A product-centric approach for assessing the energy performance of solution for building renovations

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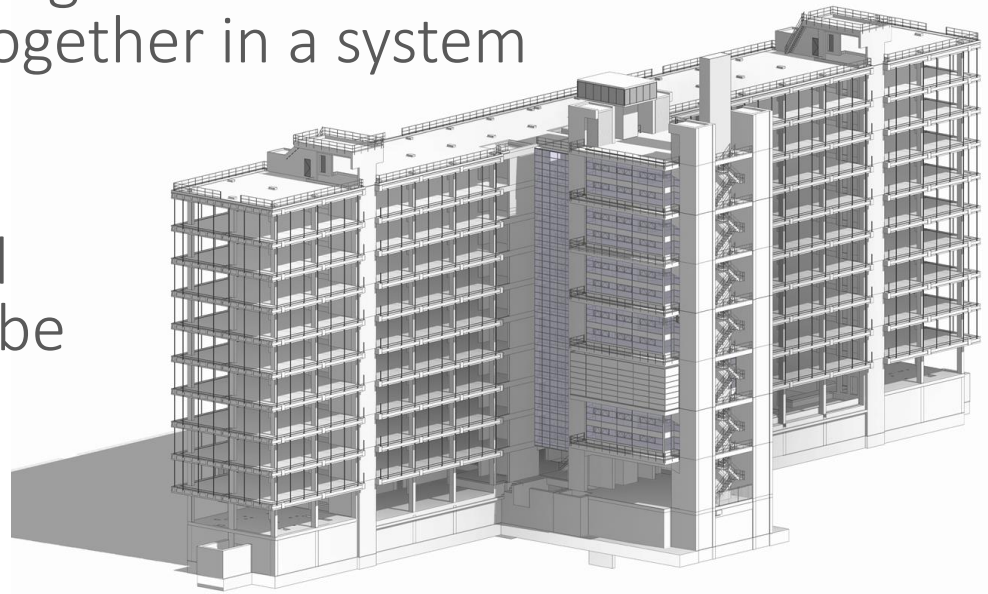
Agenda

Introduction

- 35% of the buildings in the EU are over 50 years old (European Commission)
- Renovation of buildings stock is the most viable solution to reduce energy consumption and CO2 emission (Nägeli et al. 2018, p. 444)
- The energy use of buildings depends to a significant extent on how the various elements of a building work together in a system (Harvey, 2009, p. 140)
- Renovation strategies are required to find existing energy saving products, that can be installed to archieve energy efficient renovation



Introduction

- To obtain a good renovation strategy in terms of improving the energetic values of the building, models for analyzing and predicting the energy balance are suitable
- Unfortunately, building energy performance models are rarely used in building design
- Most of the time, building energy models are generated based on building information models

  ↳ inaccurate

  difficult to make established statements

Case study

Case study based on a real demonstration case in Poland, Warsaw

Object was build in 1965 and consists a two storey kindergarten

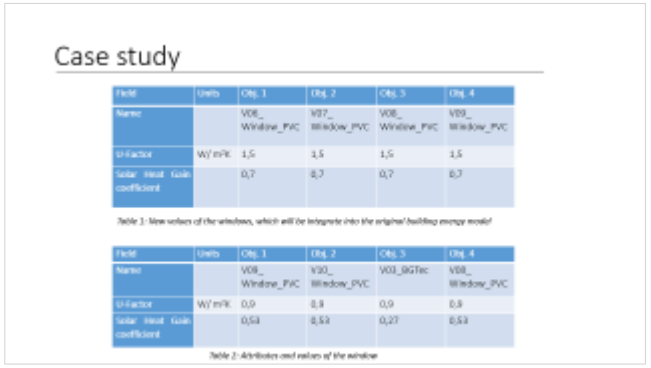
Volume: 2713 m3

Through renovation procedures, the energy consumption of the building are to be reduced

Therefore, new windows and a external facade will be installed

Case study

Based on the building energy model of the demonstration project in Warsaw, the design exchange was performed by two entity classes and parameters for windows and panels.

