ANNEX 67 NEWS

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Content

Test facility at AEE INTEC, Gleisdorf, Austria

Brief from the fifth Annex 67 working meeting

By Anna Marszal-Pomianowska, AAU & Søren Ø. Jensen, DTI

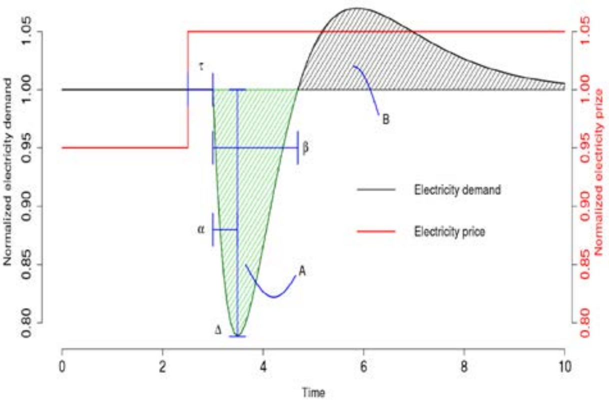
The fifth working meeting took place in Graz, Austria on September 27th-29th 2017. The meeting was attended by 42 participants from 15 countries. The meeting was hosted by AEE INTEC.

The main part of the meeting was used to focus on Subtask A: Definitions and Context.

The main topic of discussions was the development of a methodology for characterization and labelling of Energy Flexibility in buildings, as this will be a main deliverable from Annex 67. The methodology is based on the fact that the Energy Flexibility of a building is not a fixed value but varies with the daily and seasonal weather conditions, the use of the buildings, the requirements of the occupants e.g. comfort range, the requirements of the energy net, etc. Figure shows an example of the aggregated response of buildings when receiving some sort of control signal – in the following called penalty signal.

The penalty signal can be chosen according to the conditions: often the penalty signal is a price signal, but can also be a CO_2 or a RES signal. For these signals, the controller should minimize the price or CO_2 emission or maximize the utilization of RES. The penalty signal can either be a step response as in figure in order to test different aspects of the available Energy Flexibility in a building or clusters of buildings, or it can be a temporal signal varying over the year according to the weather and the requirements of the energy net in specific time periods.

Due to the variation of the conditions for obtaining Energy Flexibility the focus is on a methodology rather on obtaining a number.



Example of aggregated response when some buildings receive a penalty signal – here a price signal (source: DTU-Compute, DK).

where: τ is the time from the signal is submitted to an action starts

α is the period from start of the response to the max response

Δ is the max response

β is the duration of the response

A is the shifted amount of energy

B is the rebound effect for returning the situation back to the "reference"

However, using the methodology numbers may be obtained for the parameters mentioned in the figure and for comparison with the reference case, where no flexibility would have been received. The latter refers to labelling, where buildings including their energy system may be rated by their share of reduction on price/consumption/CO_2-emissions etc. (depending on the target of the labelling) when using penalty-aware control instead of penalty ignorant control.

The methodology for characterization and labelling of energy flexibility applies to both simulation of buildings not yet erected for optimization of available flexibility, and measurements from a building or neighborhood.

The participants of the fifth working meeting of Annex 67

So the methodology is expected to be generic and may, therefore, be utilized for different conditions, especially different penalty signals.

Test of the methodology will be carried out before the Annex 67 spring meeting in 2018. The methodology will, therefore, be described in the Technical paper together with a “cookbook” for carrying out tests.

Several of the Actions in Annex 67 are finalized or close to be finalized. Articles, papers and reports will continuously be made available on http://annex67.org/publications/. Reports as pdfs and article/papers as links.

Public seminar in Vienna, Austria

By Armin Knotzer, AEE INTEC

On 26th September 2017 a public workshop titled “Energy Flexible Buildings – Potential and Performance” was held at TU Wien by an organizing committee comprising the Austrian participants of IEA EBC Annex 67, AEE – Institute for Sustainable Technologies (AEE INTEC) and TU Wien - Automation Systems Group, as well as the Austrian Society for Environment and Technology (ÖGUT) and the Austrian Federal Ministry of Transport, Innovation and Technology. This event was held before the 5th working meeting of the IEA EBC Annex 67 Energy Flexible Buildings in Graz. The workshop in Vienna aimed at bringing together international experts and the Austrian building and demand response community for know-how exchange and discussion on the topic of energy-flexibility in buildings and its role in smart-grids transition. The focus was on thermal and electricity based flexibility potential of buildings and relevant research & development results were presented and discussed with experts and professionals. The potential for energy flexibility in buildings is determined by factors like heat storage capacity of building components, quantities and sizes of thermal storage tanks and/or batteries, quantities and type of electrical devices such as heat pumps, and the specifically utilized control systems. The aim of the workshop was to present and discuss results of ongoing studies in the field.

