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Evaluating and Modelling Near-Zero Energy Buildings; Are we ready for 2018?

Expert Meeting
30-31 January 2012
Glasgow (UK)

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EC – DG JRC
Institute for Energy and Transport

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“Evaluating and modelling near-zero energy buildings; are we ready for 2018?”

Why this expert meeting?
From the title one may derive four keywords:

- Evaluating
- Modelling
- Near-Zero Energy Building (NZEB)
- 2018, as a metaphor to the future

Modelling work is needed to develop reliable software tools for simulation and prediction of energy consumption in buildings. The development of calculation models requires thorough understanding of the physical process and mathematical representation. Modelling, by definition is a simplification of reality and therefore needs validation of the applied model from **evaluation** using dynamic techniques on measured data from real life.

The requirement of nearly-zero energy buildings (**NZEB**) as from 2018-2020 as mentioned in the **EPBD** (recast-2010) asks for the development of new design approaches, more based on energy flows in buildings. Several papers and documents discuss the definitions related to NZEB and the impact it may have on the energy system of the future in the built environment. The developments for reliable calculation software for the purpose of simulation needs EPBD related energy standards.

The question now is: What is the status of present simulation software tools in order to support the objectives of the European Energy Policy to reduce the energy consumption in the building sector? **Are we ready for 2018?**

It is now the right time to clarify all issues on definitions, calculation methods in relation to standards and to give clear signals of the reliability of software tools for use by building designers. A mandate has been given to CEN to review the current set of EPBD related energy standards.

The group of experts were asked to submit before the meeting a document addressing these keywords and related issues, while bringing up topics for discussion. These contributions present the latest developments and state-of-art in software tools, definitions for NZEB (based on the EPBD) and future developments of the set of CEN energy standards.

With a look to 2018 and beyond, the outcome of this expert meeting could contribute importantly to the aforementioned developments.

JRC - IET

The Institute for Energy and Transport (IET) provides scientific and technical support on energy issues to policy makers of the European Union (EU). Special emphasis is given to the security of energy supply and to more sustainable, safer and cleaner energy production and use for the future.

The IET is one of the seven Institutes of the Joint Research Centre, a Directorate General (DG) of the European Commission. The JRC functions as a reference centre of science and technology for the EU. Close to the policy-making process, it serves the common interest of the Member States, while being independent of special interests, whether commercial or national.

The IET is based both in Petten (the Netherlands) and Ispra (Italy) and has a multidisciplinary team of more than 300 academic, technical and support staff.

"The mission of the JRC-IET is to provide support to Community policies and technology innovation to ensure sustainable, safe, secure and efficient energy production, distribution and use and to foster sustainable and efficient transport in Europe"

ESRU

The Energy System Research Unit (ESRU) is located in the Department of Mechanical and Aerospace Engineering at the University of Strathclyde in Glasgow. It was established in 1987 as a cross-discipline team concerned with new approaches to built environment energy demand reduction and the introduction of sustainable means of energy supply. The group develops, distributes and supports Open Source programs that may be used to examine the performance of traditional or new energy systems at all scales. In particular the group has been responsible for the development of the research program ESP-r for detailed dynamic thermal simulation.

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Foreword

The European Union has set forward mandatory targets for the reduction of Greenhouse Gas emissions of 20% by 2020. In practice, this leads to reducing energy consumption by 20%, and a share of 20% of renewable energy in the final energy consumption.

In the European Union, the energy use in buildings accounts for more than a third of the entire energy consumption, and even though in the past many attempts have been made to make buildings more energy efficient, a comprehensive, European-wide package of policies has yet to be implemented.
The recast of the Directive on the Energy Performance of Buildings includes now a very ambitious requirement, to achieve for newly constructed buildings a net energy consumption close to zero, to be implemented for public financed buildings by 2018, and later, at 2020 also for private constructions.

Looking closer at this requirement, as it is the case in this meeting, one realises on one hand, that this goal requires both an essential contribution of renewable sources close to the buildings, and the application of a number of advanced technologies to make the energy performance of a building significantly better.

To make this ambitious policy a success, a number of so far fragmented knowledge has to be brought together, both from the renewable energy and the energy efficiency side. The intelligent and cost-effective integration of what is available today constitutes quite a challenge for all stakeholders involved, being construction industry, civil engineers, heating & cooling experts, financing sectors and most of all, end users.

I wish that another aspect is not forgotten in the technical debate: If we want that net- (or near-) zero energy buildings becomes mainstream, one needs to address and include designers and architects, to take up the challenge of bringing the performing building into a new product category which convinces already by its style, design and its integration in urban or rural environments.

