEE web-site at **www.dynastee.info**