BIM-BASED ENERGY MANAGEMENT FOR SMART BUILT ENVIRONMENT

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Contents:

I.Introduction

II.The Role of BIM in Smart Built Environment

III.Integrating BIM in Design Phase

IV.Integrating BIM in Post-construction Phase

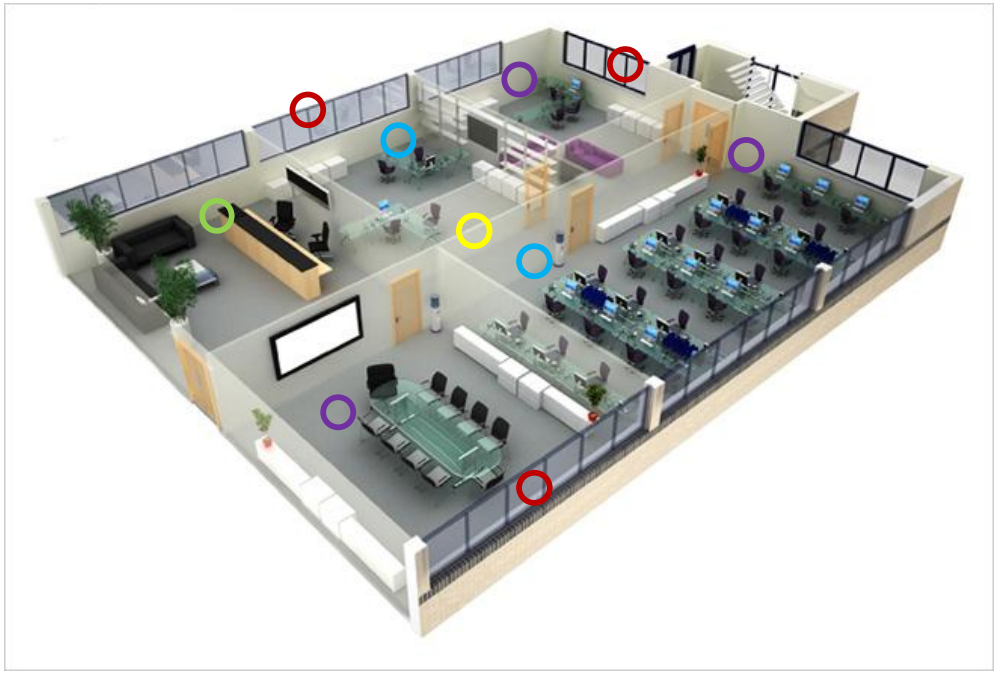
V.Conclusion & Future Work

I. Introduction

Smart Built Environment:

- Embedded with smart objects
- Making the environment 'smart' to interact intelligently with and support their human occupants in their daily activities

Light sensor



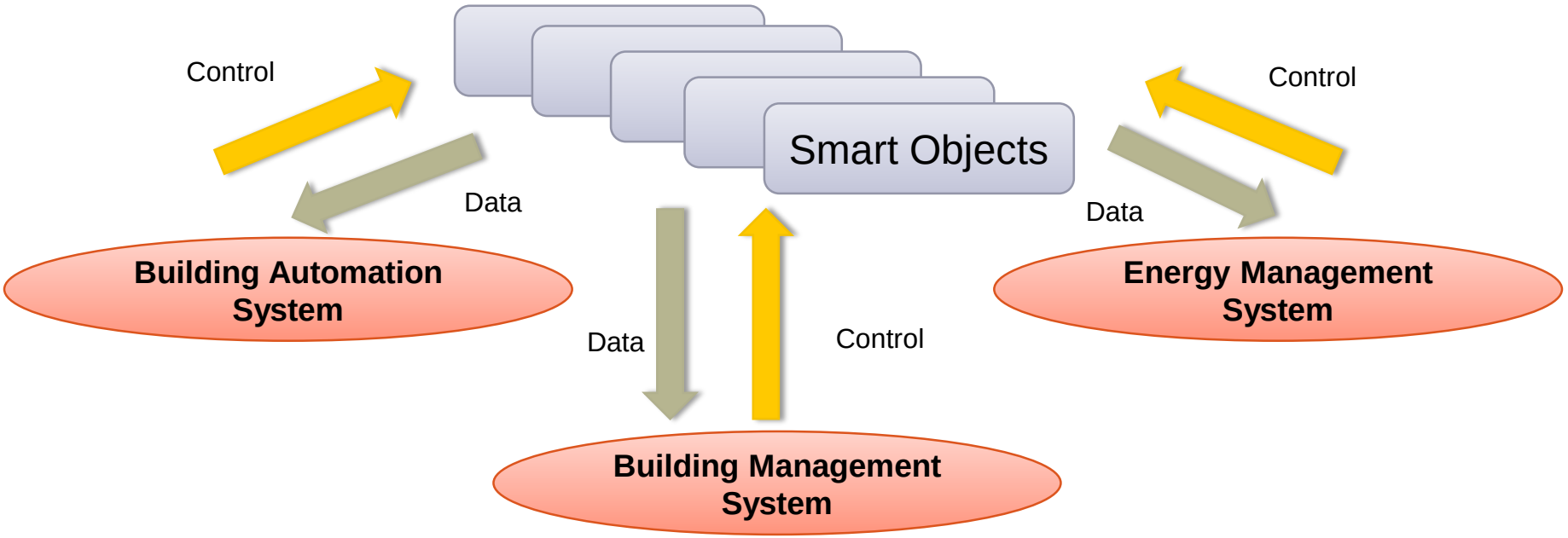
Camera

Temperature sensor

Occupancy sensor

HVAC control hub

I. Introduction



Smart Built Environment usually involves building energy management system (EMS), building management system (BMS) and building automation system (BAS).