With the present workshop proceedings we would like to give a first insight in the technological challenges and the way forward.

Dr. Heinz Ossenbrink
Head of Unit
Renewable Energy
Joint Research Centre
European Commission

List of Participants to the Expert Meeting on:

"Evaluating and Modelling Near-Zero Energy Buildings; are we ready for 2018?"

taking place at the University of Strathclyde in Glasgow, 30-31 January 2012.

Marion Hiller	DE	Transsolar
Witta Ebel	DE	Passivhaus Institute
Marta Szabo	HU	Budapest University
Henrik Madsen	DK	DTU – IMM
Etienne Wurtz	FR	CNRS / INES
Jan Hensen	NL	IBPSA
Dick van Dijk	NL	CEN/ISO (EN13790)
Johann Zirngibl	FR	CSTB (CEN)
Bart Poel	NL	BP Consultancy
Ya Roderick	UK	IES Glasgow
Darren Robinson	UK	Nottingham University
Kim Witchen	DK	SBI DK
Bogdan Atanasiu	BE	BPIE
Philip Delff	DK	DTU – IMM
Paul Strachan	UK	ESRU
Joe Clarke	UK	ESRU
Hans Bloem	EC	DG – JRC – IET

Programme
with the focus on discussion rather than presentations.
Powerpoint presentations however, will be used to support the discussions.

Monday 30 January
9:00 – 12:45 Objectives of the meeting. Brief (5 minutes) introduction by participants of their relevant background and their key topics for discussion.
Break for lunch
14:00 – 17:30 First round of discussions on selected topics
Evening dinner

Tuesday 31 January
9:00 – 12:45 Second round of discussions on selected topics
Break for lunch
14:00 – 17:30 Final discussion and drafting of a consensus report

Presented discussion papers

Evaluating and modelling near-zero energy buildings; are we ready for 2018?
Hans Bloem, JRC – IET – REU, Ispra
Paul Strachan. ESRU, University of Strathclyde

Introduction to the expert meeting on: "Evaluating and modelling near-zero energy buildings"
Hans Bloem, JRC – IET – REU, JRC Ispra, Italy

Integrated Building Performance Assessment
Paul Strachan and Joe Clarke. ESRU, University of Strathclyde

Building performance simulation: current state and challenges
Jan Hensen, Eindhoven University of Technology, Netherlands

The Passive House Planning Package (PHPP)
Witta Ebel, Wolfgang Feist, Passive House Institute, Darmstadt Germany

TRNSYS and near Zero-Energy Buildings
Marion Hiller, Transsolar Energietechnik GmbH, Stuttgart, Germany

Evaluating and modelling near-zero energy buildings; are we ready for 2018? –
IES integrated visions
Ya Roderick, IES, Glasgow, UK

Principles for implementing nearly Zero - Energy Buildings in Europe
Bogdan Atanasiu, Buildings Performance Institute Europe (BPIE), Belgium

The CEN work program to develop a second generation of CEN standards to support the (recast) EPBD and some key points for discussion regarding the modeling for this purpose
Dick van Dijk, TNO, The Netherlands

Link between the simulation tools, standards and the European Directives
Johann Zirngibl, CSTB / France

Building energy performance Model identification and parameter estimation
Henrik Madsen, Peder Bacher, Philip Delff, DTU – IMM Denmark

Simulation and Software tools, for interoperating management of thermal and electrical energies in Buildings
Etienne Wurtz, CEA – INES, Chambery, France

Simulation of Zero Energy Buildings requires the inclusion of the human factor
Bart Poel, Bart Poel Consultancy, Velp, The Netherlands

Modeling of occupancy using inhomogeneous Markov model
Philip Delff, Anne Iversen, Henrik Madsen, Carsten Rode, DTU – IMM Denmark

Comparison of Calculation tools for the Calculating Cost-optimal Levels of Minimum Energy Performance Requirements for Buildings and Building Elements (COM EPBD)
Marta Szabo, SZIE, Hungary

A very brief discussion document…
Darren Robinson, Chair in Building & Urban Physics, University of Nottingham, UK.

Expert Meeting Summary Report

Evaluating and Modelling Near-Zero Energy Buildings; are we ready for 2018?

University of Strathclyde, Glasgow, 30-31 January 2012

The initiative to organise this expert meeting was taken by the Joint Research Centre – IET – REU. It was co-organised and hosted by the Energy Systems Research Unit of the University of Strathclyde.

