Urban-scale energy building simulation: A development of a novel method for parsimonious modelling – The example of solar irradiation calculation.

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IBPSA PROJECT 1 – WP3 DESTEST

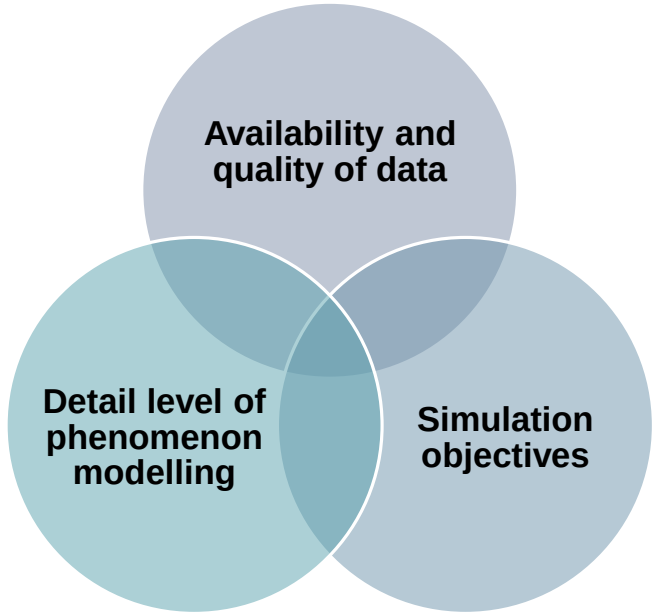
Thesis

Today : Increased interest in energy district simulation to address the issues relative to energy transition and energy supply

But:

- District level : mutltiply uncertainties
- Collecting exhaustively inputs data for parametrization complicated
- Use of detailed models expensive in computational time

→ Development of methodological approach considering several models and evaluates their relevance regarding the expected simulation outcomes

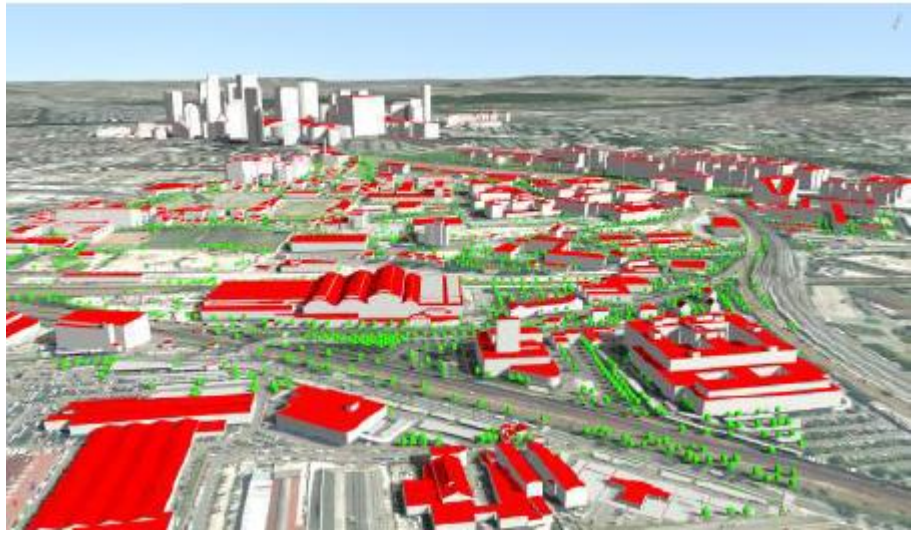


Thesis

Tendency of developing models ever more detailed

→increase in computational time and required data

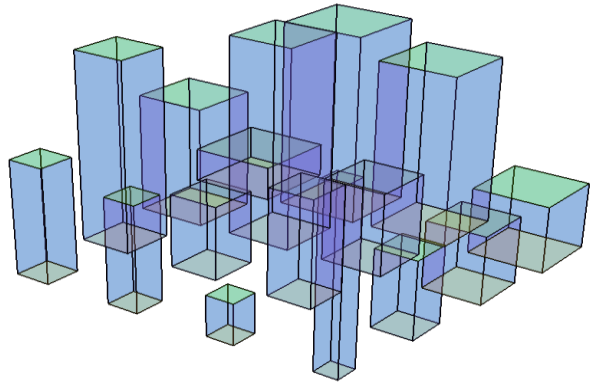
→Comparison with other models not generic but on specific districts or buildings