I. Introduction

Energy Management in Smart Built Environment:

- **Estimate and evaluate the energy consumption**
- **Justify the balance between power consumption and comfort**
- **Achieve energy awareness**

I. Introduction

Energy Management in Smart Built Environment:

PHEV

Smart Meter

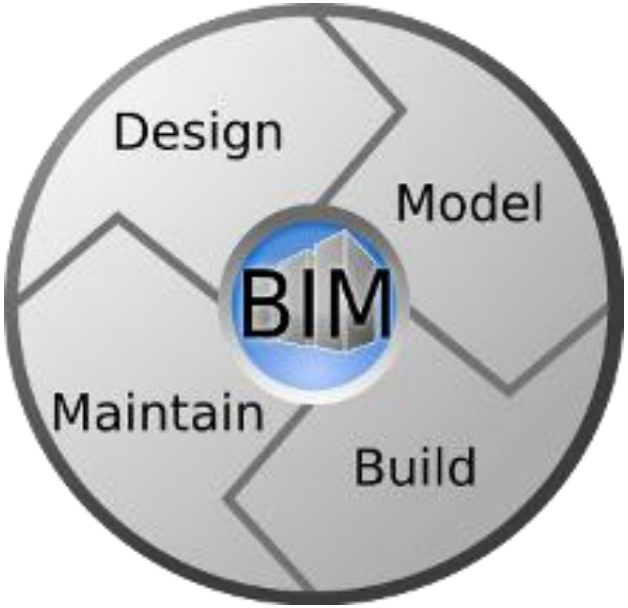
On-site Renewable

Exchanging energy and/or information

Also Considered as Smart Objects

I. Introduction

Smart Built Environment construction requirement and procedures



Utilising Building Information Modelling

I.Introduction

II.The Role of BIM in Smart Built Environment

III.Integrating BIM in Design Phase

IV.Integrating BIM in Post-construction Phase

V.Conclusion & Future Work

II. The role of BIM

General Challenges:

- How the Smart Objects are embedded into the environment
- How the Smart Objects interact with the environment
- The maintenance of such Smart Objects in a building's post-construction phase

II. The role of BIM

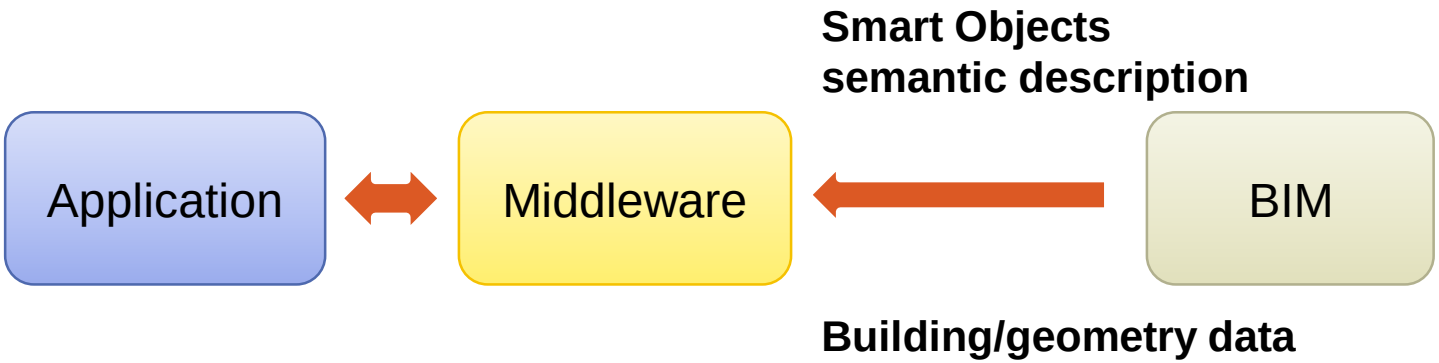
Benefits of Utilising BIM:

- **Advantageous and convenient in terms of information interaction:**
  - Serve as a data repository for the physical information of smart objects
  - Designers of the Smart Built Environment can utilise the building knowledge to design the layouts of tags, sensors and meters

