

URBAN MICROCLIMATE AND BUILDING ENERGY: A COUPLED SIMULATION APPROACH

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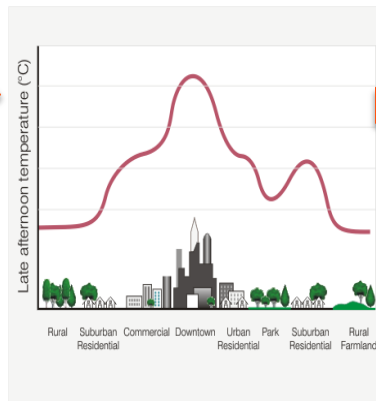
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CONTEXT : TOWARD A BIOCLIMATIC AND URBAN DESIGN OF BUILDINGS



Impact of local microclimate on buildings

- New buildings are very sensitive to their environment
- A bioclimatic and dynamical design of buildings with renewable energy has to take the local microclimate into account

Impact of buildings on local microclimate

- Urban densification is also a major factor of urban microclimate degradation
- Specialists of urban issues seek more information on the influence of buildings

THE ANR MERUBBI PROJECT

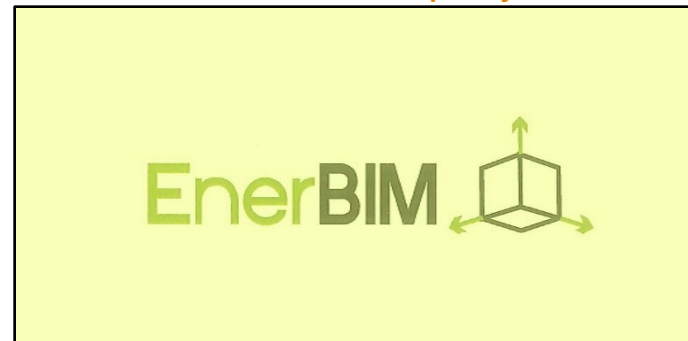


Developing a simulation platform
to optimize the design of a new
building to be added to an
existing city block

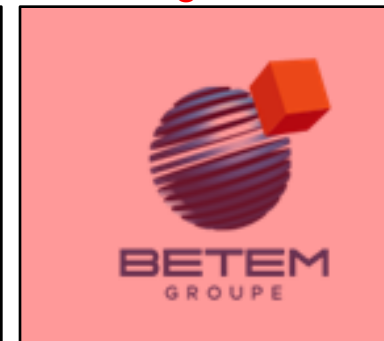
Research centers



Energy simulation
software company



Technical
design office

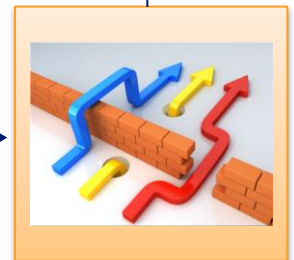
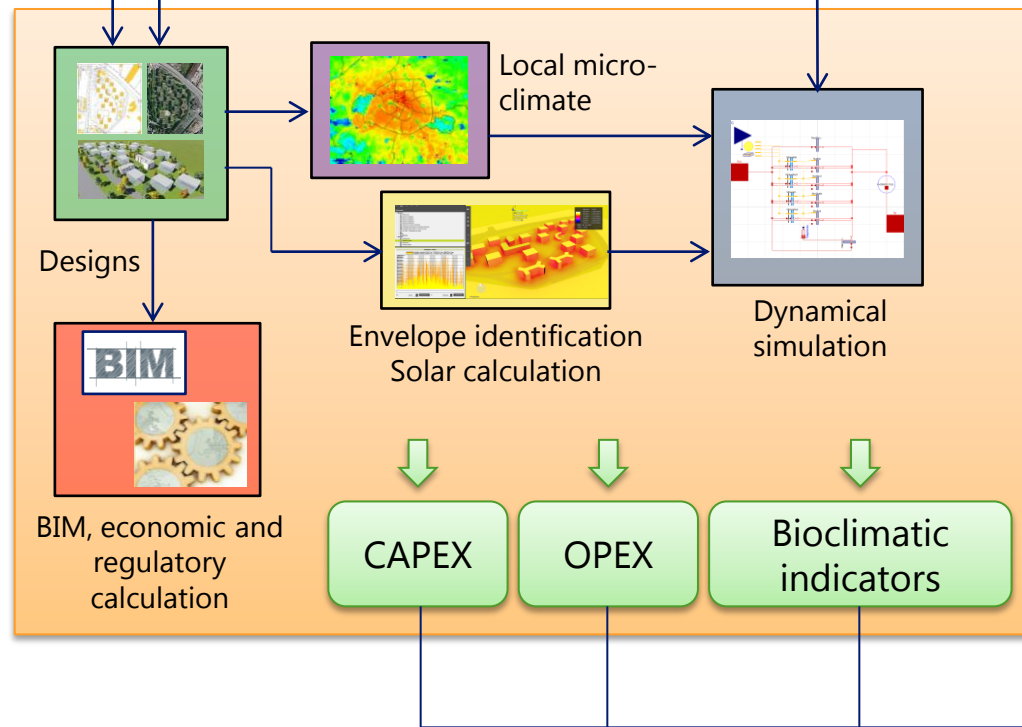


Architects

OUTLOOK: TOWARDS OPTIMIZATION OF NEW BUILDING DESIGN



Initial design taking energy efficiency into account
Existing city block analysis