After a welcome note of Volker Schaffler, the ministry’s representative, Wolfgang Kastner, Susanne A. Metzger (TU Wien) and Armin Knotzer (AEE INTEC) underlined the importance of understanding the topic “energy flexibility” as well as the political dimension and international coordination. In his key note the operating agent of IEA EBC Annex 67, Søren Østergaard Jensen from the Danish Technological Institute, gave insights into the Annex 67 work and presented results from the large Danish iPower project. An important aspect there was to integrate the flexibility of Distributed Energy Resources (DERs) into a market, based on different test houses which have been introduced.

Afterwards Peter Engelmann from Fraunhofer ISE/Germany spoke about the grid interaction of buildings and the used KPI “Grid support coefficient” (GSC_{abs} and GSC_{rel}). In the future, power consumption around noon will be most favorable. In 2050 Germany expects that 80 % of the buildings will be heated up by heat pumps and 20 % will be connected to district heating. Different technologies such as batteries, the use of thermal mass and CHPs can increase the flexibility.

Robert Hammerling from Aspern Smart City Research (ASCR), which is a joint venture between a grid operator, an international technology company, an energy supply company, and the City of Vienna, explained how they are going to test energy flexibility in demonstration buildings at the Vienna Urban Lakeside Aspern. The focus lies on the Building Energy Management and the Smart User Interaction that feed buildings via pooling into a virtual power plant offering to the market.

Armin Knotzer and Tobias Weiss, both from AEE INTEC, pointed out that the current focus only on power load fluctuation instead of including thermal load fluctuation, and on only energy efficiency instead of CO_2-emissions in the energy networks may lead to wrong decisions for the use of flexibility. An easy way to estimate the energy flexibility potential based on Austrian building typology for designing buildings and solutions of the building energy system was presented, including the effect of different seasons on the potential.

Glenn Reynders from KU Leuven/EnergyVille in Belgium concluded that thermal mass is available in many buildings and has a significant potential as short-term storage and as a way of reducing peak capacity. Further optimization of energy in buildings requires a clear district energy perspective also to mitigate CO_2-emissions in a cost-effective way. Underlining that the massive construction such as concrete structure of a building helps increasing the energy flexibility when using thermal activation of ceilings as heat emission system.

QA time during workshop
Photo by Petra Blauensteiner, ÖGUT

Sebastian Spaun (Association of the Austrian Cement Industry, VCÖ), Roman Prager (WEB Windenergie AG) and Simon Handler (Allplan) presented demonstration projects: One single family house where they use the wind power surplus for the activation of a concrete ceiling and a multifamily building planned to operate as thermal storage for the surrounding grid. In the single family house they got 70 % of the heating demand from renewable and surplus wind energy from one wind farm.

The last presentation by Katharina Eder and Florian Judex, both AIT, highlighted a new “controller-in-the-loop” method for the automation testing in the planning phase of a building using a case study office building in Vienna, called „Post am Rochus“. The aim was to review implemented control strategies for shortening the commissioning phase and lowering energy costs before operating the building in real life, while at the same time utilizing flexibility options.

The day was concluded by a technical tour visiting first the SMARTest lab and the ENERGYbase building at the Austrian Institute of Technology (AIT), second the TU Wien‘s Plus-Energy Office High-Rise Building, both in Vienna.

The event offered a high level knowledge exchange between the Austrian experts and stakeholders and the Annex 67 participant group.