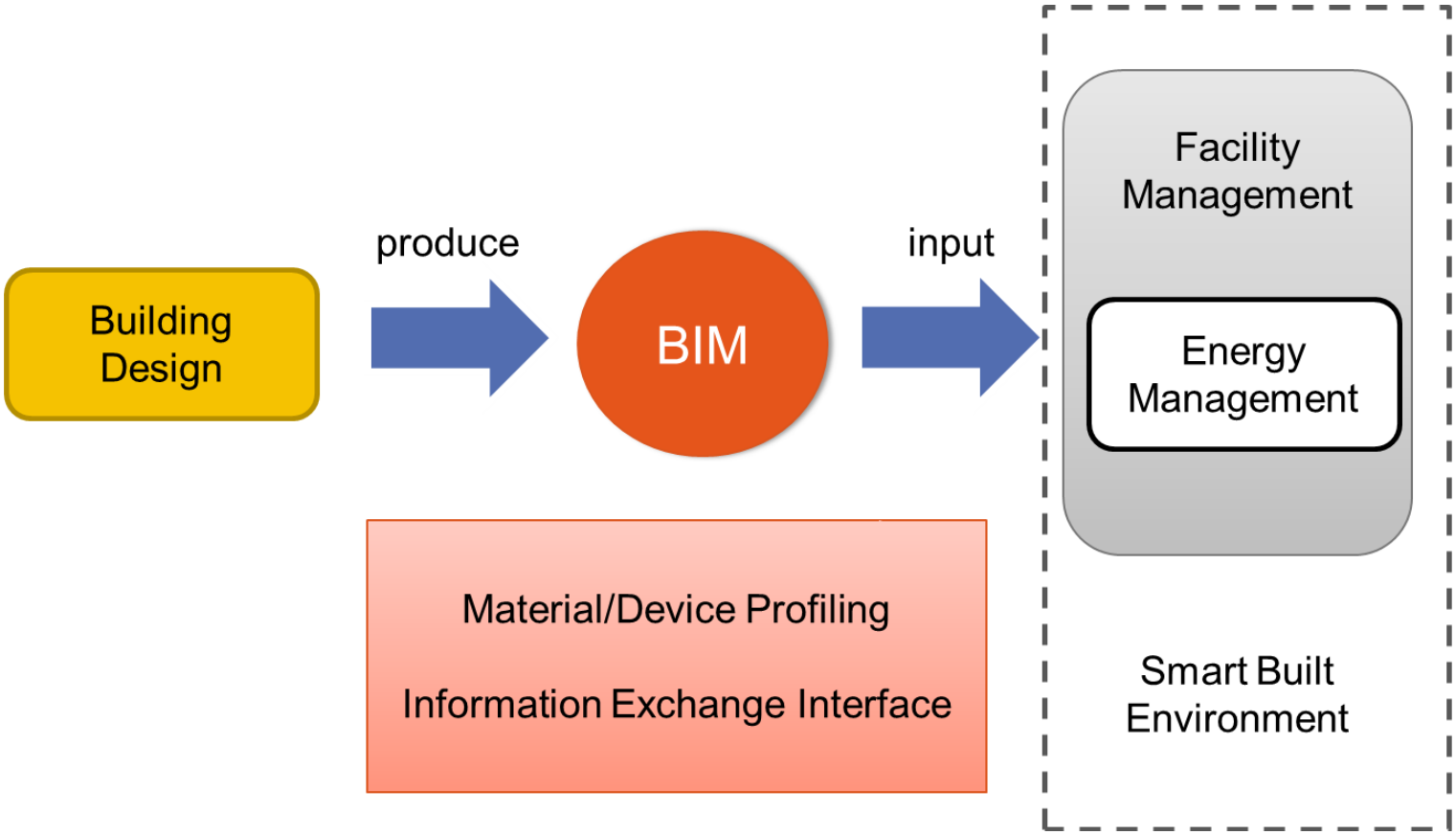
II. The role of BIM

Benefits of Utilising BIM:

- **Provides a perfect ontology database for Smart Built Environments**



II. The role of BIM



I.Introduction

II.The Role of BIM in Smart Built Environment

III.Integrating BIM in Design Phase

IV.Integrating BIM in Post-construction Phase

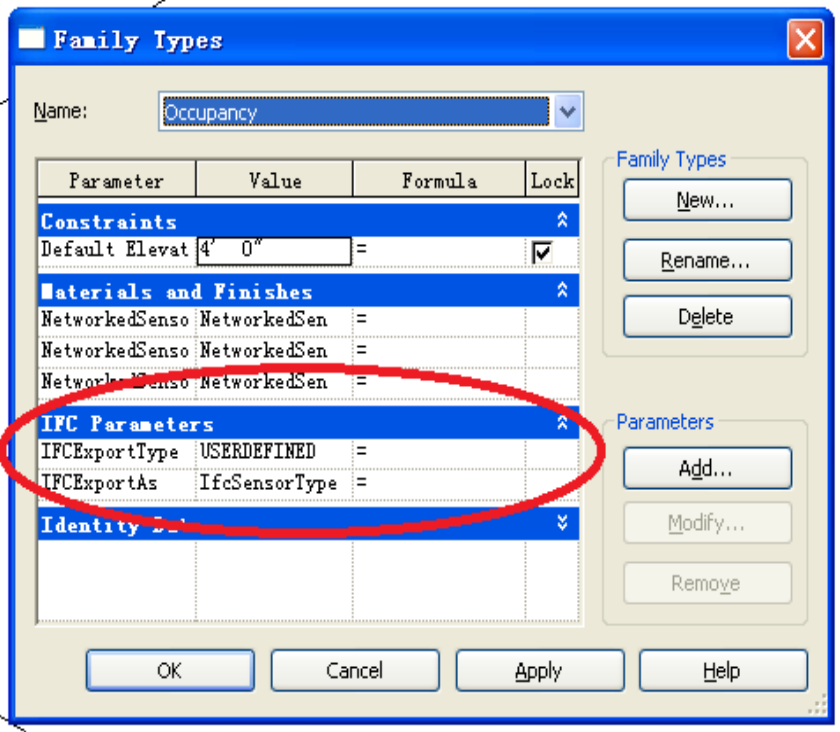
V.Conclusion & Future Work

III. BIM in design phase

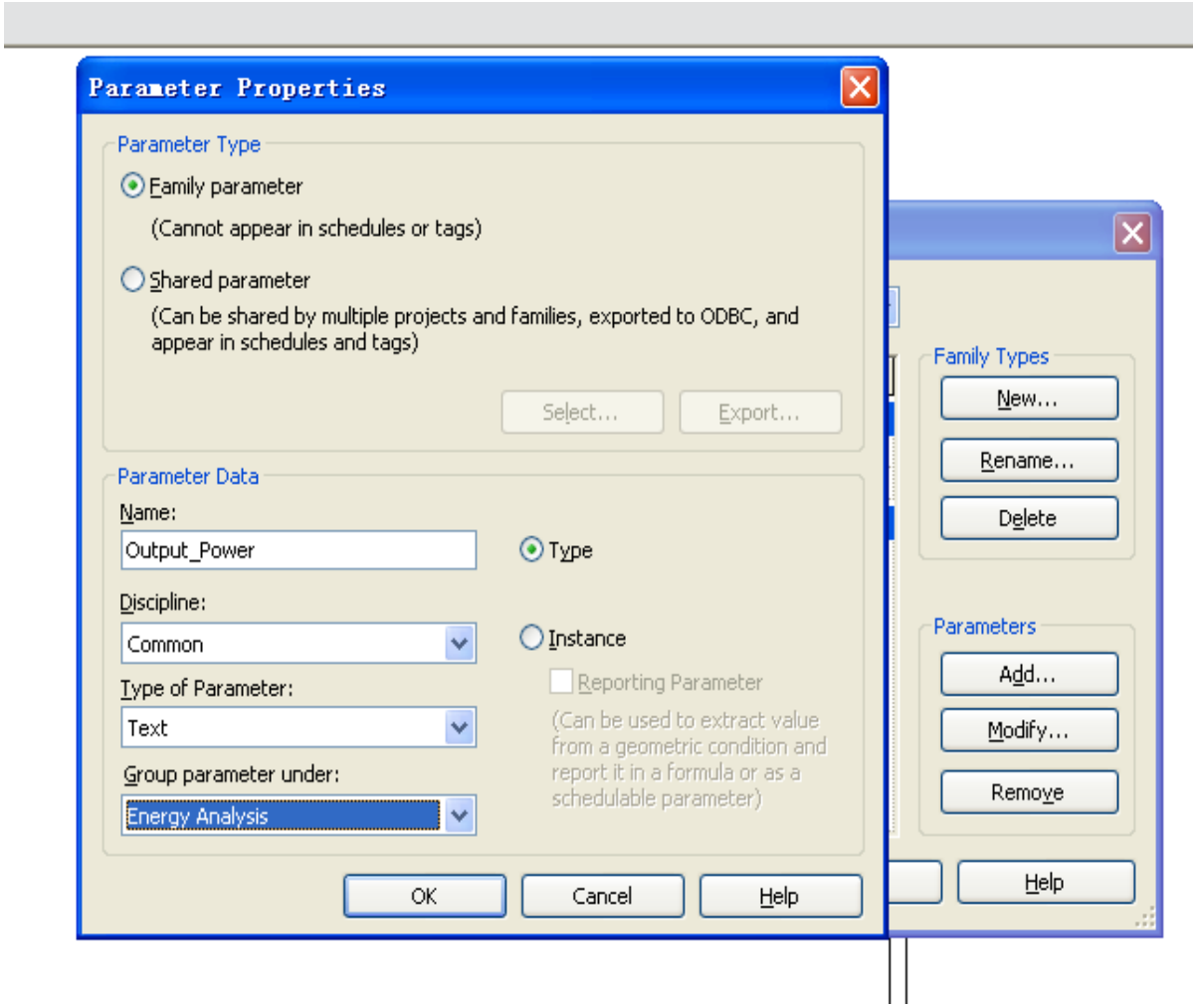
Profiling Smart Objects to design Smart Built Environment using BIM:

- **IFC shared parameter**
- **Family properties parameter**
- **Mark tag**

III. BIM in design phase



III. BIM in design phase



III. BIM in design phase

Using the family properties parameters as semantic description for Smart Objects:

- **Output: interface from which external software can read the output of the object. Name format : “Output_xxxxx”.**

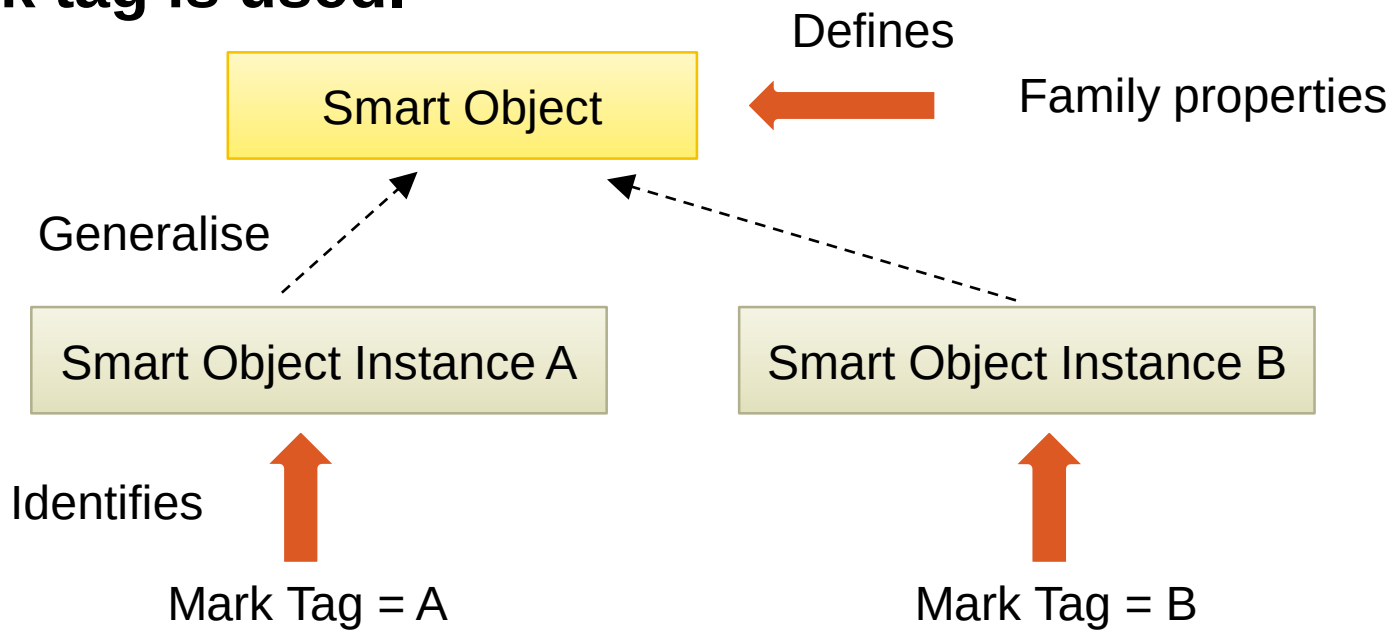
- **Input: interface from which external software can read the generation factors/status of the device. Name format : “Input_xxxxx”.**

- **Control: interface from which external software can modify the status of the device. Name format : “Control_xxxxx”.**