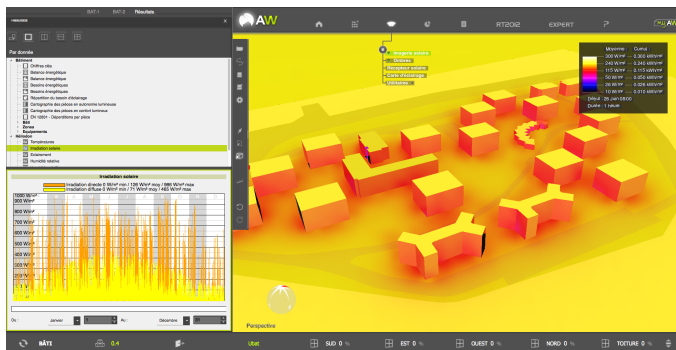


Optimization

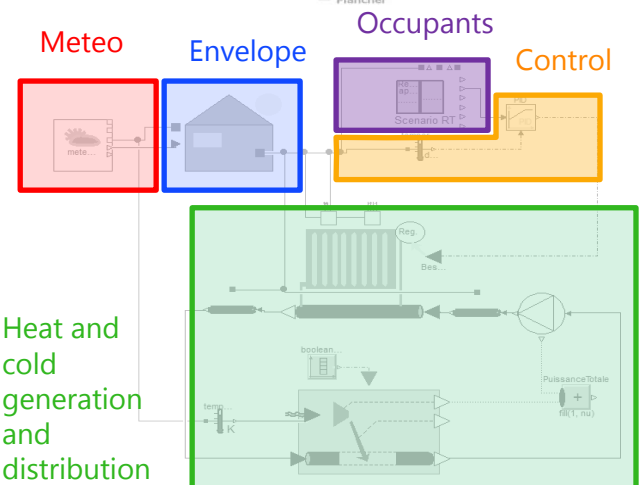
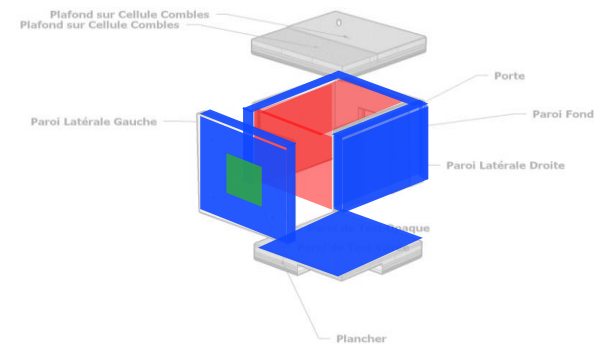
GETTING FROM A 3D MODEL TO A 0D DYNAMICAL SIMULATION

■ ArchiWIZARD[®]

- Business software for building and radiative transfer simulation
- Import of Setchup 3D model
- Identification of building envelope attributes
- Solar radiation calculation by ray tracing
- Regulatory calculations

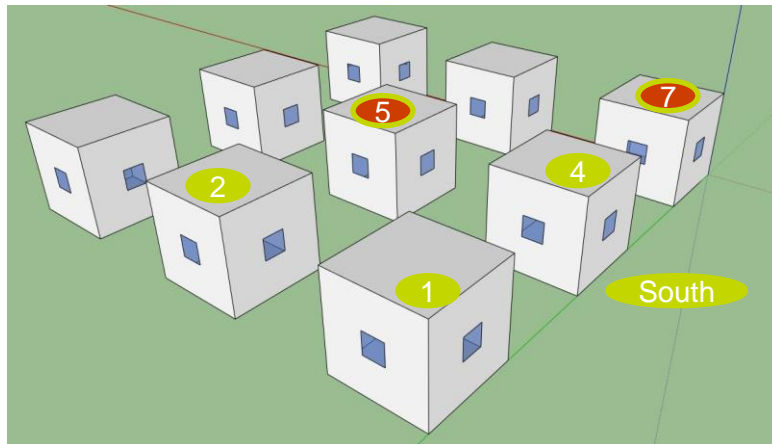


- BuildSysPro: EDF's model library for building energy simulation - written in Modelica under the Dymola environment



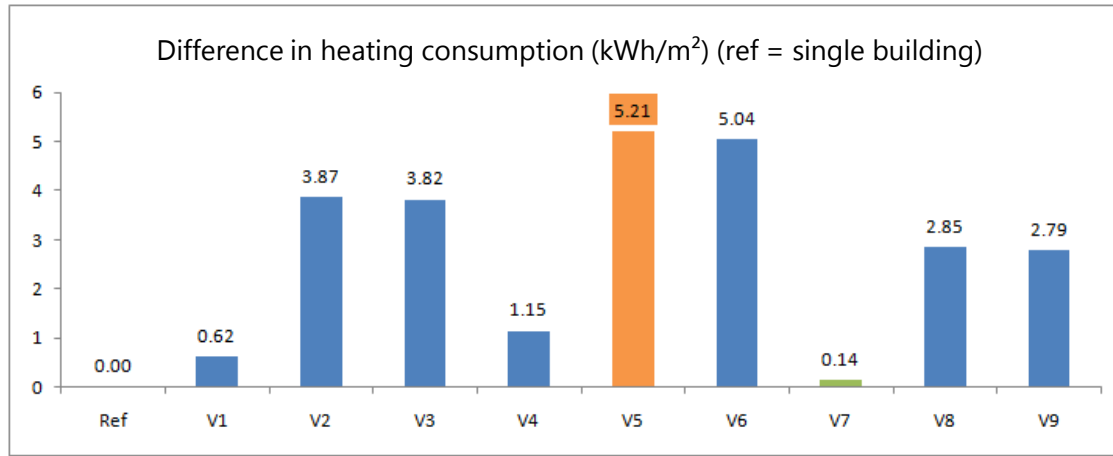
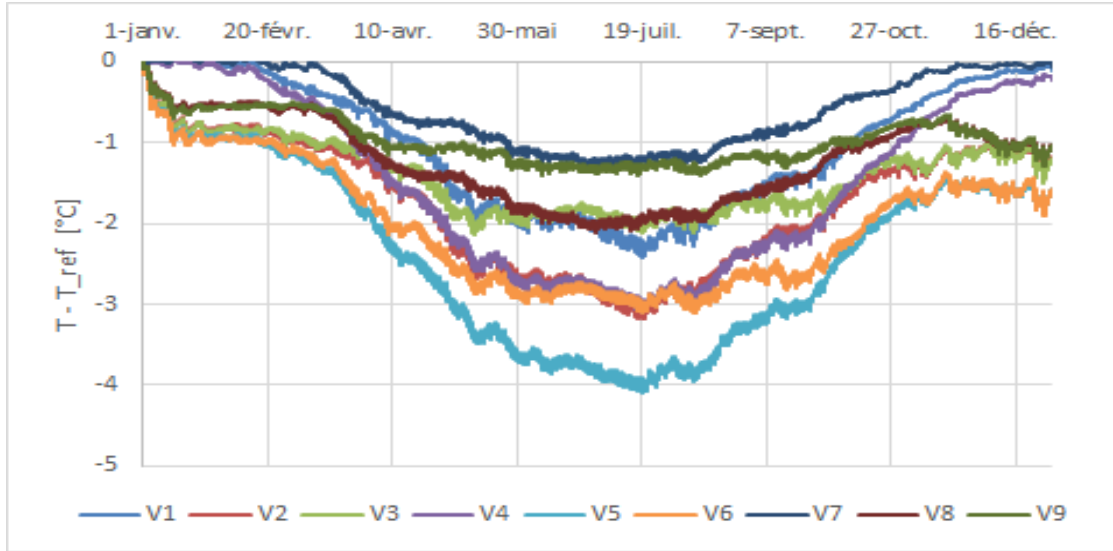
FEASIBILITY: THEORETICAL CASE STUDY