SUMMARY

The requirement of nearly-zero energy buildings (nZEB) from 2018-2020 as mentioned in the EPBD (2010/31/EU) requires the development of new design approaches, supported by short and long term research activities, focusing more on the energy flows in, to and from the buildings and the variation in input variables (building/system characteristics) and internal and external conditions like climate and user behaviour. The trend for energy consumption in buildings is a decrease of energy for heating space conditioning and an increase of electricity for installations and appliances. As buildings become more energy efficient, dynamic effects associated with gains and occupancy behaviour (and the associated use of appliances and equipment) assumes a more important role. The assessment of the energy and environmental performance of new and refurbished buildings requires a more dynamic and intelligent urban energy management that takes into consideration local climate, interaction with the energy infrastructure, distributed energy supply, demand and storage, etc. Balancing the building energy system with the urban transport energy system is a valuable but complex issue also. To support the reduction of final energy consumption and in particular the reduction of GHG emission, the integration of renewable energy technologies in the built environment is a valuable option. It can be concluded that the building energy sector will become a very important component in the overall energy policy and in the whole energy system of our future society.

INTRODUCTION

This summary report is intended to inform decision makers about the state-of-the-art of building simulation software for energy performance assessment in relation to the EPBD requirements for nZEB and requirements for EU energy standards (CEN).

The group of 17 experts was chosen on purpose from diverse backgrounds e.g. modelling for design and simulation of building energy performance; commercial and academic organizations; modelling for evaluation of EPBD-nZEB requirements and CEN energy standard experts.

Out of a list of several topics [Bloem] based on the contributions that all participants submitted for the hand-out to the meeting, six important topics were selected for in depth discussion during the two-day meeting.

- Definitions for nZEB (EPBD 2010/31/EU)
- State-of-the-art of building simulation software
- EU energy standards (CEN)
- Occupancy related issues for modelling
- Uncertainty and data for input
- Reliability and validation of simulation models

These topic discussions were addressed several questions related to evaluating and modelling of near-Zero Energy Buildings. The most prominent question is: “are we ready for the introduction of nZEB buildings in 2018?”

Other questions addressed included:

- “How reliable are simulation methods in predicting the primary and final energy consumption?”
- How should input data and modelling uncertainty and the quest for robust designs be integrated into simulation?
- How should data be acquired and managed facilitate urban scale simulation analyses?
- “Is current simulation software able to perform as well when electrical energy consumption increases to 50% in the building sector?”
- “How can we deal with Renewable Energy supply in the built environment and in particular how can we consider it in energy calculations when the share rises to 50% in the energy mix? Can simulation tools handle the variable resource?”
- How can the output of simulation tools be used for compliance (reproducibility, robustness, and limited input data)?

The report gives also considerations for short- and long-term research topics.

The contents of this report reflect the discussions and observations concerning the aforementioned topics made during the expert meeting. In some cases recommendations are made.

Different timelines were discussed, in order to understand the pressure on the implementation of the EPBD and the review of CEN energy standards. Industry will continue to develop innovative building construction products and equipments that will support a further reduction of energy consumption and in some cases will produce or store energy. Therefore the need for short and long term research and demonstration projects to support the validation of simulation models and software is requested for use by nZEB building designers.

This report will be distributed to DG JRC, DG ENER, DG ENTR, DG MOVE, DG RESEARCH, EACI, CA-EPBD, all participants to the expert meeting (see list).

Organisers:
H. Bloem (JRC)
P. Strachan (ESRU)

Topic 1: Definitions for nZEB (EPBD 2010/31/EU)

The definition for nearly Zero-Energy Buildings (nZEB) as presented in the re-cast Energy Performance of Buildings Directive (EPBD) requires that from 2020 all new buildings are near-to-zero energy consuming on an annual basis. The "annual basis" refers to the calculation period and not to the time step of the calculation which can be monthly, daily, hourly or sub-hourly time step. In order to guarantee the optimal use of available energy resources, optimisation requires a detailed calculation dealing with dynamics from the direct environment and the energy infra- structure. The definitions as in the EPBD (see frames) are the start for the discussions.

