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Find the Gap: Project MOEEBIUS, a Holistic Energy Performance Optimization Framework †

Rui Martins *, Filipe Silva, Muriel Iten and Ricardo Rato

Instituto de Soldadura e Qualidade (ISQ) 1, 2740-120 Porto Salvo, Portugal;
fjsilva@isq.pt (F.S.); mciten@isq.pt (M.I.); RARATO@isq.pt (R.R.)
* Correspondence: rmmartins@isq.pt; Tel.: +351-214-229-005

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Abstract: Project MOEEBIUS focus is the reduction of the gap between predicted and actual energy performances in buildings. This project will introduce a Holistic Energy Performance Optimization Framework with new tools and methodologies that enhance current building energy performance simulation tools and current modelling approaches. This strategy aims to deeply grasp and describe real-life building operation complexities and introduce continuous optimization of building energy performance in real-time or through retrofitting.

Keywords: optimization; energy performance; energy efficiency

1. Introduction

Energy efficiency in buildings is nowadays a very popular topic, however buildings are still underperforming when compared to the predicted consumptions. Another observed problem is that such predictions seem to be unrealistic, translating into a gap between actual energy consumption and predicted energy consumption. This gap is denominated by "performance gap". For instance, the measured energy consumption can be 2.5 times higher than the predicted consumption highlighting the need to understand the reasons for this gap and how this can be solved [1,2].

Moreover, this performance gap is one of the main constrains in ESCO business implementation because it makes the business risk higher, and consequently the ESCOs need higher equity to cover such risks. Also, this gap reduces the customers trust in these business models. Therefore, the reduction of this performance gap would allow to facilitate and enhance the penetration of ESCOs businesses in the market [3].

In a simple way, one can attribute this problem to the current modelling techniques. Either they are not accurate enough or they are using to many simplifications, such as ignoring occupants' behaviour or weather inaccuracies which lead to this discrepancy. Other cause of this gap is related with poor management strategies that are not accounted for during energy consumptions predictions.

2. Mitigation Strategies

The MOEEBIUS project started in November 2015 and has a duration of 42 months. During that time, 20 months are allocated to testing project results, in real-life conditions, on pilot sites scattered across three countries. The project is being developed in a consortium with 16 partners from 10 different countries.

To mitigate the observed problem, MOEEBIUS project developed strategies to reduce this "performance gap". The first strategy is to improve predictions by further develop the current building energy performance simulation tools in order to improve their accuracy.

Afterwards, it is possible to monitor critical building components in real-time and to perform real-time performance optimization by controlling some of these components. This strategy allows to continuously ensure that building components are working as predicted. Also, monitoring these components will allow to support decision-making regarding the need of maintenance and retrofitting.

Finally, developing new methodologies to adjust the current measurement and verification inefficiencies corresponds to another way to reduce the performance gap.

3. Conceptual Solution

Based on the mitigation strategies that have been identified, MOEEBIUS develops a framework (Figure 1) with solutions based on tools and applications. The main outcomes of this holistic framework are [4]:

- Enhance building energy performance simulation models that work dynamically based on the feedback from monitoring of the actual building and the incorporation of dynamic aspects such as occupancy and weather data to obtain a more accurate representation of real-life complexities/behaviour of the building;
- Precise allocation of detailed consumption contribution of critical building components for the assessment of the performance deviations;
- Real-time building performance optimisation and real-time self-diagnosis features that correct some of the variability that occurs due to changing conditions and hence again it addresses the performance deviations;
- Optimized retrofitting decision based on LCA/LCC predictions;
- Real-time peak-load management optimisation at district level.