- Theoretical building block
 - Square matrix of low energy individual houses
 - (10m x 10m x 3m), placed 10m from each other



North					
			3	6	9
West			2	5	8
			1	4	7
			South		
			East		

THEORETICAL CASE STUDY: RESULTS FOR HEATING CONSUMPTION

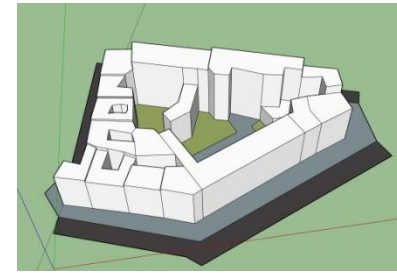
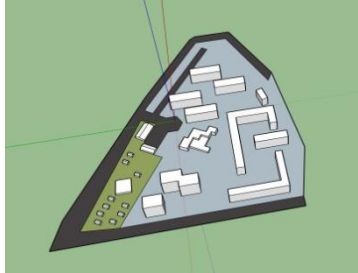


North		
3	6	9
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1	4	7
South		

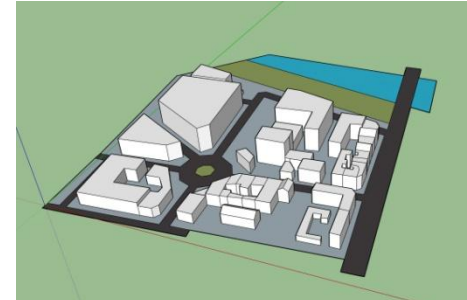
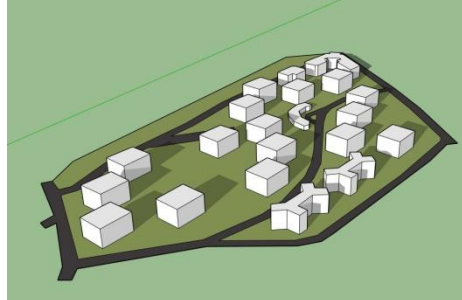
West East

9 REAL CASE STUDIES × 3 CONFIGURATIONS

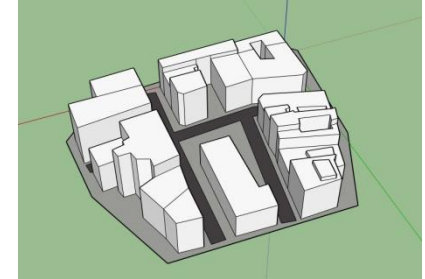
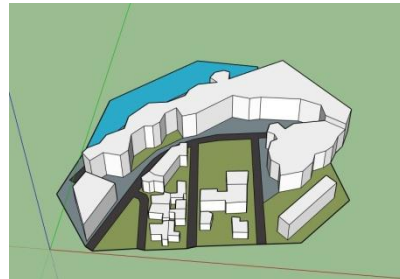
- Individual house near Paris