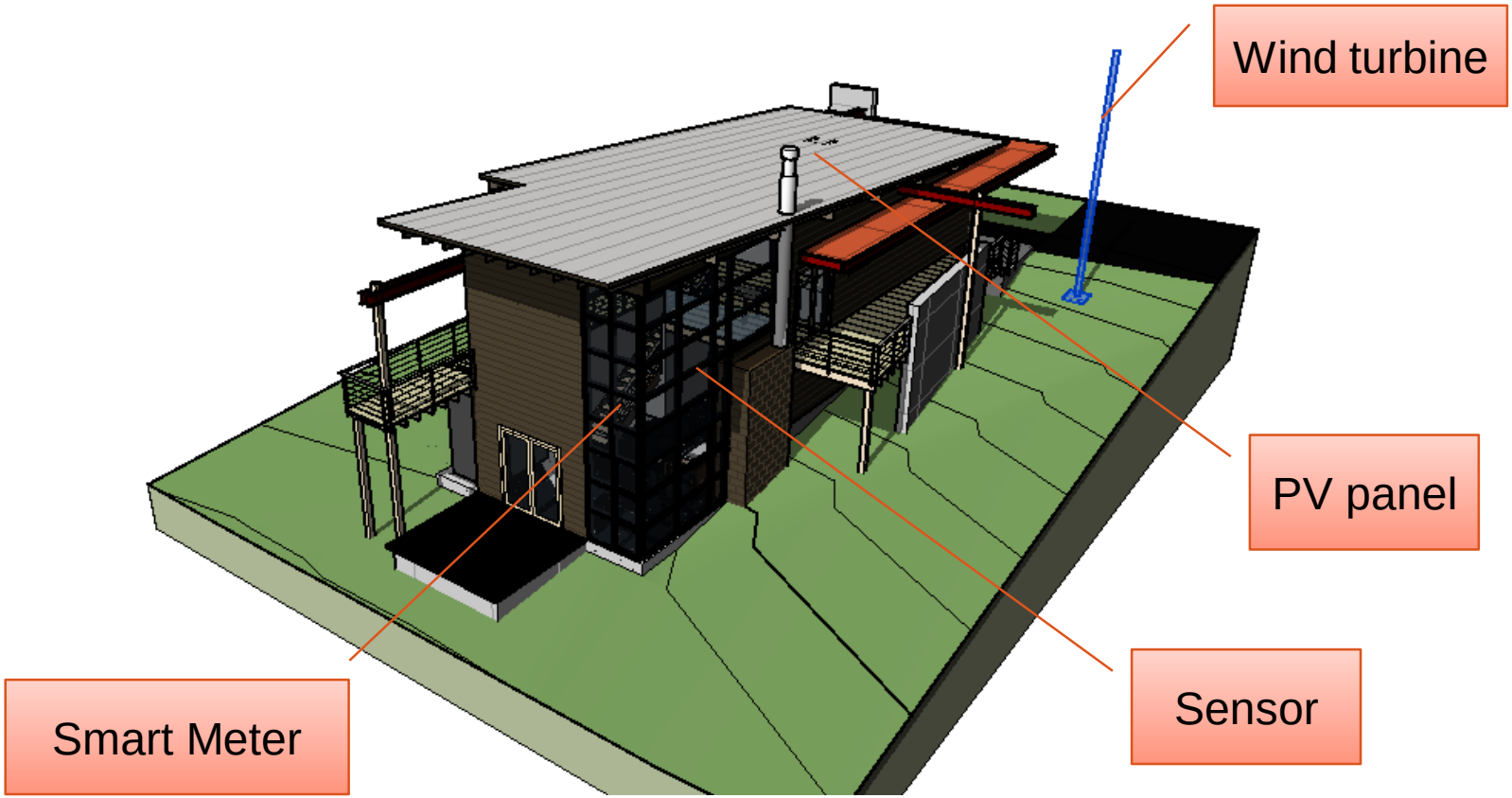
III. BIM in design phase

The semantic description helps to profile a type of Smart Objects.

To map a Smart Object placed in a building design from BIM to an individual real world device the mark tag is used.



III. BIM in design phase



Example house design in Revit

III. BIM in design phase

```
.....
#192496=
IFCSENSORTYPE('3Ea9KIygfFOf3hy58KLU_a',#52,'Occupancy',$,$,$,(#192495),'211594','Occupancy',.USERDEFINE
D.);
.....
#186580=IFCBUILDINGELEMENTPROXY('31vPjYM8b9$Aof7XNLJOFw',#52,'Wind Power Generator_modified:60"
High:60" High:201370',$,'60" High',#186579,#186574,'201370',.ELEMENT.);
#186581=IFCPROPERTYSINGLEVALUE('Mark',$,IFCLABEL('OutdoorWindTurbine'),$);
#186583=IFCPROPERTYSINGLEVALUE('Input_windspeed',$,IFCINTEGER(0),$);
#186586=IFCPROPERTYSINGLEVALUE('EnergyResource',$,IFCINTEGER(1),$);
#186587=IFCPROPERTYSINGLEVALUE('Control_angle',$,IFCPLANEANGLEMEASURE(0.),$);
#186590=IFCPROPERTYSINGLEVALUE('Output_power',$,IFCINTEGER(0),$);
.....
```

Exported IFC file

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TE WĀNANGA ARONUI O TAMAKI MAKAU RAU

I.Introduction

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IV. BIM in post-construction