The presentations from the workshop may be found at:

https://nachhaltigwirtschaften.at/en/sdz/events/2017/20170926-energieflexible-buildings.php

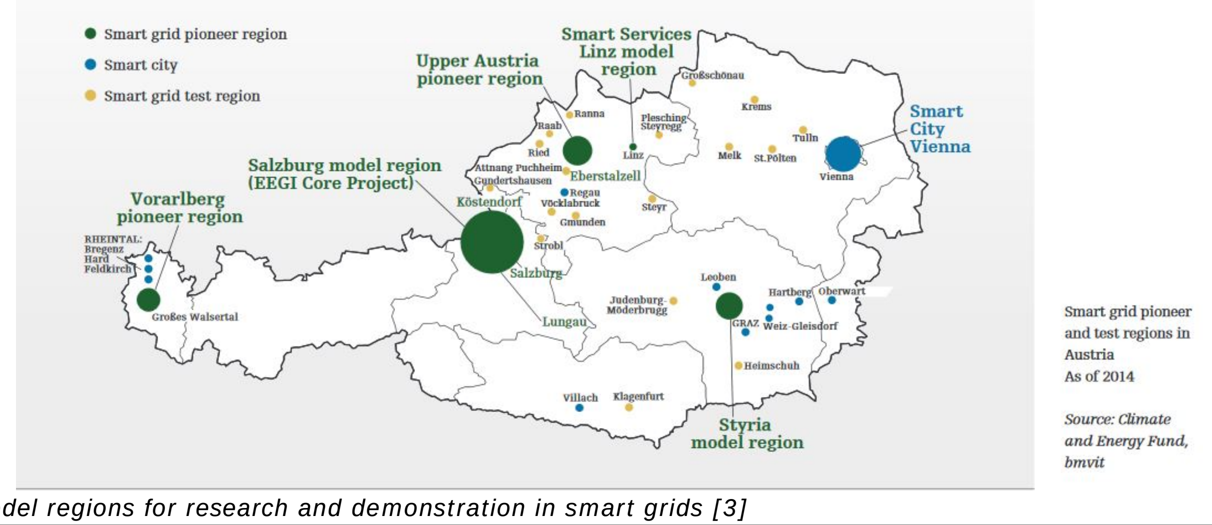
Austrian perspective on energy flexibility

By Sysanne Metzger, TU Vienna

Austria aims at a future with zero emissions, where new technologies and optimized energy applications together with a sustainable and emission-free national energy production form the basis for future independence from imported oil and gas. Until 2050, a minimum of 80% reduction in CO_2 emissions (compared to 1990) is expected to be achieved this way. Currently, 32.8% of the national energy mix comes from renewable energy sources, and until 2020, it is scheduled to reach 34%. In 2015, more than three quarters of the final energy consumption were covered by the renewable sources of hydro power (37.3%), wood fuels (29.2%), and renewable district heat (9.8%), and their associated technologies [1].

The Austrian electricity grid is undergoing a large change to accommodate the new relationship between producers and consumers. In addition to the large power generators of former times, decentralized sources such as photovoltaic ones make energy production possible at a local scale. Such prosumers use the generated energy for self-consumption, but also feed the surplus into the distribution grid. To be able to do this, a smart grid infrastructure has to be built, which requires among others on the part of the automation a reference architecture for integration of energy systems, and the provision of security for the new infrastructure [2]. Until 2019, 95% of all metering points in the electricity grid are planned to be “smart”. Some electronic meters currently installed have the required functionalities, but the infrastructure to connect them to the grid is in some areas still missing. As the newest development, battery storage appears as a new participant in smart grids requiring new legislation. There are currently several model regions throughout Austria for research and demonstration of smart grid functionalities for the diverse participants (Fig.).

The City of Vienna has a strategic framework plan for meeting the 80% reduction in CO_2 emissions until 2050, which aims at a minimum of 50% renewable energy (including imported energy), and a minimum of 40% reduction of per capita energy consumption (compared to 2005) [4]. Measures that are currently discussed are in the areas of operation of existing building



Model regions for research and demonstration in smart grids [3] clusters, how new buildings are supplied with energy, and options for decarbonisation of electricity, district heating, and gas generation. The role of the individual building in this context is “building as a load manager” with a heat pump that can be flexibly operated, district heating which uses storage and power to heat solutions for exploiting RES, and thermal mass with concrete core activation, among others (see [5] for more aspects under investigation). Following this future “load managing” aspect of buildings, from 2020 on, a lot of changes in the energy performance certification or at least in the voluntary building assessment tools will be implemented in Austria. One example here is the so called “klimaaktiv” building standard, where flexibility and smartness of buildings, as well as certification of areas instead of single buildings will have much more importance than today [6].