- Apartment building in Nantes



- Office building in Strasbourg



ARCHITECTURAL ANALYSIS OF THE « NANTES RANZAY » CITY BLOCK



Cadastral map
Plot n°1 – Sheet 000
RV 01
City of Nantes

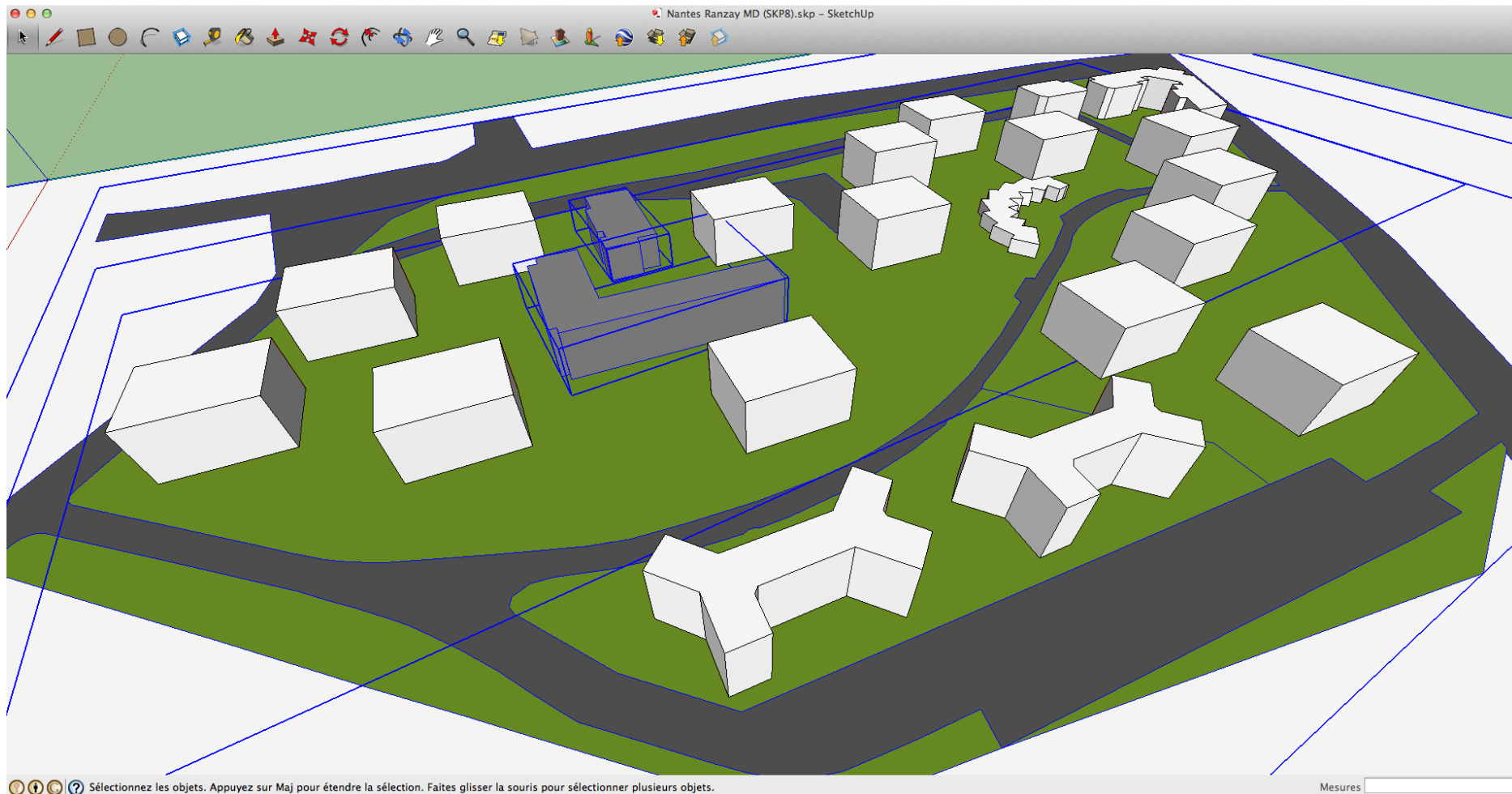


Google Maps
location plan

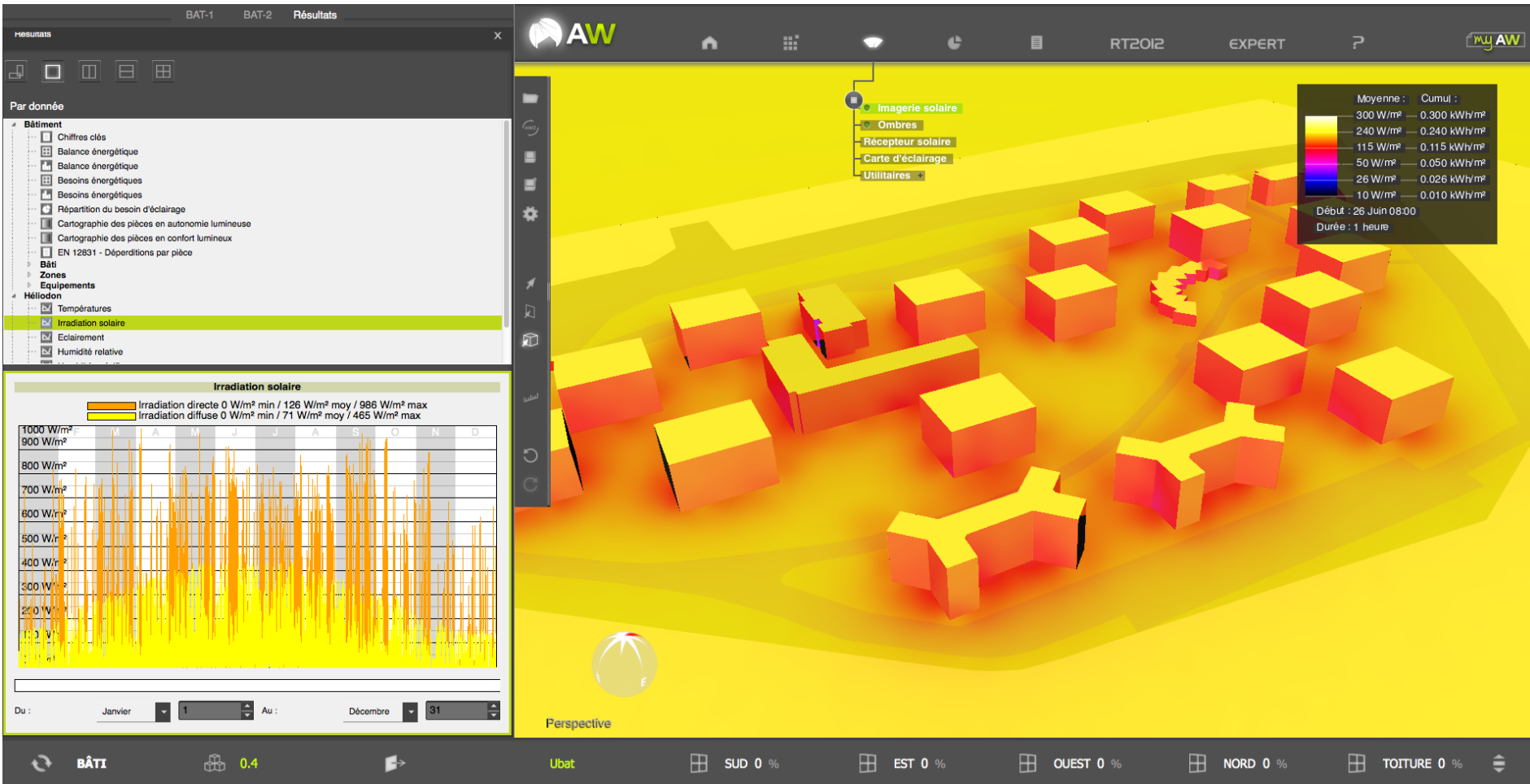
New building layout plan



SKETCHUP 3D MODEL



SOLAR RADIATION CALCULATION (ARCHIWIZARD)