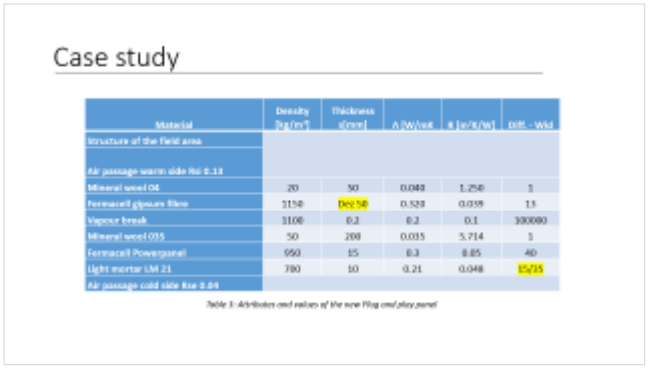

Case study

Field	Units	Obj. 1	Obj. 2	Obj. 3	Obj. 4
Name		V08_ Window_PVC	V07_ Window_PVC	V08_ Window_PVC	V09_ Window_PVC
U-Factor	W/ m²K	1,5	1,5	1,5	1,5
Solar Heat Gain coefficient		0,7	0,7	0,7	0,7

Table 1: New values of the windows, which will be integrate into the original building energy model

Field	Units	Obj. 1	Obj. 2	Obj. 3	Obj. 4
Name		V08_ Window_PVC	V30_ Window_PVC	V03_0GTec	V08_ Window_PVC
U-Factor	W/ m²K	0,9	0,8	0,9	0,8
Solar Heat Gain coefficient		0,53	0,53	0,27	0,53

Table 2: Attributes and values of the window


Case study

Material	Density [kg/m³]	Thickness s[mm]	λ [W/mK]	R [m²K/W]	Diff. - Wid
Structure of the field area					
Air passage warm side Rsi 0.13					
Mineral wool 0it	20	50	0.040	1.250	1
Fermacell gipsum fibre	1150	Dec 50	0.520	0.039	13
Vapour break	1100	0.2	0.2	0.1	100000
Mineral wool 035	50	200	0.035	5.714	1
Fermacell Powerpanel	950	15	0.3	0.05	40
Light mortar LM 21	700	10	0.21	0.048	15/15
Air passage cold side Rse 0.04					

Table 3: Attributes and values of the new Plug and play panel

Case study

Field	Units	Obj. 1	Obj. 2	Obj. 3	Obj. 4
Name		V06_ Window_PVC	V07_ Window_PVC	V08_ Window_PVC	V09_ Window_PVC
U-Factor	W/ m^2K	1,5	1,5	1,5	1,5
Solar Heat Gain coefficient		0,7	0,7	0,7	0,7

Table 1: New values of the windows, which will be integrate into the original building energy model

Field	Units	Obj. 1	Obj. 2	Obj. 3	Obj. 4
Name		V09_ Window_PVC	V10_ Window_PVC	V03_BGTec	V08_ Window_PVC
U-Factor	W/ m^2K	0,9	0,9	0,9	0,9
Solar Heat Gain coefficient		0,53	0,53	0,27	0,53

Table 2: Attributes and values of the window

Case study

Material	Density [kg/m³]	Thickness s[mm]	Λ [W/mK	R [m²K/W]	Diff. - Wid
Structure of the field area					
Air passage warm side Rsi 0.13					
Mineral wool 04	20	50	0.040	1.250	1
Fermacell gipsum fibre	1150	50	0.320	0.039	13
Vapour break	1100	0.2	0.2	0.1	100000
Mineral wool 035	50	200	0.035	5.714	rechner1
Fermacell Powerpanel	950	15	0.3	0.05	40
Light mortar LM 21	700	10	0.21	0.048	0,371
Air passage cold side Rse 0.04					