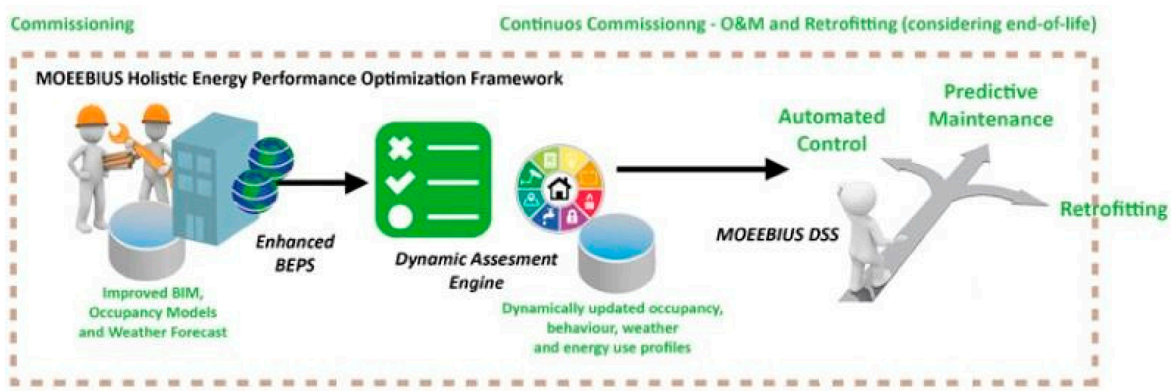

Figure 1. MOEEBIUS Holist Energy Performance Optimization Framework.

4. Project Objectives

With a defined framework (Figure 1), it is possible to say that the project objectives are reaching those solutions. Thus, the project objectives are:

- Develop advanced competences/knowledge in the current building energy performance simulation tools and the establishment of a standardised, model-based, measurement and verification protocol;
- Optimise the performance gap through human-centric control, predictive maintenance and retrofitting;
- Facilitate Energy Performance Contracting penetration in the European Union through a replicable and easily transferable framework;
- Developing and introducing new ESCO business models and new energy market roles for demand side aggregators.

5. Implementation Approach

The MOEEBIUS project implementation can be divided in six stages: diagnostic, analysis, design, development, deployment and business innovation.

Diagnostic is the stage where all use-case scenarios and stakeholder roles are defined. Also user and business requirements are taken into account to build the novel business models.

The analysis stage is associated with the definition of all MOEEBIUS requirements, corresponding to the definition of MOEEBIUS solutions and what is required to achieve those solutions.

Design stage is where the project architecture and all technical specifications of the framework are defined.

The development of all tools and applications and the running of the first test to MOEEBIUS outcomes in a controlled environment corresponds to the development stage. Moreover, the validation of those outcomes in real-life conditions, as well as the marketability tests are included in the deployment stage.

The last stage is reserved for the planning of the exploitation of MOEEBIUS outcomes in a commercial perspective.

6. Project Pilot Sites

The pilot sites are an integral part of MOEEBIUS since they are the means to test all outcomes. To assure the validation, user acceptance, replication and transferability of MOEEBIUS results there are multiple pilot sites which comprise of different types of buildings and are distributed through three geographical dispersed areas. These three areas are London (United Kingdom), Mafra (Portugal) and Belgrade (Serbia).

The pilot buildings have a surface area of over 450,000 m^2 and their annual consumption is over 16,000 electric MWh and over 800 thermal MWh. Furthermore, the buildings cover the following categories: residential, hotels, retail, educational, sports and offices [5].

7. Expected Impacts

The most significant impact expected in MOEEBIUS project is to reduce the gap between real and predicted energy performance of buildings. The project identified the three main causes for this gap and targeted them to achieve this goal. These identified causes are the occupant behaviour, the inaccuracies in weather conditions used to predict energy consumption and poor management and control strategies.

The results show that by correcting these three causes it is possible to increase the accuracy of predicted energy performance of buildings within 3% of real energy consumption.

Dynamic simulation engines can also help to reduce this gap if it considers real parameters to run the simulation, such as occupancy, weather, indoor temperature, etc.

Maintenance and retrofitting decision-making tools can also help to decrease the performance degradation of critical building components which will enable to maintain performance levels more stable throughout the years.

Furthermore, there are the indirect impacts resulting from the reduction of the performance gap. The reduction of this gap can be associated with the reduction of the difference between the minimum and the peak power demand. The fact that the power demand is more flat brings several benefits including an ease to implement load shifting strategies or other load strategies that enable demand response schemes. Secondly, it is expected that the better prediction can be positively related with health, safety and comfort parameters, especially if assessed during the whole building life cycle. Overall this will bring socio-economic and environmental impacts related to energy efficiency and to the new business models.

Conflicts of Interest: The authors declare no conflict of interest

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