BUILDSYSPRO STUDY

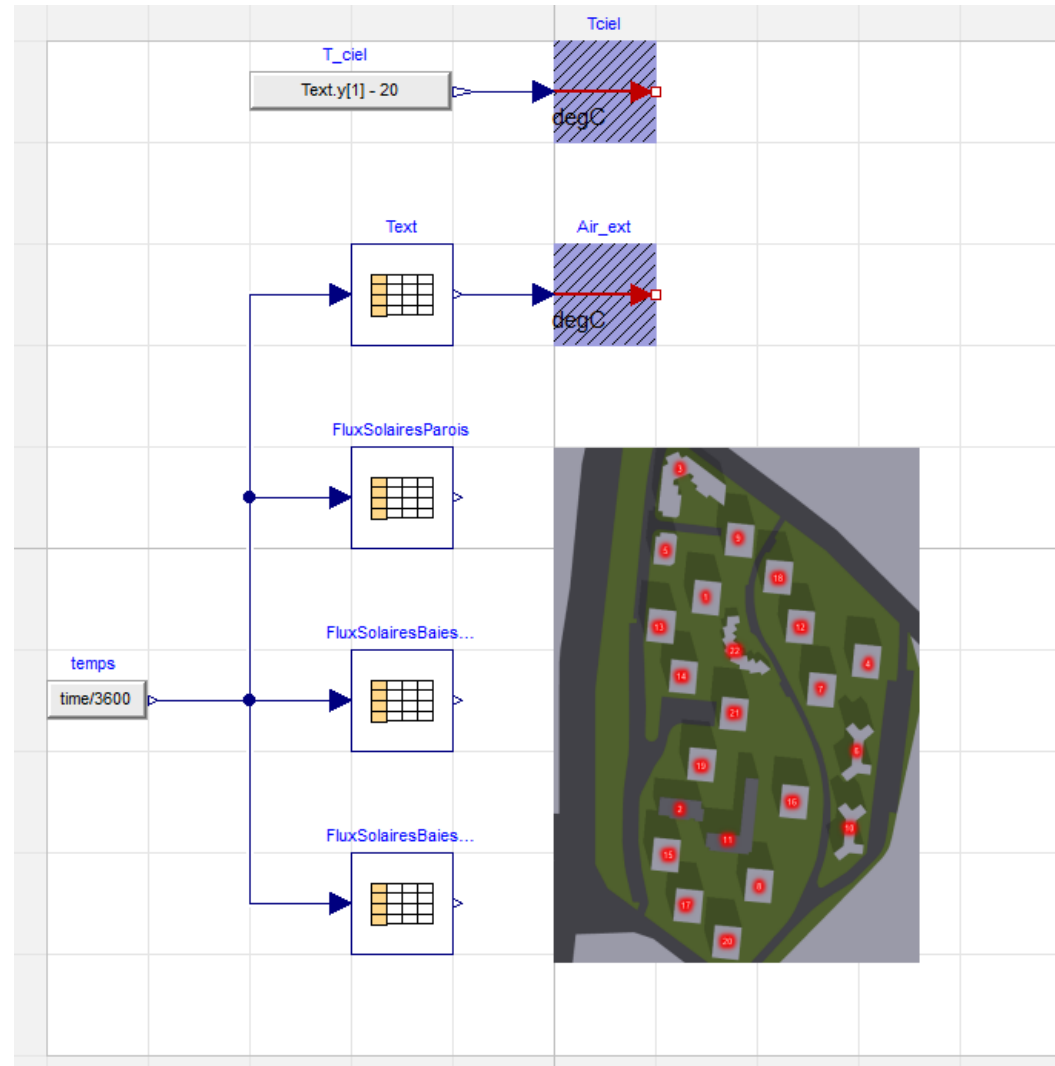
- **Physical phenomena:**

- Air renewal
- Thermal bridges
- Global radiation on walls
- Direct and diffuse radiation on windows
- Long-wave radiation exchange:
 - Between walls
 - With the sky
 - With the ground)

- 1 studied configuration: whole city block (new buildings included)