Building Manager

Utilising BIM to perform day-to-day Smart Built Environment management tasks

IV. BIM in post-construction

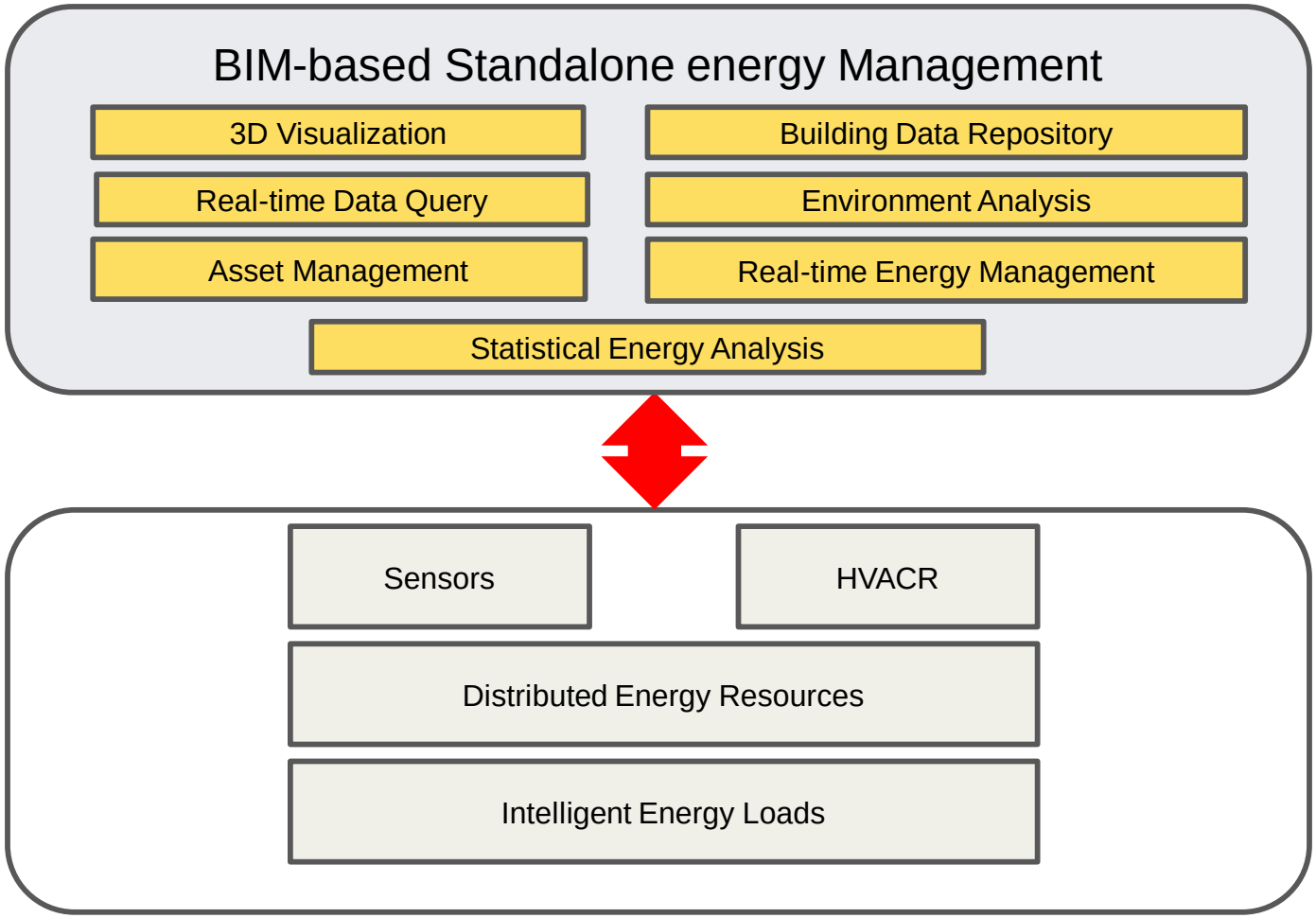
I work with CAD

Building Designer

Building Manager

Prefer BMS solution

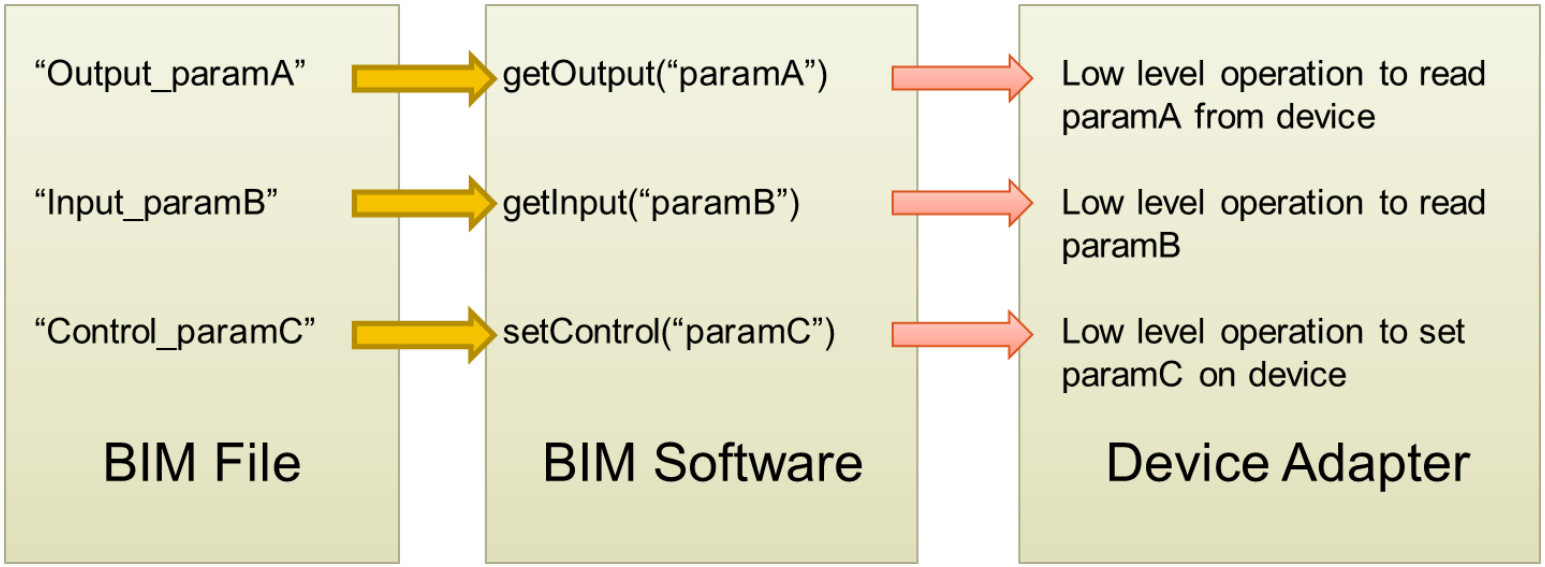