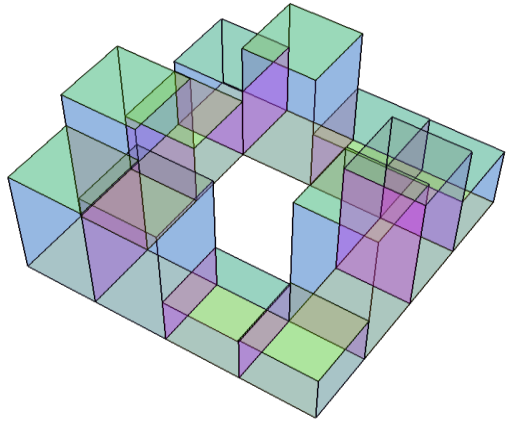


Virtual districts

Parametrization for the shapefile:

- Morphology : grid, circle, canyon, lines
- Shape and size of buildings : cube, L, U
- Density
- Heights
- Orientation

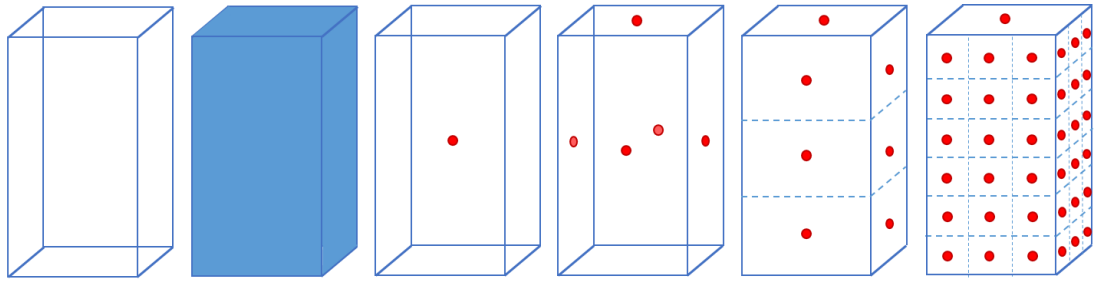




Solar radiation

SOLAR RADIATION MODELS

Model	Caractéristics	Simulator
Mask-L 0.0	Without	DIMOSIM
Mask-L 1.1	Fixed factor (different for each buildings)	SMART-E (3CL method)
Mask-L 2.2	Dynamic calculation on the center's building	DIMOSIM
Mask-L 3.2	Dynamic calculation on the center's facade building	DIMOSIM
Mask-L 4.2	Dynamic calculation on the center's of each floor facade	DIMOSIM
Mask-L 5.2	Dynamic calculation with precise mesh	DIMOSIM / Others