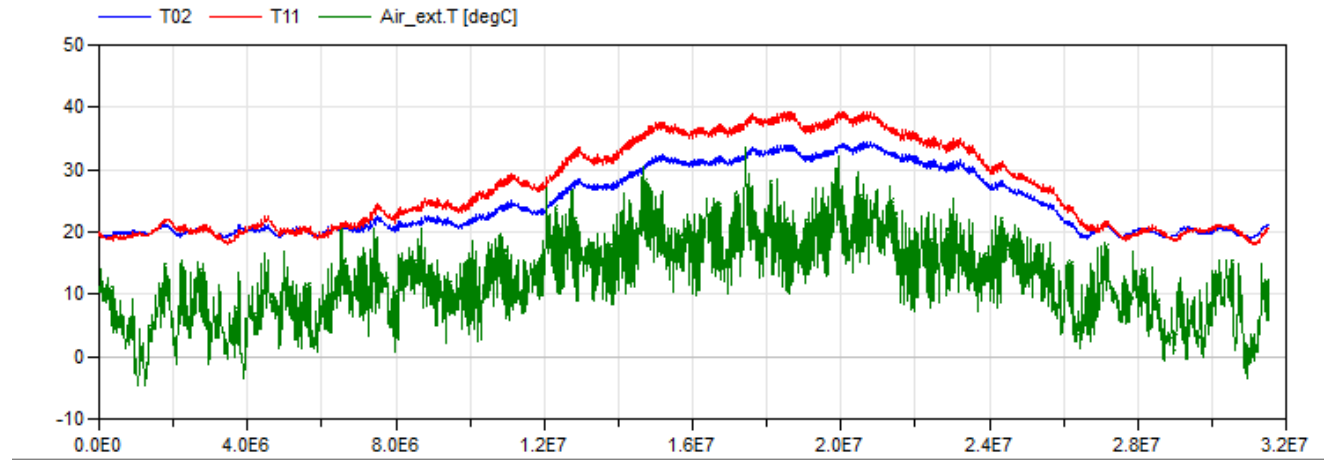
- 2 simulations

- With sun
- Without sun

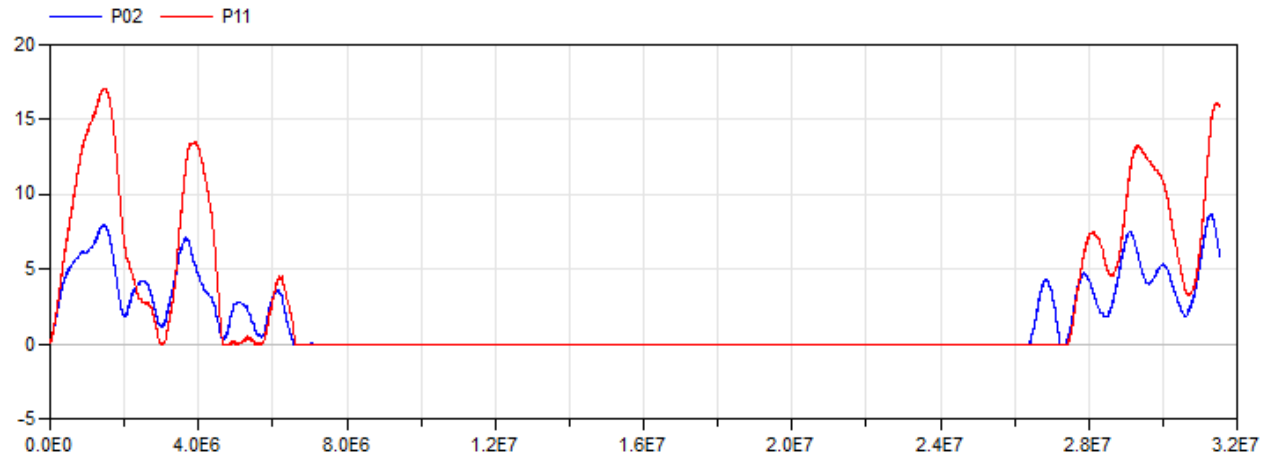


SIMULATION RESULTS WITH SUN

Temperatures [°C]

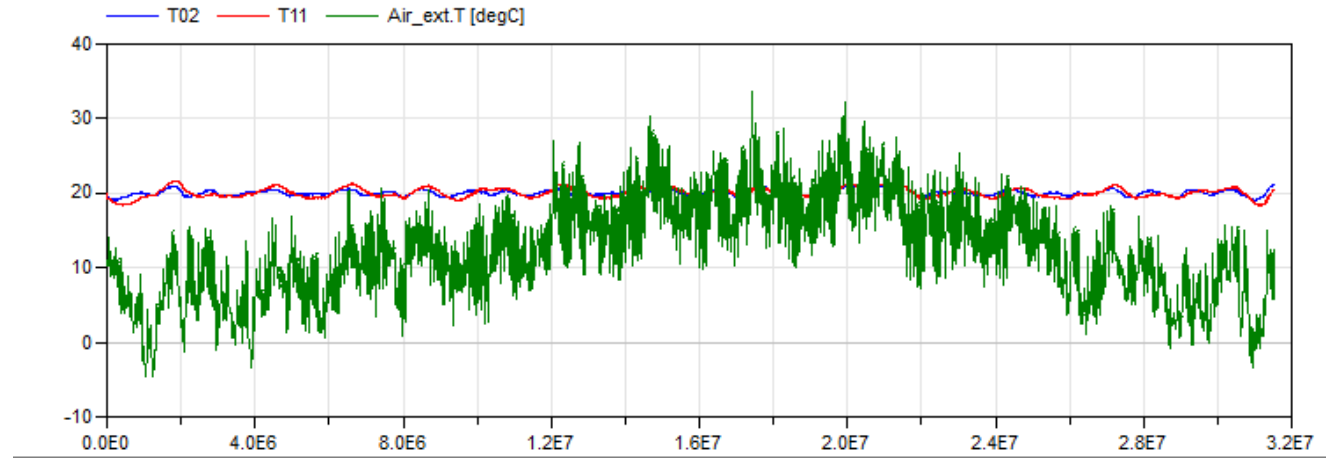


Heating load [kW]

