FIRST - Mapping flexibility of urban energy systems

(MITEXPL/SUS/0015/2017)

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ENERGY DAY

FIRST Project Workshop
November 15th 2018,
IAPMEI Auditorium
LNEG, Lumiar
Context

Interactive Buildings
- Building design
- Envelope solutions
- Energy management
- User interaction

Energy management allow for
- Automation and control
- Energy optimization
- Customer/user needs optimization
- Smart grid optimization
FIRST- Mapping flexibility of urban energy systems

MITEXPL/SUS/0015/20 - With the support of Prof. Leon Glicksman, Professor of Building Technology and Mechanical Engineering at MIT

OBJECTIVES/RESEARCH ACTIVITIES

1. Study of potential for energy flexibility at individual building level (load shifting of typical buildings);
2. Study of potential for energy flexibility at community level (load shifting with algorithms)
3. Mapping out the potential

Partner institutions
Project Team

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For the benefit of the Atlantic societies
A new long-term platform for scientific and economic cooperation across and along the Atlantic, based on existing research capacities and infrastructures.

The AIR Centre is a knowledge and data driven organization, enabling innovative work through bottom-up initiatives that will face new and greater challenges and R&D gaps within the 6 Societal Benefit Areas aligned with the UN Sustainable Development Goals (SDGs)
Background

IEA EBC Annex 67
Energy Flexible Buildings

Operating Agent: Søren Østergaard Jensen,
Danish Technological Institute
Duration: 2015 - 2019
Energy Flexibility Challenge

**EF at individual building level** with demand flexibility (response) strategies - when the electricity consumption of controllable devices is shifted from their normal consumption...

**EF at community level** achieved with approaches supporting energy planning spanning time and spatial scales...Energy of prosumers is made available to a cluster of buildings...
Energy Flexibility Challenge

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Energy Flexibility Challenge (examples)

Daily loads profile of a residential building in Lisbon during winter (numerical results) (1)

Heating flexibility with no thermal insulation on a typical Winter in Bragança (numerical results) (2)

(2) Ema Barradas (2017), MSc Thesis, Estudo da flexibilidade através da inércia térmica, FCT-UNL
Urban Building Energy Modelling (UBEM)

Hyunwoo Lim, Zhiqiang Zhai, *Review on stochastic modeling methods for building stock energy prediction*, Building Simulation 2017
Methodology

Characterize the energy services use for each household
- Physical Modelling using EPlus
- Data driven model using clustering on smart meter data
- Monitoring during Winter and Summer time
- Data from Energy Certificates

Optimization with a tool which uses a GPS and a GA4S (in the case of the community approach) to find the operation starting times of the controlled devices that minimize the electricity costs.
Demo

Prof. Daniel Aelenei – FIRST Workshop
Investigating the potential for energy flexibility in an office building with a vertical BIPV and a PV roof system

Daniel Aelenei\textsuperscript{a, b, *}, Rui Amaral Lopes\textsuperscript{a, b}, Laura Aelenei\textsuperscript{c}, Helder Gonçalves\textsuperscript{c}

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Highlights

- Case study is a low energy office building with BIPV and a PV roof system.
- Study focused on the potential to increase load matching between energy generation and consumption and improve grid interaction.
- The integration of Battery Energy Storage Systems can improve the load energy flexibility.
HIGHLIGHTS

- Presents a unique study of 30 NZEBs that have been constructed and have had their performance measured for at least 12 months.
- Study based upon an international collaborative research initiated by the International Energy Agency - the Solar Heating and Cooling Programme (SHC) – Task 40.
- The first book to evaluate building strategies in houses, educational buildings and offices that have been demonstrated to work in practice.

![Graph showing energy balance](image)
Relevant publications

Handbook of Energy Efficiency in Buildings

Presents a complete and thorough coverage of energy efficiency in buildings

HIGHLIGHTS
- ZEB and NZEB (definitions, design methodologies, good practices and case studies)
- Passive houses and bioclimatic architecture
- Sustainability rating systems (LEED, BREEAM, Green Star, ITACA)
- Life Cycle Assessment of buildings
- Simulation tools (steady-state and dynamic codes, critical review, advantages and disadvantages, accuracy and reliability)
- Physical properties of building materials
- Innovative and advanced insulation materials and systems
- Innovative and advanced glazing materials (electrochromic, thermochromatic, selective coatings)
- Adaptive Facades
- Building integrated PV
- Building automation for energy efficiency
- Energy management in buildings

New technologies in energy efficient building renovation
Potential Societal Impacts

- Can help in the transition to a renewable-based power system;
- Valuable to the construction sector and related markets;
- Valuable to ministries and national agencies;
- Can cause high socio-economic impact as it helps in progressing towards a data-driven, cooperative economy and society…

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Obrigado!