*"**nearly-zero energy building'** means a building that has a very high energy performance, as determined in accordance with Annex 1. The nearly zero or very low amount of energy required should be covered to a very significant extent by **energy from renewable sources**, including energy from renewable sources produced on-site or nearby"*

In Annex 1 to the EPBD:
*"The energy performance of a building shall be expressed in a transparent manner and shall include an energy performance indicator and a numeric **indicator of primary energy use**, based on primary energy factors per energy carrier, which may be based on national or regional annual weighted averages or a specific value for on- site production."*

and

*"The methodology for calculating the energy performance of buildings should take into account **European standards** and shall be consistent with relevant Union legislation, including Directive 2009/28/EC."*

and

*"The energy performance of a building shall be determined on the basis of the calculated or actual **annual energy** that is consumed in order to meet the different needs associated with its typical use and shall reflect the heating energy needs and cooling energy needs (energy needed to avoid overheating) to maintain the envisaged temperature conditions of the building, and domestic hot water needs. "*

A recent study by the Building Performance Institute Europe [BPIE] provides a good introduction to this topic. It shows that there are a number of uncertainties and challenges, specifically in terms of methodologies, boundaries and threshold energy consumption, renewable energy share and CO_2 emission targets of such buildings.

The need for developing a sustainable, effective and practical nZEB definition for nearly-Zero Energy Buildings is emphasised.

It can be stated that buildings will become an important part of the overall energy system and should no longer be considered as a stand-alone system. Community or urban energy systems will be the dimension for assessment of the energy consumption in the built environment.

*"The energy performance of buildings should be calculated on the basis of a methodology, which may be differentiated at national and regional level. That includes, in addition to thermal characteristics, other factors that play an increasingly important role such as heating and air-conditioning installations, application of energy from renewable sources, passive heating and cooling elements, shading, indoor air-quality, adequate natural light and design of the building. **The methodology** for calculating energy performance should be based not only on the season in which heating is required, but **should cover the annual energy performance** of a building. That methodology should take into account existing European standards. "*

The definition of nZEB is more a concept rather than a building. Therefore the balancing of demand, supply and storage has to be taken into account at an urban scale.

The building should not anymore be considered as an aggregation of building construction products (Directives such as the CPD and ECODesign) but rather as a part of a more global energy system (Directives such as EPBD, EESD, RESD), probably at the level of an urban energy infrastructure. In particular, in relation to renewable energy resources and the variable energy aspect of occupancy, the balancing of dynamic energy flows will become more important at a much smaller time scale than the annual energy performance of the building considers at present. The energy infrastructure and information technology will play a more important role in optimizing the use of primary energy resources. The building will be an essential part of the overall reduction of energy (and reduction of CO_2) in our future society.

Therefore the definition of nearly-zero energy buildings has to be reviewed in relation to the boundaries of the climate and energy resources. One may conclude that *on-site or nearby* is not enough for defining energy produced from renewable energy sources and off-site renewables should also be considered. Moreover, the term 'nearby' is not clearly defined and may be taken as renewable energy within the city, region or even country borders. In addition, the energy balance of a nZEB should be evaluated at a proper timescale in order to minimise the CO_2 balance when dealing with the time disparities of locally generated renewable energy (nZEB on yearly basis is the easiest, but the optimum seems to be on a monthly basis in order to deal properly with the CO_2 emissions associated with the energy supply). However note that the definition of 'energy performance' is related to primary energy. The question remains: "Why PV on **my** roof?" In considering the answer to this question, the CEN energy calculation models may differ from the building design models. Today's answers may also differ within 10 years from now. For a better understanding, the definition could distinguish building energy needs, building operational energy needs and variable energy, such as gains and occupancy behaviour.

The electricity consumption of households' appliances has an increasing trend and will become predominant in a nZEB. At the same time, the operational energy consumption of a nZEB will be significantly reduced and the energy consumption share during the construction and disposal phases of a building will increase importantly. Therefore, in the long run, the electricity consumption of the household appliances, ICTs and buildings systems (such as lifts or security lighting) as well as the life cycle approach may be included within the scope of a revised EPBD.

The trend in energy consumption is clear from statistical information: more electricity will be consumed for equipment and appliances whereas the energy demand for space heat conditioning is lowering due to improved insulation techniques. There is more uncertainty for future cooling requirements, depending on the growth of appliance use and future climate projections. The future will demonstrate the importance of local energy storage and management by information technology (also known as smart or intelligent metering environment) and the power of dynamic analysis.

Topic 2: State-of-the-art of building simulation software

Building energy design should be considered as a part of the overall building design. The consequence of compliance (M.S. regulation in terms of energy consumption, e.g. performance requirements) and overall building design, occupancy behaviour, etc.) does not guarantee the optimisation of energy use and reducing consumption.