Table 3: Attributes and values of the new Plug and play panel

Approach – Background

EnergyPlus to perform the simulation

Energetic effects by changing the elements for renovation within the model

Different BEM based on chosen renovation design

Different design options

Renovation products

Building energy models from real construction projects

Product centric assessment process

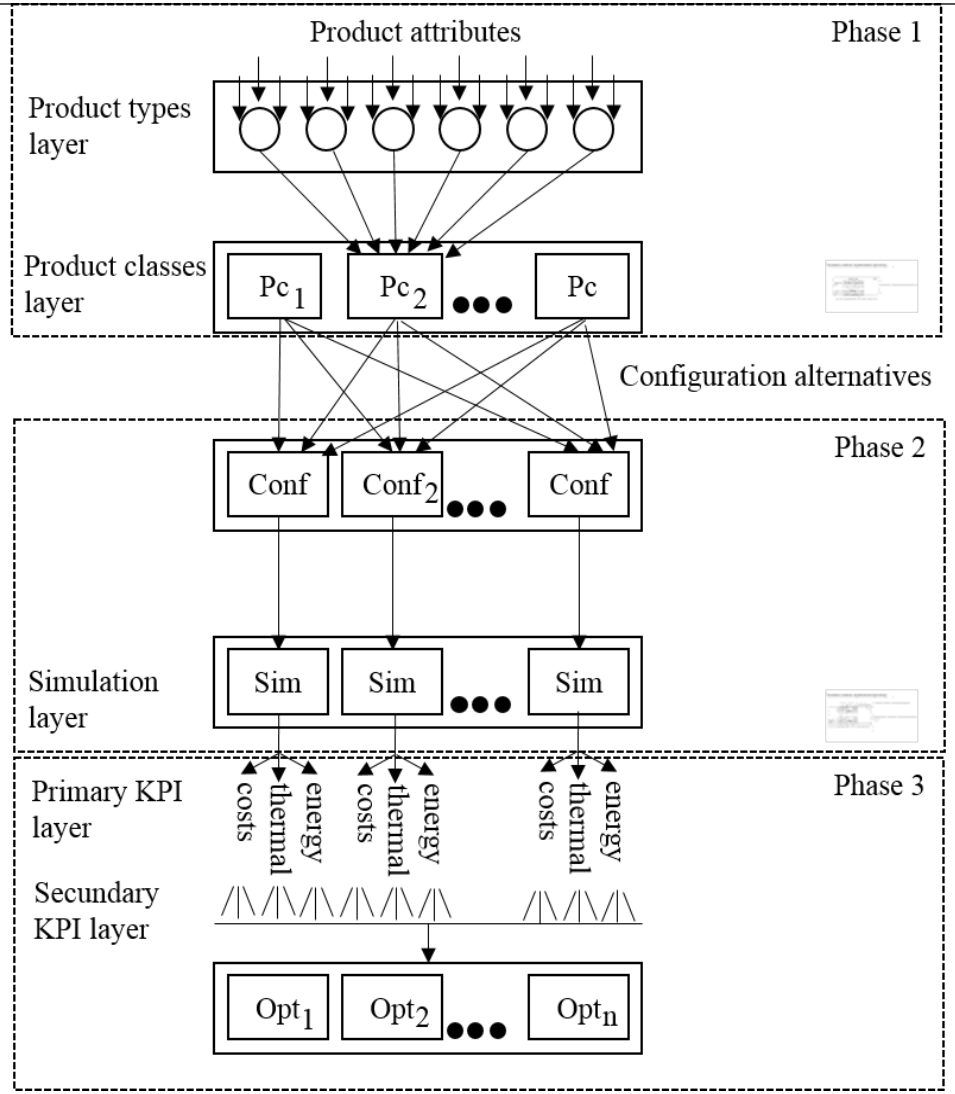


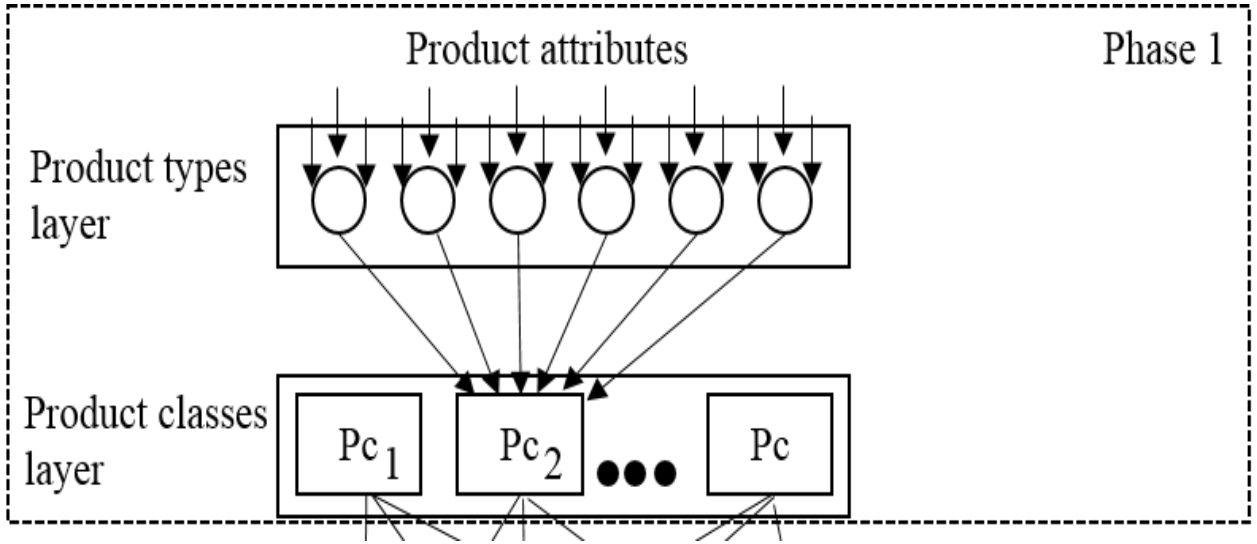
Figure 1: Overall process where we build product classes based on attributes (phase 1), run the simulation based on the chosen renovation option (phase 2) and present the results (phase 3).