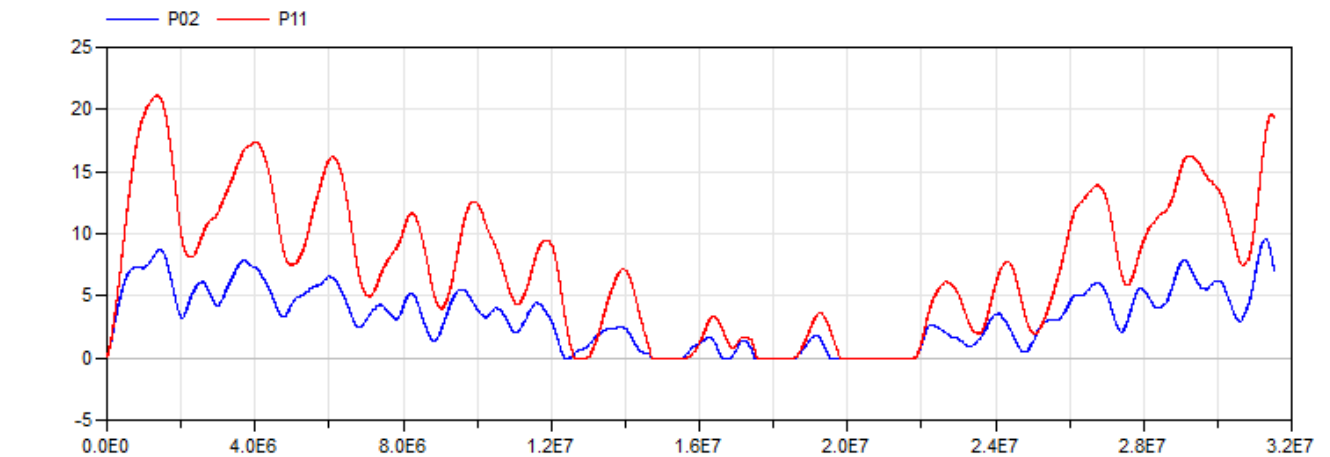


SIMULATION RESULTS WITHOUT SUN

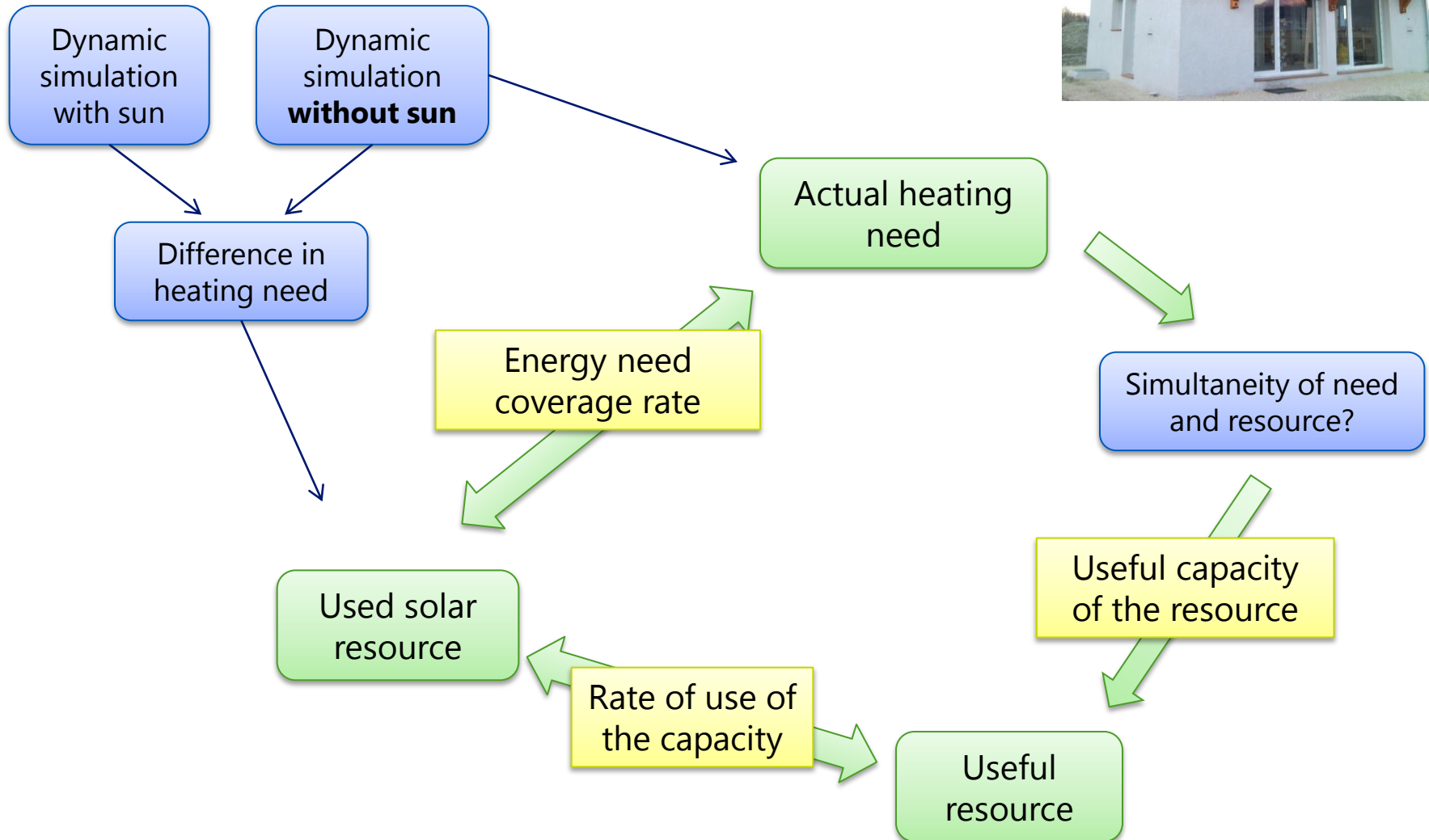
Temperatures [°C]



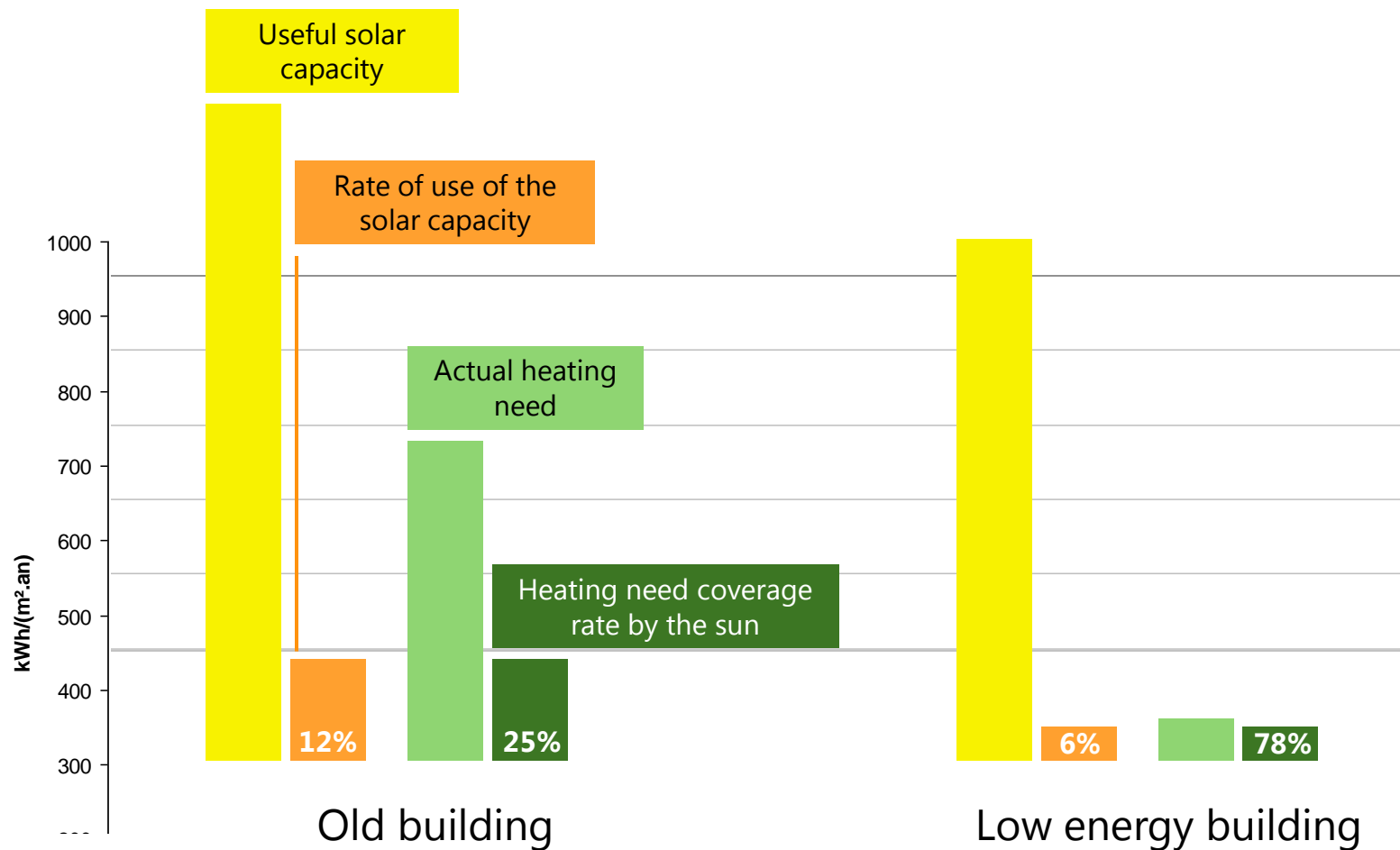
Heating load [kW]



