Demo Abstract: A RestFUL API to control a Energy Plus smart grid-ready residential building

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1 Introduction

Achieving improved energy efficiency for future buildings is a well established imperative under European legislation. However, parallel evolutions in the energy supply side are anticipated to have a similarly significant impact of how the buildings should behave from an energy point of view in the future. Particularly, the growing penetration of renewable energy systems(RES), the development of the smart grid and the roll out of smart meters are causing big changes on the demand side of the electricity system, including the residential sector. Two anticipated changes have to do with the spread of electric vehicles and the electrification of residential thermal loads. Those evolutions are not only going to change residential electricity consumption quantitatively but also qualitatively. Typical electricity demand patterns and profiles will be significantly affected. However, another change will come from the deployment of the technologically advanced communication infrastructure that will provide the option of demand response capabilities even to residential customers. The IEA Technology Roadmap [1], for energy efficient buildings, identifies four technologies that in the future will boost the environmental performance of the particular sector: solar thermal collectors, combined heat and power units, heat pumps and thermal energy storage. It is worth mentioning that the last three technologies of building energy systems are actually the ones which display the highest potential for demand response. Thus, the main question arising is how to select and control the energy systems of future buildings in such a way that will optimise not only the energy performance of the building itself but the energy performances of buildings when considered part of a larger integrated electrical grid system.

This work aims to develop a communication system between a smart grid-ready simulation model of a house and a centralised energy management system. The building encompass most of the aforementioned technologies (electric vehicle, solar thermal collectors, water source heat pump, thermal energy storage, PVs, heat recovery ventilation) and is metered from 2011. The dwelling model is built using Energy Plus [2] and is calibrated with the energy consumption data available from the energy meters installed in 2012. The house has 13 rooms, each corresponding to a thermal zone. During the heating period, the schedules of the heating system and the occupancy profile reflect the behaviour of the users. The occupancy profile is adjusted according to the working time of the occupants and their typical weekend and evening activities. The appliances typical time of use is also tuned according to their habits. Specific schedules based on typical use are adopted for washing machine, dishwasher, oven and cooking hobs. Building simulation software allows expert users to accurately evaluate the energy performances of buildings. Coupling the building simulation environment with an advanced control system requires additional and specialised knowledge of both control development and building simulation software modelling. There is a gap between developers who build software to control buildings (like home automation control systems) and building simulation software experts. The possibility to validate and benchmark sophisticated control algorithms on detailed building software models with a reduced modelling experience and knowledge could benefit building users, energy system designers and software engineers. The objective of this work is to develop a building test environment that will allow comparing and benchmarking different control algorithms and storing the results in a database a display comparison benchmark graphs. A RestFul API which directly

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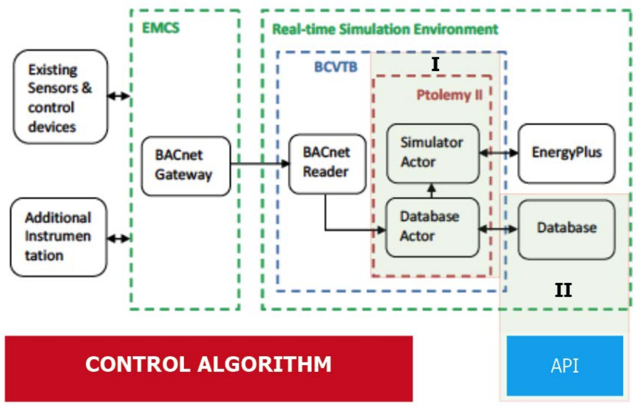
access the control system of the simulation model is developed and tested. The energy flexibility resulting from the smart building control to adjust to different demand response strategies is assessed, along with its environmental and economic performance in a dynamic grid environment.



2 API and Documentation

The goal of this part of the project is to develop a RestFUL API and connect to a database to connect a building energy management system to building simulation software and benchmark the performances. Building simulation software allows expert users to accurately evaluate the energy performances of buildings. Coupling the building simulation environment with an advanced control system requires additional and specialized knowledge of both control development and building simulation software modeling. There is a gap between developers who build software controls for buildings (like home automation control systems) and building simulation software experts. The possibility to validate and benchmark sophisticated control algorithms on detailed building software models with a reduced modeling experience and knowledge could benefit building users, energy system designers and software engineers. The objective is to develop a smart building test environment that will allow comparing and benchmarking different control algorithms and store the results in a database a display comparison benchmark graphs. The API interact with the system, firing the simulation, acquiring the control data and sending the output of the sensors. It is possible to select the select the sensors and the system to control. The API documentation can be found at *http://simapi.ucd.ie/*.

3 BCVTB JAVA CONTROL SIMULATION ACTOR

The goal of this project is to develop a simulation actor and connect to a database to connect a building energy management system to building simulation software and benchmark the performances. The objective is to develop a smart building test environment that will allow comparing and benchmarking different control algorithms and storing the results in a database a display comparison benchmark graphs. a Java actor has been developed and tested inside the BCVTB environment that has as input the commands from a DB table and, as output, the state and value of the sensors from the model at each time step. The actor performs a step-by-step simulation. It will read the commands from the database and will send instructions to appliances and systems in the building model. After the simulation it will write the output from the sensors and the variable in a specific table.

4 Conclusion

The project highlights the importance of test controls software inside residential buildings. A centralised communication infrastructure can be use to test control software on a building stock and analyse aggregate electricity consumption or benchmark the environmental impacts. Simulate a representative number of buildings could be useful to assess the performances of a electric transformer or to synthesise data for energy consumption analysis. The simulation of a basic control algorithm that will shift load based on the electricity price will be shown as a test. The algorithm will remotely run the simulation on the test bed and evaluate at each time step the temperature inside the house, the electricity consumption and the charge of the thermal storage. Based on the electricity price and on the external temperature the control will shift the electric load to a more opportune time. The control algorithm will run locally while the simulation will run remotely on the UCD server. The API will retrieve the sensor data and show on a graph. It will be possible to change locally the program through a basic web interface and control the simulation on UCD server through the http protocol. The simulation will show the CO_2 footprint of the house and all the parameters that where selected. It will be also possible to adjust the parameters (temperature set point and heat system schedule) in the control to display a different electricity consumption pattern. The demo user will start the simulation through the interface; the simulation will run and will show the data, at the end of the simulation there will be a summary of the energy consumption and a basic analysis about the building electricity demand. The user will be able to control few parameters, run the simulation and compare the results with the previous simulations to see if there was some improvement in the energy efficiency of the building.

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6 References

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