[1] Renewable Energy Facts & Figures 2016. The Development in Austria. Database 2015. https://www.bmlfuw.gv.at/english/environment/energytransition/facts-figures.html

[2] Smart Grids Austria Technology Roadmap. http://www.smartgrids.at/files/smartgrids/Dateien/Dokumente/05%20Roadmap_Management_Englisch.pdf

[3] Roadmap Management Summary. Smart Grids Austria. 2015. http://www.smartgrids.at/files/smartgrids/Dateien/Dokumente/05%20Roadmap_Management_Summary_Englisch_final.pdf

[4] Smart City Wien. https://smartcity.wien.gv.at/site/en/the-initiative/framework-strategy/

[5] Austrian projects “City of tomorrow”: https://nachhaltigwirtschaften.at/en/sdz/projects/

[6] klimaaktiv building standard: https://www.klimaaktiv.at/english/buildings.html

Smart Readiness Indicator by EU

By Glenn Reynders, EnergyVille - KU Leuven & Søren Ø. Jensen, DTI

Within the context of Annex 67, important scientific research is conducted on defining, quantifying and assessing energy flexibility in buildings as a key resource in the future energy systems. Energy flexible buildings are thereby defined to be able to manage their demand and generation according to local climate conditions, user needs and grid requirements in order to optimize the integration of renewable energy sources and minimize the CO_2 emissions on a community level.

In order to increase the visibility and uptake of smart technologies that can unlock the energy flexibility of buildings (by e.g. providing communication with the energy network, enabling adaptive control…), the European Commission proposed the introduction of a Smart Readiness Indicator (SRI) in the ‘winter package.’ A consortium mandated by the European Commission is currently investigating the potential definition, scope and calculation of the SRI as an amendment to the Energy Performance for Buildings Directive (EPBD).

Although both Annex 67 and the development of the SRI aim at increasing the knowledge on the role and potential benefits of energy flexibility in buildings, participation in the SRI stakeholder group pointed out some significant differences and compatibilities between the SRI and the energy flexibility indicators being developed in Annex 67. The current proposal for the SRI aims at being an indicator that is easy and fast to evaluate in an expert audit and informs building owners on the current state of their building by analyzing the availability of smart services. The quantification methodologies developed in Annex 67 aim at giving detailed and quantitative insight to building and system designers and operators into the available energy flexibility of a building (including its systems, controls and users).

For this, Annex 67 is working on dynamic simulation and experimental protocols on component, building and district level that allow to quantify and predict the available energy flexibility in design and operation.

Annex 67 is currently working on both a Position paper and a more detailed Technical paper, which for a broader audience will explain how Annex 67 aim to characterize and quantify energy flexibility in buildings.

National Projects

EnergyLab Nordhavn – New Urban Energy Infrastructures, Denmark

By Rongling Li, DTU

The project utilizes Copenhagen’s Nordhavn as a full-scale smart city energy lab and demonstrates how electricity and heating, energy-efficient buildings and electric transport can be integrated into an intelligent, flexible and optimized energy system.

EnergyLab Nordhavn is a largescale integrated research and demonstration project in Denmark that contributes to the grand challenge of transforming the energy system to efficiently integrate a large share of renewable energy.

Nordhavn project outlined in red. Photo by R. Hjortshøj

The project focuses on a cost-effective future smart energy system that integrates multiple energy infrastructures (electricity, thermal, buildings and transportation) and provides intelligent control of subsystems and components – providing necessary flexibility for efficient utilization of renewable energy.

The EnergyLab Nordhavn project will establish itself in Copenhagen's Nordhavn as a living laboratory for future smart energy technologies, innovative business models and new operational solutions on all scales - component, building, grid infrastructure and system level - and provide basis for design and dimensioning of future energy infrastructure in sustainable low-energy city districts.

The project is led by DTU Electrical Engineering, Center for Electric Power and Energy. More about the project can be found at http://www.energylabnordhavn.dk/

Control strategies for Large scale aggregation of Energy Flexible buildings (CLEF), France

By Jérôme Le Dréau, University La Rochelle

Modulating the energy use of new and existing buildings could provide 10 to 20 GW of flexible load in France according to the literature and demonstrator projects. Despite a large potential identified, a number of issues prevents the deployment of this technology: communication, privacy, cost-effectiveness, control and reliability of the response. The project focusses on the last two issues and will test indirect control strategies to maximise the flexibility potential and coordinate the response of energy flexible buildings. Indirect control strategies combined with a rule-based controller at the building level will be simulated on different case studies, accounting to the diversity of buildings and users. The considered flexible loads will be the electrical load related to the heating or cooling of buildings (direct electric or heat pump), the hot water preparation and the white goods (e.g. washing machine). The project includes both simulations at the district level and measurements in the Atlantech low carbon district.