Some key issues for simulation programs are:

a) the need to ensure that dynamics are included throughout - the use of simple efficiency factors only approximates to reality which may be helpful at early stages where the analysis will be done by architects etc.;
b) the need to continuously add technical improvements to reflect new technologies (e.g. phase change materials);
c) the need to improve usability - the number of skilled modellers is limited. Improvements include developing structured guidelines for performance assessment methodologies, development of program specific and general courses on modelling and simulation.
d) the need to include stochastic processes including the occupants' behaviour and related comfort, such as inference engines which are given limited (early stage design type) information and provide occupancy data (neutral data format only) that is reflective of EU occupancy norms for different building types/stock;
e) the need to extend the urban scale (and not just individual buildings), in terms of the impact of urban radiant and thermal climate on buildings' energy used and the interface between buildings and the wider energy system (building + transport + energy supply, storage and control infrastructure + water and waste treatment);
f) the need for interoperability;
g) the need to extend performance to Life Cycle Analysis, not just operational energy requirements - as buildings become more energy efficient, so embodied energy assumes a greater importance.

Different commercial and academic software are available often with specific and characteristic calculation models and approaches. A common accepted performance check is needed suited for nZEB.

There is a clear separation between modelling for design and modelling for compliance. If CEN produce a new prescriptive method for compliance energy modelling (at least hourly is required), then it is likely this will become used also for design - otherwise users would need to develop separate models for design and compliance. This could limit design freedom, may not result in accurate predictions and does not promote better-than-compliance performance.

Topic 3: EU energy standards (CEN)

The 2nd mandate to CEN to review the present set of EPBD related energy standards will be more structured along Member States specific requirements in relation to EU targets. There will be greater focus on the more variable character of energy supply and demand.

The USA has adopted a different approach for Standards, with the development of ANSI/ASHRAE Standard 140-2007: Standard Method of Test for the Evaluation of Building Energy Analysis Computer Programs. Software must pass the prescribed tests to be used in a variety of contexts: for example the Internal Revenue Service for certifying software used to determine tax deductions, ASHRAE building energy efficiency Standards 90.1 and 189.1, RESNET for building performance rating system, LEED certification and COMNET for general modelling procedures for a variety of applications including energy labelling. Any simulation program that has been accredited to pass the tests (with other requirements such as the ability to model various technologies) can be used.

The question is raised also how new technologies can be dealt with. The equivalence principle could be a method to insert in the Standards and meanwhile the standards should be flexible enough to be able to embrace them quickly without the need to wait until a new round of regulations come out.

In general, compliance should not become too prescriptive with regulation but instead should come closer to building design requirements, although there may be more differences when national regulations are considered.
Standards may request from industry the provision of more specific technical information, in particular dynamic performance data, to allow more realistic energy predictions. Many innovative technologies, such as heat pumps and solar technologies are dynamic and variable and their efficiencies vary significantly according to the prevailing climatic and operational conditions. The dynamic energy flows due to occupancy behaviour are not properly addressed in the present set of energy standards.

Topic 4: Occupancy related issues for modelling
In the evaluation and modelling of nZEBs we are not only interested in comparing the relative energy performance of alternative building design proposals or on labelling buildings, but we need to understand whether a particular building design proposal is a robust one and whether the building is likely to be comfortable. In addition, it is necessary to evaluate the effectiveness with which the building exploits locally generated energy; indeed the effectiveness with which it is embedded within the wider urban energy system. For these analyses it is **essential** that the stochastic nature of occupants' journeys, presence at each destination and presence-dependent activities and related behaviours is faithfully emulated in dynamic simulation. Furthermore, and as stated earlier, this need will become more pronounced as the quality of buildings' envelopes improves, thus better conserving energy and exaggerating the impact of occupants' actions to regulate the envelope and the internal lights and appliances.

Fairly good progress has been made in respect of the modelling occupants' use of lights, shading devices and windows; but data from more widespread experimental campaigns is essential if the models are to have sufficiently broad scope of applicability (in terms of occupants' diversity and the diversity of building uses and passive/active systems to regulate the indoor climate). In terms of models predicting occupants' activities, their control of HVAC systems and their activity-dependent use of electrical appliances the surface has been barely scratched. Addressing these shortfalls, and improving the knowledge of the probability with which homeowners will invest in more sustainable technologies, is of paramount importance.

In addition to detailed experimental campaigns to develop the required bottom-up behavioural models, detailed (and ideally concurrent) building energy use datasets will also help with determining the reliability of the developed models and may also help with the formulation of simplified aggregate models for application in the shorter term. The roll-out of smart meters will help considerably in this.