Mask-L 0.0 Mask-L 1.0 Mask-L 2.2 Mask-L 3.2 Mask-L 4.2 Mask-L 5.2

KPI AND BASELINE

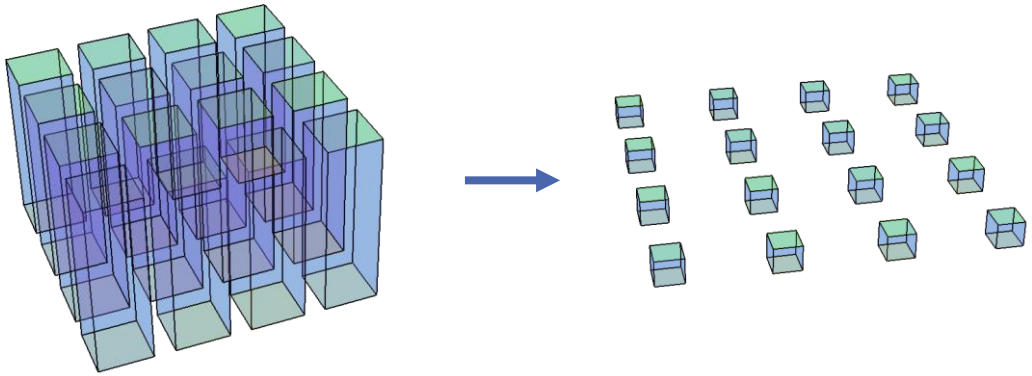
KPI in relation with the model comparison in order to find for the differents simulation objectives the relevant level of detail of the mask model.

KPI	T_{int} : Discomfort $C_{lighting}$: Lighting consumption[kWh/an] $C_{heating}$: Heating demand [kWh/an] $C_{cooling}$: Cooling demand[kWh/an] $P_{heating-peak}$: Peak heating power [kW] $P_{cooling-peak}$: Peak cooling power [kW] P_{ray} : Maximal solar gains [kW] E_{ray} : Total solar gains receive by the building[kWh] Time : Simulation time [s]
Baseline	Mask-L 5.2

Solar radiation

DISTRICT TYPES

Caractéristic	Q1	Q2	Q3	Q4	Q5	Q6
Mean height [m]	21	21	21	6	6	6
Density [-]	0.6	0.4	0.1	0.6	0.4	0.1
Building size [m*m]	8*8	8*8	8*8	8*8	8*8	8*8
Number of buildings	16	16	16	16	16	16



SIMULATION CARACTERISTICS

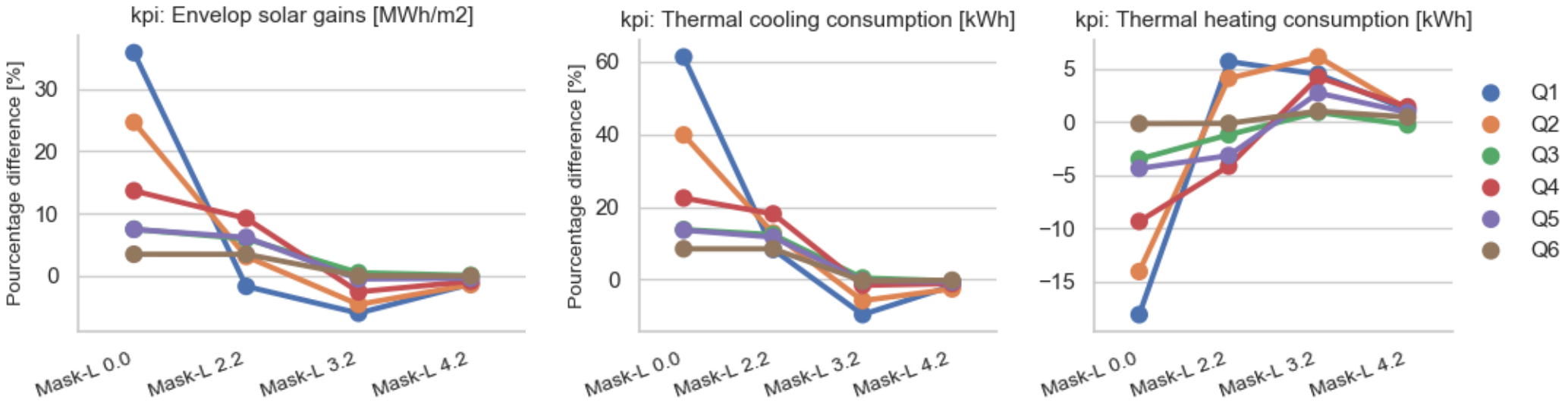
U_{wall} (W/m²K)	U_{window} (W/m²K)	window_ ratio (%)	Solar factor	Weather	Internal gains (W/m²)	Temperature set-points (°C)
1	2	10 %	0,789	Nice	10	Cooling : 26°C Heating : 20°C