First Phase: define the building elements

Second Phase: simulation of the building energy model

Third Phase: visualization of the energetic values takes (not part of the paper)

Product centric assessment process



First Phase: define the building elements

Figure 1: process where we build product classes based on attributes (phase 1)

Process step 1

define product classes based on their attributes

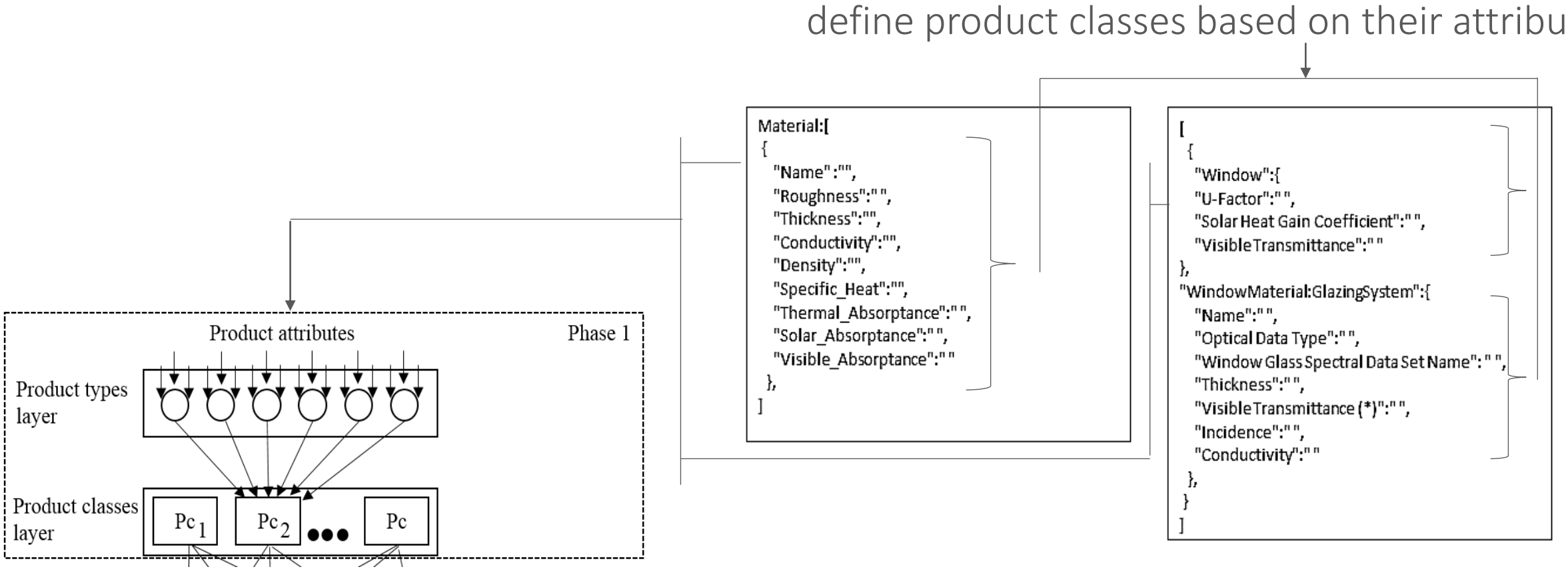


Figure 2: Description of the attributes for the renovation product class Material and Window