In the short term a top-down approach could give the boundaries for energy consumption related to occupancy behaviour. Identifying the characteristic parameters for specific building energy consumption from available measured data (smart metering) could support the optimization of energy balancing. In the longer term bottom-up research should give more insight in important aspects related to occupancy behaviour in a wider urban related energy consumption context (including transport, living-work relationships). This includes daily energy flow patterns. Another aspect is the robustness of technical solutions related to occupant behaviour. This also includes the user friendliness of technologies in terms of their operation and maintenance.

Topic 5: Uncertainty and data for input

One problem for dynamic modelling of energy technologies is the lack of appropriate manufacturer's data, which often are steady-state tests and which do not cover the range of operational conditions the equipment will be subject to in practice. It is recommended that product testing requirements should improve to generate performance characteristics over typical operational ranges. Balancing between energy demand, supply and storage can only be optimised when the input data have similar dynamic characteristics. Within that context it is important to distinguish between the integration of renewable technologies in the built environment and the energy infrastructure.

Another area where data for modelling is not readily available is cost. This needs more attention now the implementation of the Cost Optimality Methodology is required within the frame of the recast EPBD. One further complicating factor is that the scale of analysis increases from the building to the urban scale, so the input data uncertainties to the simulations tools are likely to increase. Sound methodologies to rigorously represent input uncertainties will thus be increasingly important.

Topic 6: Reliability and validation of simulation models

Dynamic energy calculation models require realistic data for validation of building simulation calculation models. Validation sets for compliance to CEN standards are also needed. There is a lack of high quality experimental datasets encapsulating a building's full thermal energy balance from full-scale buildings, both occupied and not, that can be used for model validation.

In this context the training and user accreditation for simulation software is considered also for all types of users. In general, expertise is needed to utilise building energy software effectively. There have been useful precedents set in the USA recently with energy modelling training workshops developed by IBPSA-USA (International Building Performance Simulation Association) and ASHRAE.

In the longer term, energy simulation should be seen as a route to membership of professional bodies such as CIBSE and ASHRAE and the associated CEng and PE status.

Considerations for EU supported research and demonstration projects.

The answer to the question "Are we ready for 2018?" has to be differentiated.

Research and demonstration of available technologies have to be performed in the near future in order to push forward developments in design of new buildings and major renovation as well as design of the energy infrastructure, to fulfil the requirements of the energy related EU Directives. Community efforts to seek cost and energy-efficient solutions for the renovation of buildings should be given the high priority taking into account the low replacement rate due to recent marked reduction of new constructions.

<u>Recommendations for the short term:</u>

- Validation of simulation programs with high quality experimental datasets from tests on buildings and systems in test buildings.

- Convergence between harmonised energy performance calculation procedures (CEN) for energy performance compliance and energy performance certificates and simulation programs. This requires for the standards that they become more dynamic and where possible 'performance criteria based' instead of 'prescriptive' and for the simulation programs to become more transparent, robust, reproducible and able to deal with necessary limitations in input data.
- Data analysis of large scale, high frequency energy consumption data from smart meters, (perhaps to provide asset ratings).
- Control systems to monitor (intelligent energy management environments) and improve building energy performance by investigating balancing supply, demand and storage.
- Harmonised and transparent climate data have to become available for calculation methods, although ISO Standards exist for the calculation method; likewise rigorous procedures for representing the radiant environment (shading from the sun and sky and reflections from surrounding buildings) and thermal environment (e.g. urban heat island) in the urban context.
- More dynamic data for products, such as heat pumps, solar related technologies, etc. are required for improved energy performance assessment. Annual based technical spec*i*fications are not sufficient for use by building designers. Industry could provide these data; however interaction with the research community is needed to define the required information.
- In general a lack of comprehensive data on the building stock at European level is observed. At this level Member States should pay more attention in particular when it concerns the energy policy and strategy to optimize the use of available energy resources.
- Procedures to take into consideration uncertainties relating to the representation of newly constructed / renovated buildings and the peculiarities of their subsequent operation; this should be informed by experimentation.
- Create an approach to check robustness of technical solutions (sensitivity cases to calculate, criteria to judge).

<u>Longer term recommendations</u>

- A network of realistic low energy research buildings could provide the necessary data for evaluation, and expertise on management. Development of design and simulation methodologies for energy-efficient buildings integrated in the neighbourhood energy systems requires a much wider approach and thinking than at present.
- In particular the lack of sufficient knowledge on occupancy behaviour will be crucial in a future low-energy system. Energy consumption and optimising the use of it will be more linked to peoples' location; at home (residential), moving (transport) or at work (non-residential, office, school, etc.), their subsequent activities at that location and their related behaviours.
- The ongoing slow change of the energy-mix in EU M.S. will lead to different approaches and strategies of the energy policy. An EU policy will have to deal with regional and national data sets.

