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Towards Increasing the Building Energy Performance Estimation Accuracy: BIM-to-BEPs and Occupant Profiling Methods

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EXTENDED ABSTRACT

This work presents the technical work that has been conducted in the context of a Horizon 2020 funded project, towards delivering a service that aims to increase the Building Energy Performance estimation accuracy utilizing IFC and obXML data. Core functionality of this service is an automated transformation process that is applied to convert data extracted from an IFC file to EnergyPlus input data. Establishing a link between the resulted input data file and occupant behaviour data models (obXML), so that dynamic schedules can be incorporated in the simulation, is of paramount importance towards increasing the energy performance estimation accuracy. This functionality, which we refer to as co-simulation, along with the IFC-to-IDF transformation process are introduced in this abstract.

Introduction

The utilization of Building Energy Performance (BEP) simulation has gained significant attention recently that stems from its capability to accurately predict the energy performance of building sector under specific conditions. Among a wide range of calculation methodologies, 3D zonal-type simulation engines (e.g. EnergyPlus) are frequently used, as they manage to strike a balance between accuracy and computational complexity. However, the preparation of the input data files for the 3D zonal-type simulation suffers from two major drawbacks: (1) it is a very time-consuming process, often requiring more time than is available due to project's deadlines, and (2) it is a non-standardized process that produces BEP simulation models whose results can significantly vary from one modeler to another according to their experience.

The input data of a 3D zonal-type simulation can be grouped into three main categories: (1) static data that include the building geometry, construction materials, glazing information, systems used in the building, building's spatial discretization to thermal zones, to name but a few; (2) dynamic data that consist of all time-variant data, such as user-actions, occupancy schedules at each thermal zone, use of equipment, etc; and (3) weather data. In recent studies, dynamic data, widely known as Occupant Behaviour (OB), has been criticized as the major cause of uncertainty in building energy performance results. Despite its stochastic nature, in common practice OB is oversimplified and introduced to the 3D zonal-type simulation engines as either deterministic or predefined rule-based schedules. Having a deeper understanding and properly modelling the occupant behaviour have been the main research subjects of IEA EBC Annex 66, where data, methods and models have been developed to reduce the gap between simulated and measured BEP by representing OB in a standardized XML schema (obXML). Concerning the static data, the Building Information Models (BIM) data has gained interested as a key enabler to automate the BEP model generation.

Methodology

In this work, a BEP service is introduced, where unified building and occupant behaviour data models, the Industry Foundation Classes (IFC) (a widely used open BIM schema) and the occupant behaviour eXtensible

Markup Language (obXML) standards, respectively, provide data for extracting relevant information, used to setup the BEP simulations. Interfaces, aimed at automatedly generating respective inputs and invoking relevant external simulation engines (EnergyPlus), and methods of post-processing the results, are also incorporated so that Energy Key Performance Indicators (KPIs) can be computed.

In summary, core functionalities of this service are the following: (1) it retrieves IFC, EPW (EnergyPlus weather data file) and obXML data as input for a specific simulation scenario and applies a transformation process to populate the input data file of EnergyPlus; (2) it automatically generates the configuration files requested for the co-simulation setup of EnergyPlus and obXML, based on the Functional Mock-up Interfaces standard (FMIs); (3) using the EnergyPlus and obXML Functional Mock-up Units (FMUs) as input, it automatically invokes the co-simulation execution; and (4) when the simulation run is finished, it further processes the simulation output files and generates a JSON file as an output message that contains values of a predefined list of energy KPIs.

Results

As an initial demonstration of our BEP service, a hypothetical two-storey building, has been selected. Sending the request to the BEP service, the IFC, EPW and obXML files of this building are received and initially the IFC-to-IDF transformation process is performed. As Figure 1 (left) illustrates, the process correctly identifies: (1) Building and Fenestration surfaces; (2) their boundary condition type; (3) the corresponding surfaces, when boundary condition type is surface; (4) the surface type; (5) the surface construction; and (5) the 3D geometric representation of each surface. With the IDF correctly generated, ObXML and EnergyPlus are co-simulated to eventually calculate the Energy KPIs. A subset of the automatedly generated co-simulated parameters setup is also depicted in Figure 1 (right).

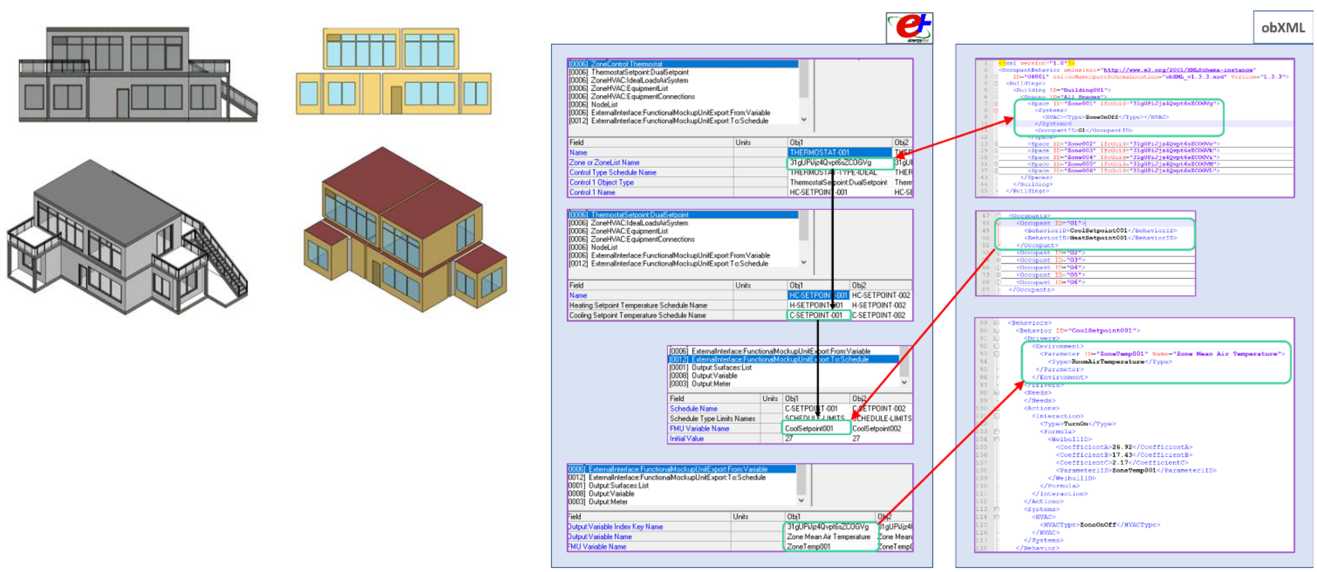

Figure 1. BEP service – Automated generation process results

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