IV. BIM in post-construction



A standalone energy management tool is developed

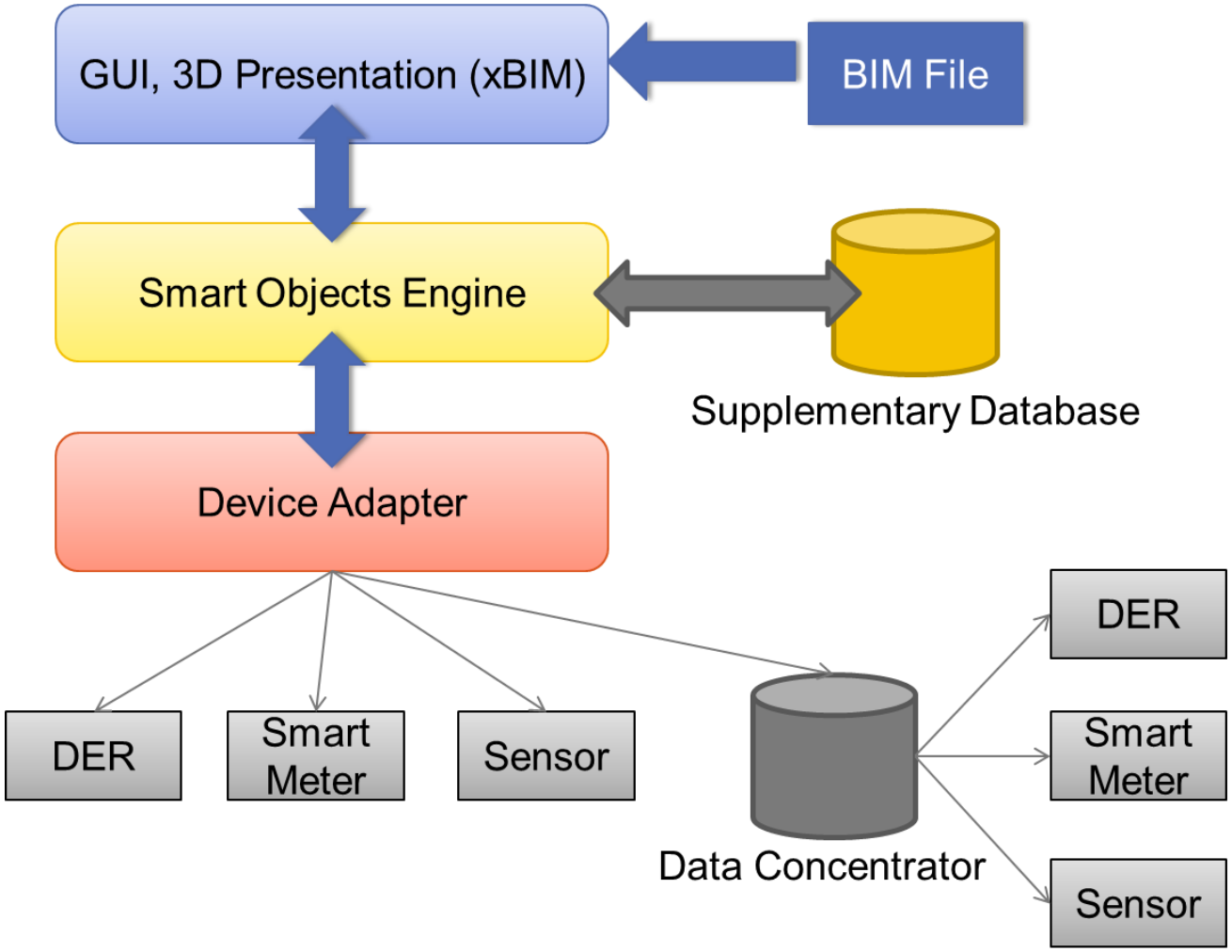
IV. BIM in post-construction

Adapter layer



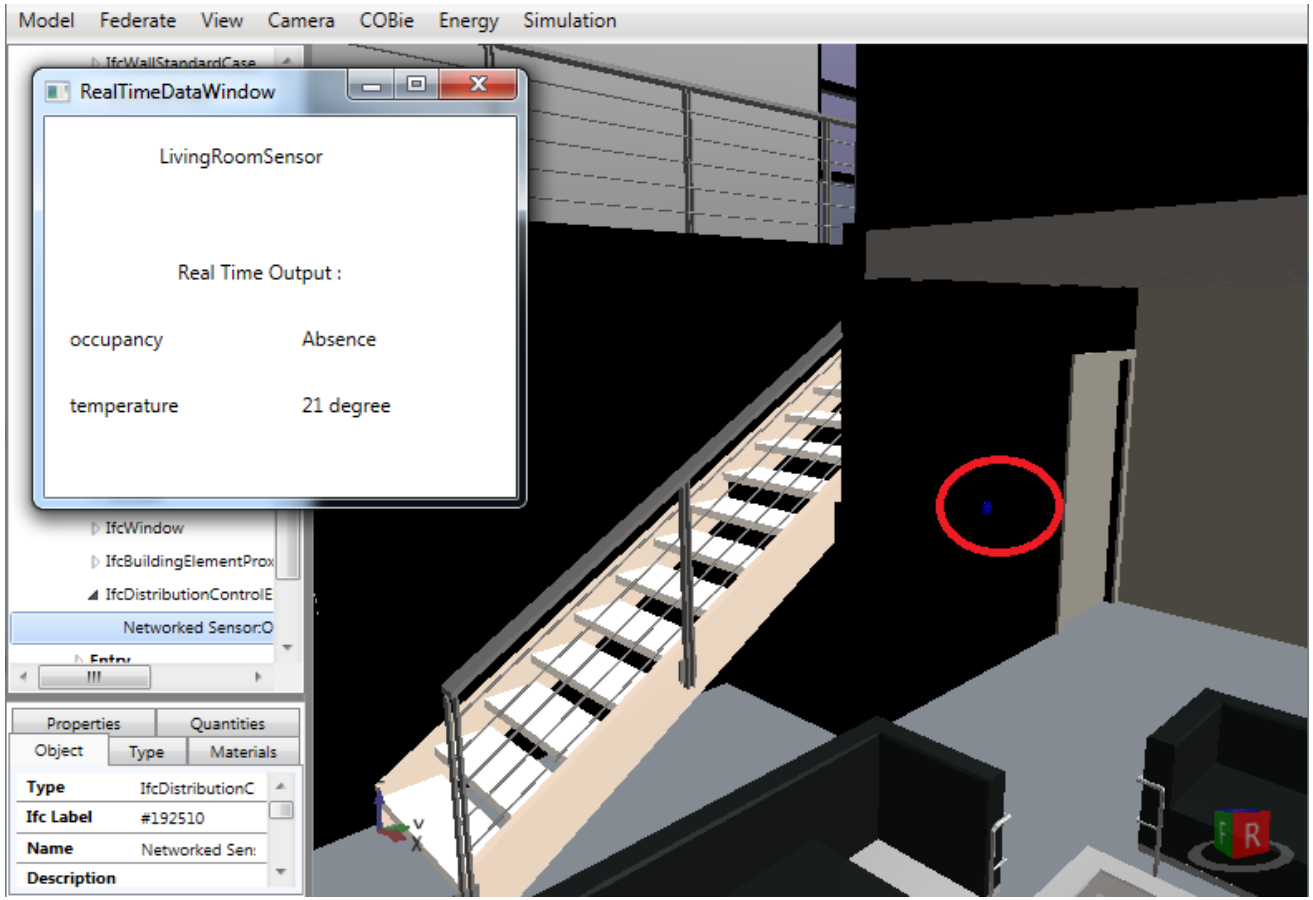
Parsing the semantic description from BIM