Timeline EPBD, CEN and nZEB

There is pressure on M.S. to implement the energy related Directives. This means a challenge for the experts working on the EPBD and CEN related issues for implementation. The next 5 to 10 years will be crucial but dedicated approaches by governments and innovative products from industry could give the boost that is required.

Simplified Timeline

2010	-	recast EPBD
2012	-	implementation EPBD; 2nd mandate to CEN (M480)
2015	-	nZEB national Plan; revised CEN energy standards
2016	-	M.S. report on progress
2018	-	nZEB public new buildings
2020	-	20-20-20 targets; nZEB all new buildings

References

[Bloem] Invitation document to the expert meeting. (2011)

[BPIE] Atanasiu B., et al. Buildings Performance Institute Europe (BPIE), Belgium. 'Principles for nearly Zero-Energy Buildings. Paving the way for effective implementation of policy requirements' Brussels, November 2011, ISBN: 9789491143021

[EPBD] DIRECTIVE 2010/31/EU of the European Parliament and of the Council of 19 May 2010 on the Energy Performance of Buildings (recast).

[EN 15603] :2008 Energy performance of buildings – Overall energy use and definition of energy ratings.

[EN ISO 13790] Energy performance of buildings: Calculation of energy use for space heating and cooling

Annexes

- Invitation letter
- Agenda
- Context
- Participants

INVITATION LETTER
to the Expert meeting on:
"Evaluating and modelling near-zero energy buildings; are we ready for 2018?"

Date : 30-31 January 2012
Venue : University of Strathclyde, Glasgow (UK)
room M329 in the James Weir building (*details of the location; see below*)
The expert meeting is organised by European Commission, Institute for Energy and Transport in collaboration with ESRU of the University of Strathclyde, Glasgow. Several experts have been invited to write a contribution for the hand-out that will mailed the week before the meeting.

The organisers, ESRU Strathclyde University and the DG JRC – Institute for Energy and Transport, are very happy with the composed group of participating experts to this meeting on **"Evaluating and modelling near-zero energy buildings; are we ready for 2018?"** The group of around 20 persons is composed of Simulation tool developers (commercial as well as academic), EPBD experts and CEN standardisation representatives.

All participating people can volunteer to submit a short paper for the hand-outs however the deadline is strict and is 15 January. The contribution has to be based on the discussion topics that are listed below. The participants are invited to submit a paper, minimum 4 pages. The hand-outs will be sent as PDF to all participants before the meeting.

Scope
The JRC Institute for Energy and Transport is studying at present in a wider context the nearly-zero energy building design in the energy system of the future. Buildings will be the core part of the EU energy policy. Therefore the energy system takes into consideration climate, infra-structure, resources, local energy-mix and variable supply and/or demand and means of storage.

This meeting aims to address the following topics:

- Assess a "State of Art" on evaluation and modelling methods and tools for nearly-zero energy buildings; what is required and how to achieve it?
- Find a consensus on the energy flow perspective. Place the building (as an energy system) in a greater energy (resource) system. Take into account that the building will have a more important functionality (a cornerstone) in our overall energy infrastructure.
- To report on present dynamic simulation tools for their ability to deal with this approach. Most simulation tools start from building components/systems.
- Define a strategy for low energy building design in relation to EU Energy Policy (e.g. Directives such as EPBD, EESD, RESD and RED) and EU legislation (such as EU energy standards) that have recently be reviewed.
- Can existing calculation methods support the renovation design of existing buildings in order to half the present primary and final energy consumption? That could be, for example, reducing the consumption from 150 to 75 kWh/m^2 or even from 100 to 50 kWh/m^2.
- Find an answer to the question: "how reliable are simulation methods in predicting the primary and final energy consumption?"
- How can the existing calculation methods support the Cost Optimality calculation method as proposed by the Commission (June 2011; http://www.epbd-ca.org/).

AGENDA
The invited experts will briefly present their contribution to the expert meeting. These presentations will be the base for the two rounds of Round Table discussions.

The preliminary agenda for the expert meeting is as follows:
Monday 30 January.
9:00 – 12:30 Start of the meeting
Welcome message on behalf of ESRU and JRC – IET
Presentation on the background on evaluating and modelling nearly-zero energy buildings.
Presentations by the invited experts
Lunch break 12:30 – 13:30
13:30 – 15:30 First Round table discussions on selected topics
16:00 – 17:30 Continuation of discussions on selected topics.