BIOCLIMATIC INDICATORS FOR A SOLAR HOUSE



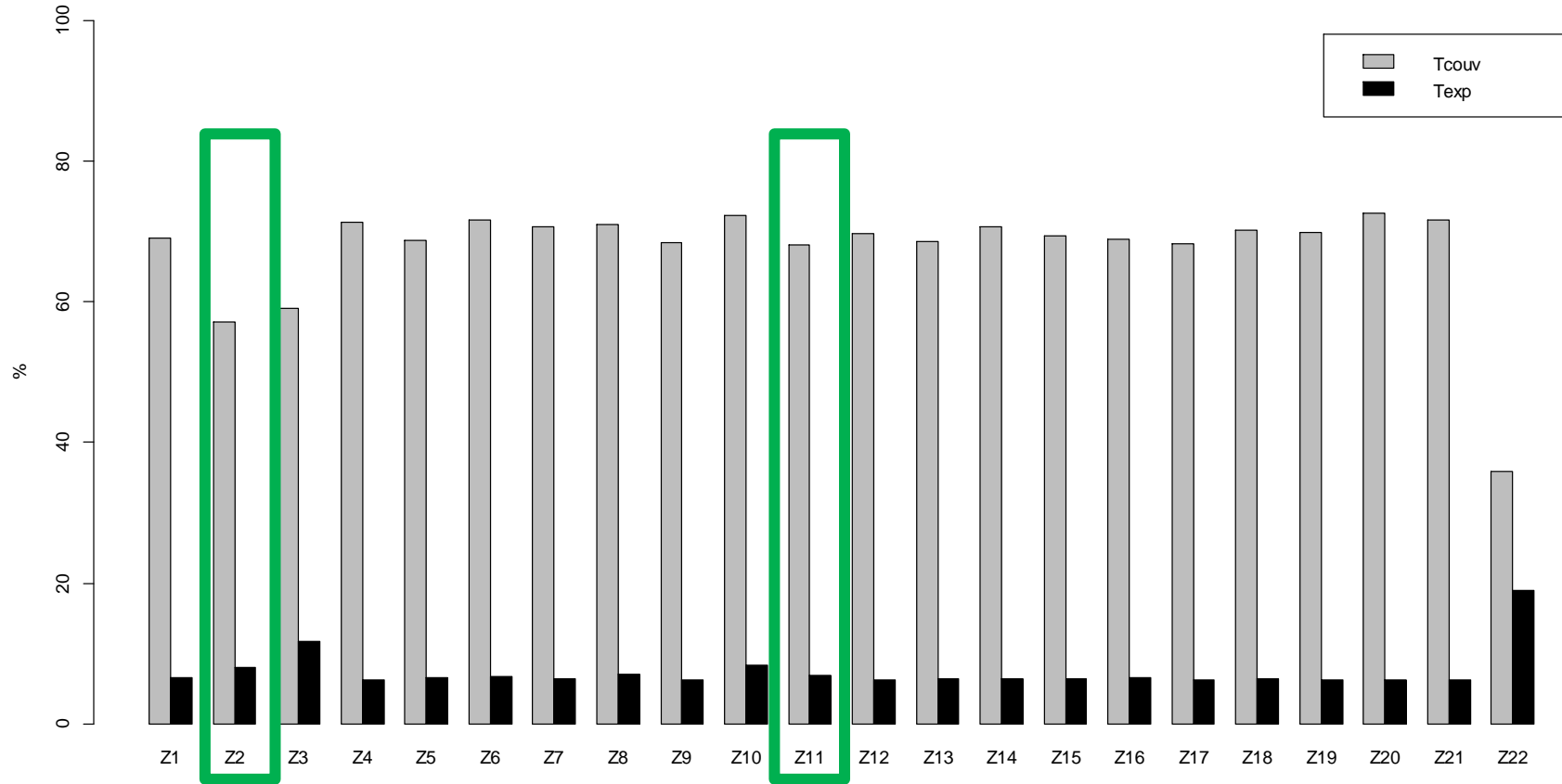
BIOCLIMATIC INDICATORS OF THE SOLAR RESOURCE FOR THE HEATING NEED



RESULTS POST-PROCESSING

COVERAGE RATES

Taux de couverture des besoins et d'exploitation du soleil



PERSPECTIVES

- For optimization, it is necessary to switch from detailed to reduced order building models
- Studying the impact of our findings on new design methods with help of the architects
- Identified challenging tasks:
 - Multi-criteria optimization and economical optimization mechanisms
 - Availability of sufficient and relevant data on existing city blocks
- Promising elements have been detected:
 - Convincing link between 3D CAD-views and 0D/1D detailed energy modeling (with a « BIM » spirit)
 - Introducing local micro-climate in building simulation tools
 - A positive adoption by architects

THANK YOU FOR YOUR ATTENTION