IV. BIM in post-construction



Software architecture

IV. BIM in post-construction

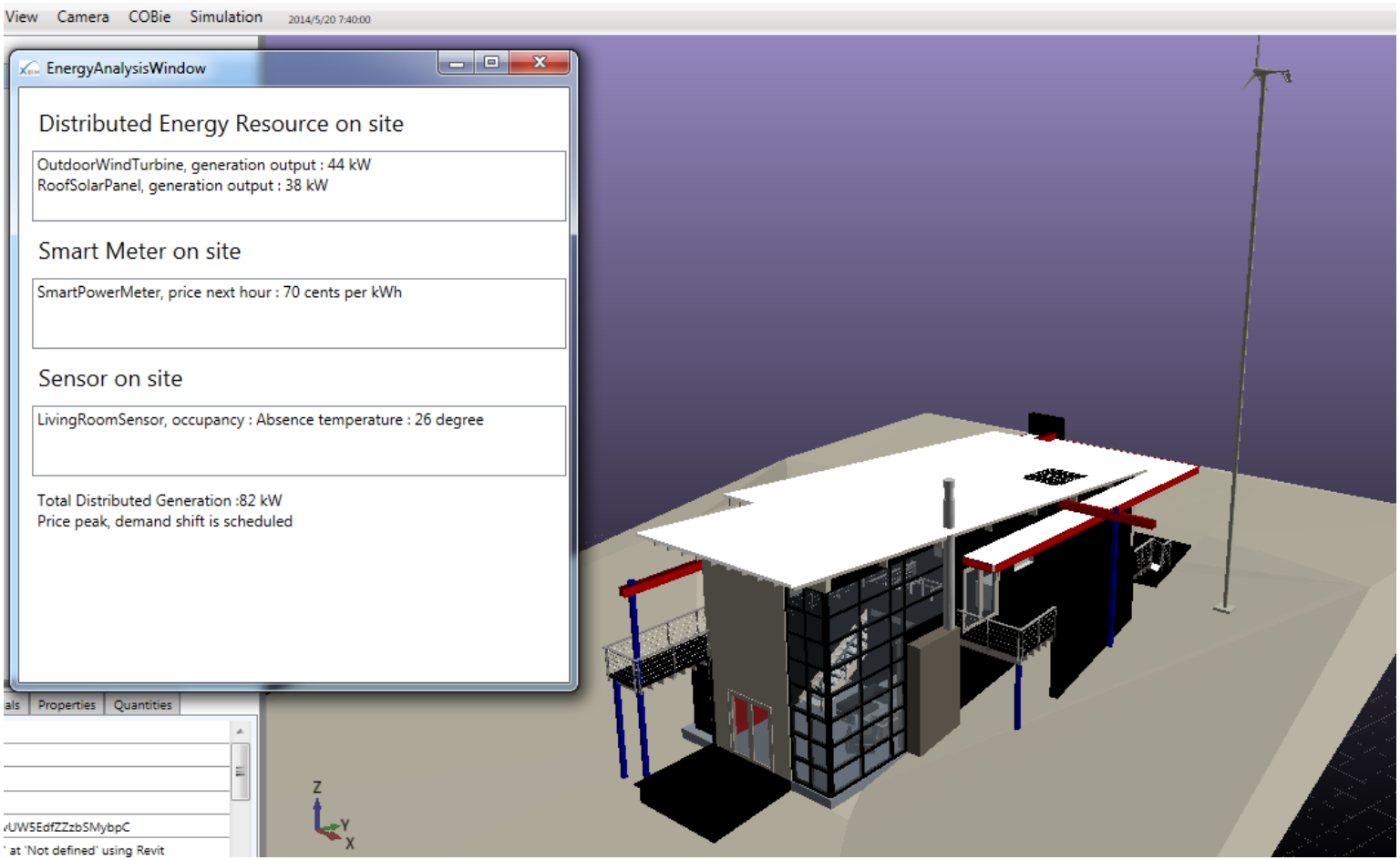


Real time data from Smart Objects

IV. BIM in post-construction

- **Real-time generation data of on-site DER give the current energy production and indicate how many loads can be supplied off power grid.**
- **Weather and temperature data from sensors forms a view of the present and future energy generation/consumption.**
- **The price signal from the smart meter helps the building interact with the power grid and perform demand response actions.**

IV. BIM in post-construction



Overall energy analysis

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V. Conclusion

- **This project explored how BIM can be utilised for energy management in smart built environments, both in design phase and post-construction phase.**
- **Through this research, an advanced BIM-based energy management platform is envisioned.**

V. Future Work

- Include geometry data for energy analysis/forecast
- Use space/room data from BIM for precise energy consumption control
- Extend the BIM tool to control BACnet compatible appliances
- Smart Grid applications

Project video

http://www.youtube.com/watch?v=2nC2qgmcts0

THANK YOU!