Evening dinner

Tuesday 31 January
9:00 – 12:30 Presentation of outcome of the first round table discussion
Defining points for second round of discussions.
Lunch break 12:30 – 13:30
13:30 – 15:30 Second Round table discussions on selected topics.
16:00 – 17:30 Conclusive discussion and drafting of conclusive notes

Contacts are made with experts from the following organisations (the meeting will have limited number of participants (maximum 20 and registration therefore is required):

- ESRU – ESP-r University of Strathclyde, UK
- Transsolar TRNSYS, DE
- Passivhaus Institute, Darmstadt, DE
- IMM University of Denmark, DK
- CEA / INES Chambery FR
- EC – JRC - IET, Petten, EC
- IBPSA University of Eindhoven, NL
- CEN/ISO, international
- BPIE, nZEB, Brussels, BE
- IES, VE, Glasgow, UK

For travel details to the University of Strathclyde, go to:
http://microgen11.supergen-hidef.org/microgenII/webpages/getting_here.html.
The campus map - can be found at http://www.strath.ac.uk/maps/
Accommodation http://www.strath.ac.uk/esru/contactus/accommodation/
Premier Inn is closest, but all of them are reasonably close.

CONTEXT

The requirement of nearly-zero energy buildings as from 2018-2020 as mentioned in the EPBD-2010 requires the development of new design approaches, more based on energy flows in buildings. The trend for energy consumption in buildings is a decrease of thermal energy for space conditioning and an increase of electricity for installations and appliances. Apart from the building design it requires a much more dynamic and intelligent local energy management that takes into consideration, local climate, distributed energy supply and demand and interaction with the grid, etc.

Calculation tools based on dynamic methodology, test installations for innovative and energy complex building elements are required to support building and urban designers.

Major renovation is seen as an important option to reduce energy consumption. The integration of renewable energy technologies in the built environment is a valuable option to support the reduction of final energy consumption and in particular in the reduction of GHG emission.

The EPBD and its recent recast are demanding more from simulation calculation programs. Validation of the applied models is required (from testing and benchmarks). The NZEB new buildings and major renovation projects have to come with a cost optimal calculation (as in the EPBD delegated act (June 2011). The lack of a reference building is notified. However reference can be made to a calculation method as presented in national building codes and CEN energy standards.

Conclusions on Validation of Simulation methods from the recently held workshop on "Whole Building Testing, Evaluation and Modelling for Energy Assessment". 18-19 May 2011, Copenhagen, Denmark:

- *The complexity of constructional materials, fabric, heating and cooling systems is increasing. Modelling program capabilities have developed to model these.*
- *In spite of international validation projects, program validation has not kept up with the increased use of simulation programs. There is often reported a mismatch between designed and measured performance – but is it due to incorrect assumptions in the design, to deficiencies in the modelling programs, or to poor commissioning? This is of increasing importance now that simulation is becoming main-stream and increasingly used for energy compliance regulations and in design analysis for reduced energy use.*
- *We need a major international effort to obtain validation-quality data from large-scale buildings that incorporate a range of low-energy technologies. Given the advances in knowledge of experimental techniques and availability of comprehensive data acquisition systems, it should be possible now to undertake such experiments without the shortcomings of earlier attempts.*

For further information please do not hesitate to contact me.

If you have further questions, hoping to hear soon from you (preferably before 22th December),

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PARTICIPANTS by 15 January 2012.

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Jan Hensen	NL	IBPSA	BP&S
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Abstract

The requirement of nearly-zero energy buildings (nZEB) from 2018-2020 as mentioned in the EPBD (2010/31/EU) requires the development of new design approaches, supported by short and long term research activities, focusing more on the energy flows in, to and from the buildings and the variation in input variables (building/system characteristics) and internal and external conditions like climate and user behaviour. As buildings become more energy efficient, dynamic effects associated with gains and occupancy behaviour (and the associated use of appliances and equipment) assumes a more important role. The assessment of the energy and environmental performance of new and refurbished buildings requires a more dynamic and intelligent urban energy management that takes into consideration local climate, interaction with the energy infrastructure, distributed energy supply, demand and storage, etc. Balancing the building energy system with the urban transport energy system is a valuable but complex issue also. To support the reduction of final energy consumption and in particular the reduction of GHG emission, the integration of renewable energy technologies in the built environment is a valuable option. It can be concluded that the building energy sector will become a very important component in the overall energy policy and in the whole energy system of our future society.

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