No occupants or equipments
One-zone model
No influence from near masks

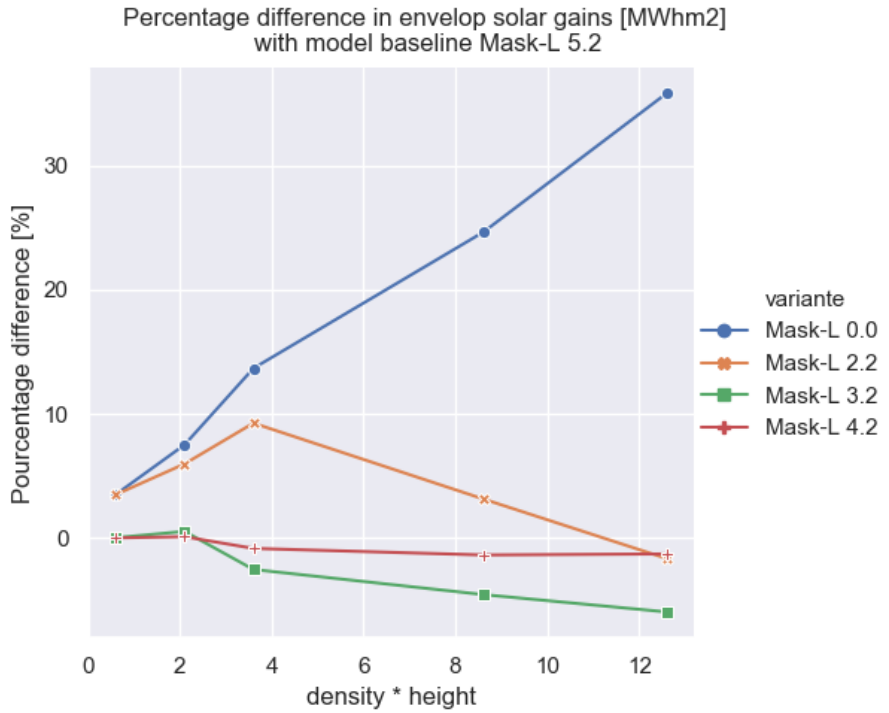
KEY GUIDANCE INDICATOR

$$K_{dh} = density * height$$

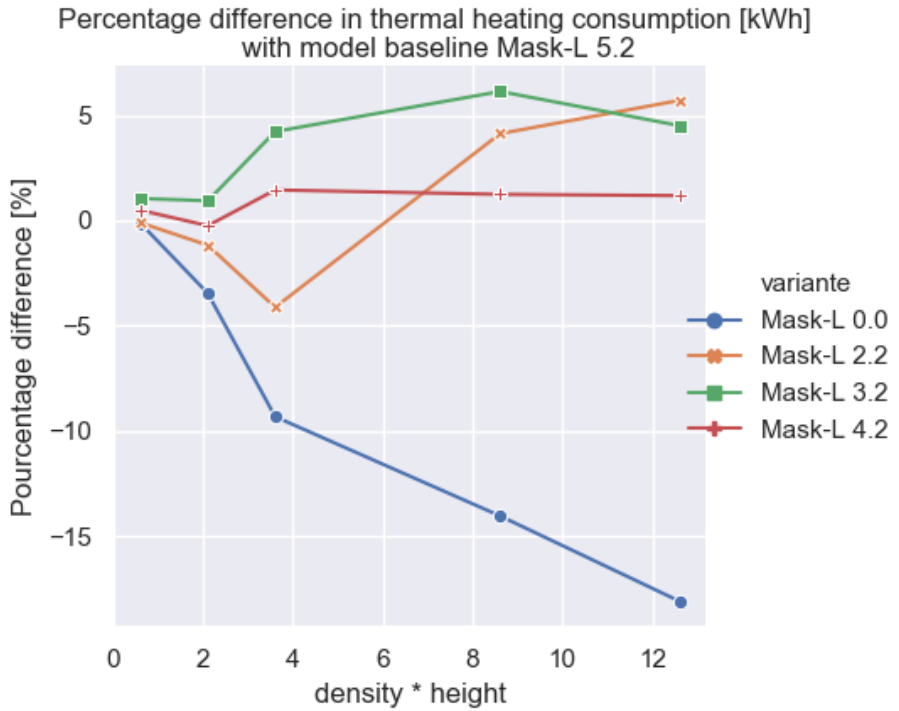
Solar radiation



Solar radiation

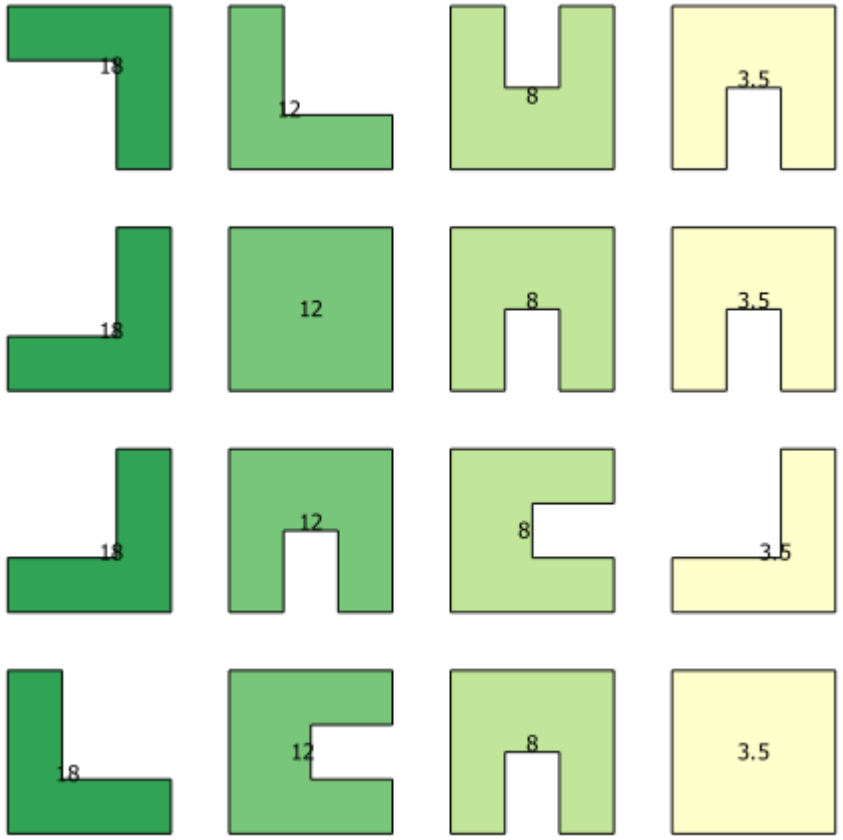


Solar gains [kWh/m2]



$C_{heating}$[kWh]

Solar radiation



Absolute percentage difference with model Mask-L 5.2					
KPI	Mask-L 0.0	Mask-L 1.1	Mask-L 2.2	Mask-L 3.2	Mask-L 4.2
D_thermal_heating_kWh	20,3%	4,0%	9,0%	3,5%	0,3%
P_max_heating_kW	1,1%	0,2%	0,5%	0,5%	0,1%
P_mean_heating_kW	20,3%	4,0%	9,0%	3,5%	0,3%
P_std_heating_kW	6,9%	1,3%	3,5%	0,8%	0,0%
S_envelop_MWhm2	47,3%	2,4%	27,7%	4,2%	1,5%
S_max_opaque_kW	6,9%	23,9%	6,9%	0,9%	0,9%
T_sup_28C_%	55,1%	4,1%	33,2%	3,5%	1,4%

District of 16 buildings with the same parameters except a difference in height [18m, 12m, 8m, 3.5m], orientation and shape.