Organisation of the Atlantech low carbon district in La Rochelle (France)

The project starts in January 2018 and will last for 3 years. The project coordinator is the Laboratory of Engineering Science for Environment (LaSIE, La Rochelle) and partners from G2Elab (Grenoble) will bring their expertise in the modelling of electrical networks.

More about the project can be found at http://lasie.univ-larochelle.fr/2018-2012-CLEF-ANR

Acknowledgement: The work is supported by the French National Research Agency (ANR) under the grant agreement no. ANR-17-CE22-0005-01

Laboratories for testing energy flexibility in buildings

By Jaume Salom , IREC

Part of the activities in Annex 67 consists of laboratory tests of components, systems and control strategies to exploit energy flexibility in buildings. In this framework, several partners have made their laboratory facilities available for the needs of the Annex 67 as well as for the scientific community and the industry. A number of the available laboratories (see Table 1) are described in a comprehensible report.

Table 1. Overview of test facilities

Lab acronym	Managed by	Location
SEILAB	IREC - Catalonia Institute for Energy Research	Tarragona, Spain
Energy Smart Lab	IREC - Catalonia Institute for Energy Research	Barcelona, Spain
NZEB Emulator	VTT / Aalto University	Espoo, Finland
EnergyVille labs	EnergyVille (VITO, KU Leuven, IMEC)	Genk, Belgium
OPSYS test rig	Danish Technological Institute (DTI)	Taastrup, Denmark
ZEB Living Lab	NTNU / SINTEF	Trondheim, Norway
Semi-Virtual Laboratory	Laboratory Polytechnique Montréal	Montréal, Canada

In order to better understand the capabilities and specificities offered by the available laboratories, the report describes each of the test facilities. For each, a general presentation enables to quickly understand the purpose of the facility. The interested reader then has access to a more detailed description, with the technical specifications of the installation and illustrations. Some examples of previous tests performed in these labs are also presented, along with references to the corresponding publications. The final objective of the report is to provide a clear overview of the potential offered by the testing facilities in the network of Annex 67. In this way, any interested stake-holder, within or outside this network, can contact directly the responsible entity in order to perform experimental testing in these facilities. Currently, the report can be downloaded from: http://annex67.org/publications/reports/.

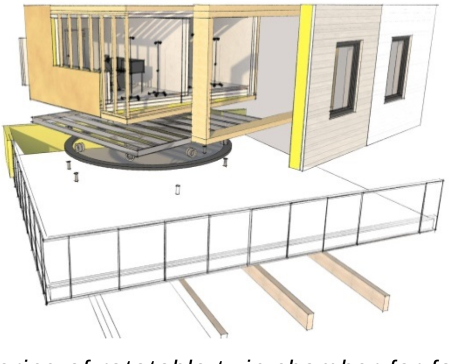
Test facilities at AEE INTEC

By Armin Knotzer & Anna Maria Fulterer, AEE INTEC

AEE INTEC emerged in 1988 as independent research association from a cooperation of people constructing their own solar collectors. Due to this historic reason the laboratory had a strong focus on testing solar thermal systems. Since then, the scope of the lab widened from pure component testing to the creation, assessment and optimization of integrated systems. The focus is on technologies using solar energy.

Solar thermal collectors facility located on the laboratory roof

The laboratory has been expanded in 2016 to create space for new experiments. One of them is a membrane distillation setup, to investigate and demonstrate the recovery of resources (e.g. metals) from process waste water using solar heat. In summer 2017 a twin chamber has been realized, which is used to test façade integrated building components, like windows as well as ventilation and heating units. All surfaces excluding the one to be tested can be set to standardized conditions.



Rendering of rotatable twin chamber for facade testing, realized in 2017

Available facilities and environment: To assess the performance of a device under development, standard components are available that can be combined with the newly developed device. Standard components include heat sources for different applications which deliver energy at a needed temperature, as well as heat sinks. Experiments are usually accompanied by simulation. For component design and optimization, hardware can be included into simulations setups ("hardware in the loop").