Product centric assessment process

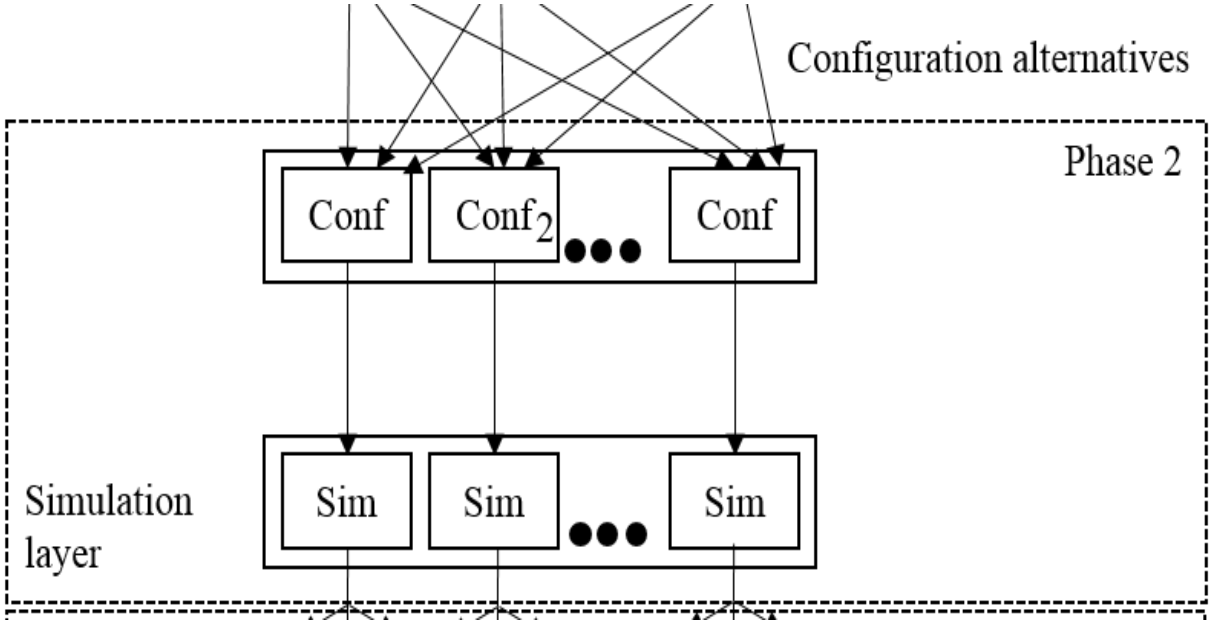


Figure 1: run the simulation based on the chosen renovation option (phase 2)

First Phase: define the building elements

Second Phase: simulation of the building energy model

Process step 2

Second phase of the process is characterized by three internal process steps

3 Start the new simulation

2 Insert elements of the new window

1 Analyzing building model regarding the elements to be removed

```
! ======================  GAP - MATERIAL GLASS ======================
WindowMaterial:SimpleGlazingSystem,
  V07_Window_PVC_2350x2250_Win (10mm), ! Name
  1.5,          ! U-Factor
  0.7,          ! Solar Heat Gain Coefficient
  ;             ! VisibleTransmittance (*)

! ======================  GAP - MATERIAL FRAME ======================

! ========================  GAP - CONSTRUCION ========================
 Construction,
  H06_Window,     ! Name
  V07_Window_PVC_2350x2250_Win (10mm); ! Outside Layer
```

Figure 3: Attributes for the renovation product class Window in EnergyPlus

Results

- Our product centric approach allows us to use, add and remove building elements within the as-is building energy model
- as-is energy model serves as the baseline for the further simulation of the different renovation options
  - no additional expenditure in the redesign of energy models
- fast and comparable way of simulating and displaying energy data

Future work

- We only consider windows and panels as renovation options
- During the comingmonths we will continue to expand our process and be able to map more product types, such as HVAC

Thank you for the attention