Many of AEE INTEC research issues culminate in the realization of demonstration buildings, where new concepts are realized and monitored during operation, in order to accompany the market entry of new technologies. The depart-ment of Measurement Engineering designs the measurement and data acquisition setup to provide data on comfort and energy flows. Especially in first generation components and systems, measurement results have proven useful for trouble shooting and control optimization. Monitoring data is also employed to assess user comfort and allow for remote maintenance. In some projects, e.g. the renovation to passive house standard of a multi-family house, results from physical measure-ments have been combined with social studies to get deeper insight into the correlation of user behaviour, indoor climate and user satisfaction.

Experimental setup on seasonal heat storage at the AEE INTEC laboratory for EU project COMTES

Since 2011 seasonal heat storages based on the adsorption technology are investigated and developed at AEE INTEC. The target is to increase the solar fraction of heating systems in buildings. The heat is stored by drying the sorption material and is released again by the adsorption of water vapour on the material surface. The EU project "COMTES" on seasonal heat storage has been followed by another project called "CREATE", where a seasonal sorption heat storage system will be realized in an inhabited building and monitored during operation.

Heat can be stored in times of surplus energy from the grid or environment, and released on demand in times of short supply. Since the energy is stored in form of a thermochemical reaction and not in form of sensible heat, the thermal losses are low and do not affect user comfort.

Selected articles and papers of Annex67

Being only half way, the work of Annex 67 was already widely disseminated in number of publications. Various aspects of energy flexible buildings such like terminology, evaluation methodologies, impact on thermal comfort and energy cost, users' awareness and willingness to be part of the new buildings' concept, were studied and described in eight articles published in high ranked journals and eleven papers presented at different conferences e.g. IBPSA Building Simulation Conference 2017, CISBAT 2017 International Scientific Conference, 2017 IEEE Technology & Engineering Management Conference.

- *Impact of Demand-Side Management on Thermal Comfort and Energy Costs in a Residential nZEB. Thibault Péan, Joana Ortiz and Jaume Salom (2017). Buildings, 7(2), p.37*
- *Are building users prepared for energy flexible buildings?—A large-scale survey in the Netherlands. Rongling Li, Gamze Dane, Christian Finck, Wim Zeiler. Applied Energy. Applied Energy 203 (2017) PP 623-634.*
- *A Business Ecosystem Driven Market Analysis: The Bright Green Building Market Potential. Zheng Ma et al. 2017 IEEE Technology & Engineering Management Conference. Santa Clara, CA, USA, June 7-9, 2017.*
- *Flexibility Quantification for Building Energy Systems with Heat Pumps. Sebastian Stinner, Kristian Huchtemann, Dirk Müller. IBPSA Building Simulation Conference 2017, San Francisco, USA, August 7-9, 2017*

Moreover, the Annex's scope, main objectives, structure and first results were outlined in an article published in EBC special issue of Energy and Buildings in November 2017:

- *IEA EBC Annex 67 Energy Flexible Buildings. Søren Østergaard Jensen, Anna Marszal-Pomianowska, Roberto Lollini, Wilmer Pasut, Armin Knotzer, Peter Engelmann, Anne Stafford and Glenn Reynders. EBC special issue of Energy and Buildings.*

https://authors.elsevier.com/a/1Vmc41M7zGsiYW (active until November 12th).

Report with descriptions of seven test facilities available in Annex 67 has as earlier mentioned been published. Descriptions of two more test facilities will be added later. http://annex67.org/publications/reports/.

A full list of publications can be found on Annex webpage: http://annex67.org/publications/

Next IEA EBC Annex 67 meetings

- IEA Annex 67 6th expert meeting – March 26-28, 2018 Barcelona, Spain
- IEA Annex 67 7th expert meeting – autumn 2018. Probably in Canada

Energy flexibility related events

- Conference On Building Energy Environment (COBEE2018)

RMIT University, Australia,

February 5th-9th 2018

http://www.cobee2018.net/

- 5th International Solar District Heating Conference

April 11th-12th 2018

http://solar-district-heating.eu/NewsEvents/SDHConference2018.aspx

- eSim IBPSA 2018,

May 9th-10th 2018

http://www.esim.ca/

- International Building Physics Conference (IBPC) Syracuse, NY

September 23rd-26th 2018

http://ibpc2018.org/

- ISEC - International Sustainable Energy Conference

October 3rd-5th 2018

https://www.aee-intec-events.org/index.php/en/

IEA EBC ANNEX 67
Energy Flexible Buildings

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