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## Towards Context & Climate Sensitive Urban Design An integrated simulation and parametric design approach

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# Towards Context & Climate Sensitive Urban Design

## An integrated simulation and parametric design approach

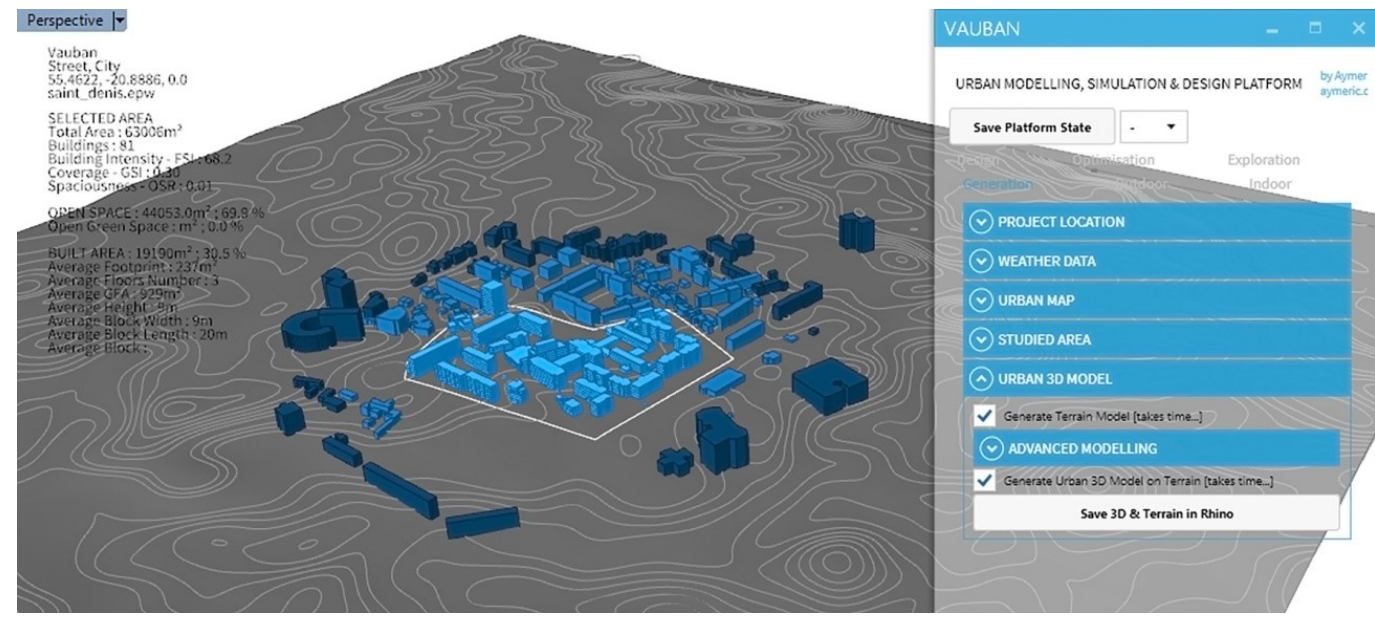
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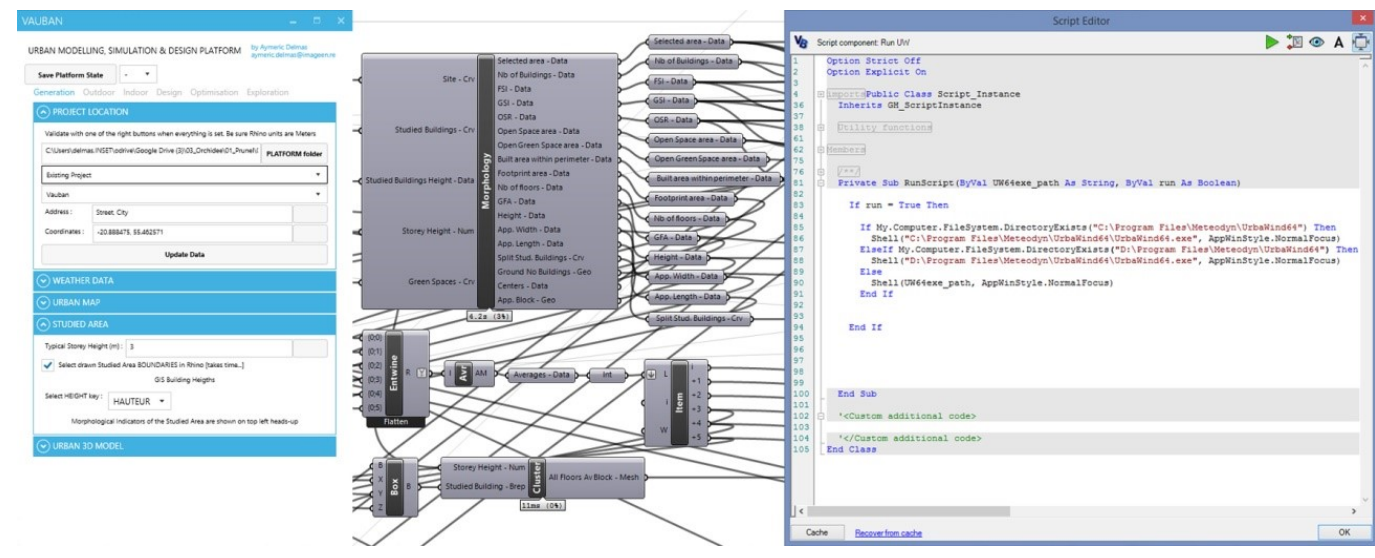
### DESIGN PLATFORM & FRAMEWORK

#### Supporting urban bioclimatic design

To implement the concept of integrated design, an urban **modelling, simulation and design** platform was developed. It embeds a design framework built upon the strengths of **parametric modelling** and existing **building performance simulation tools**.

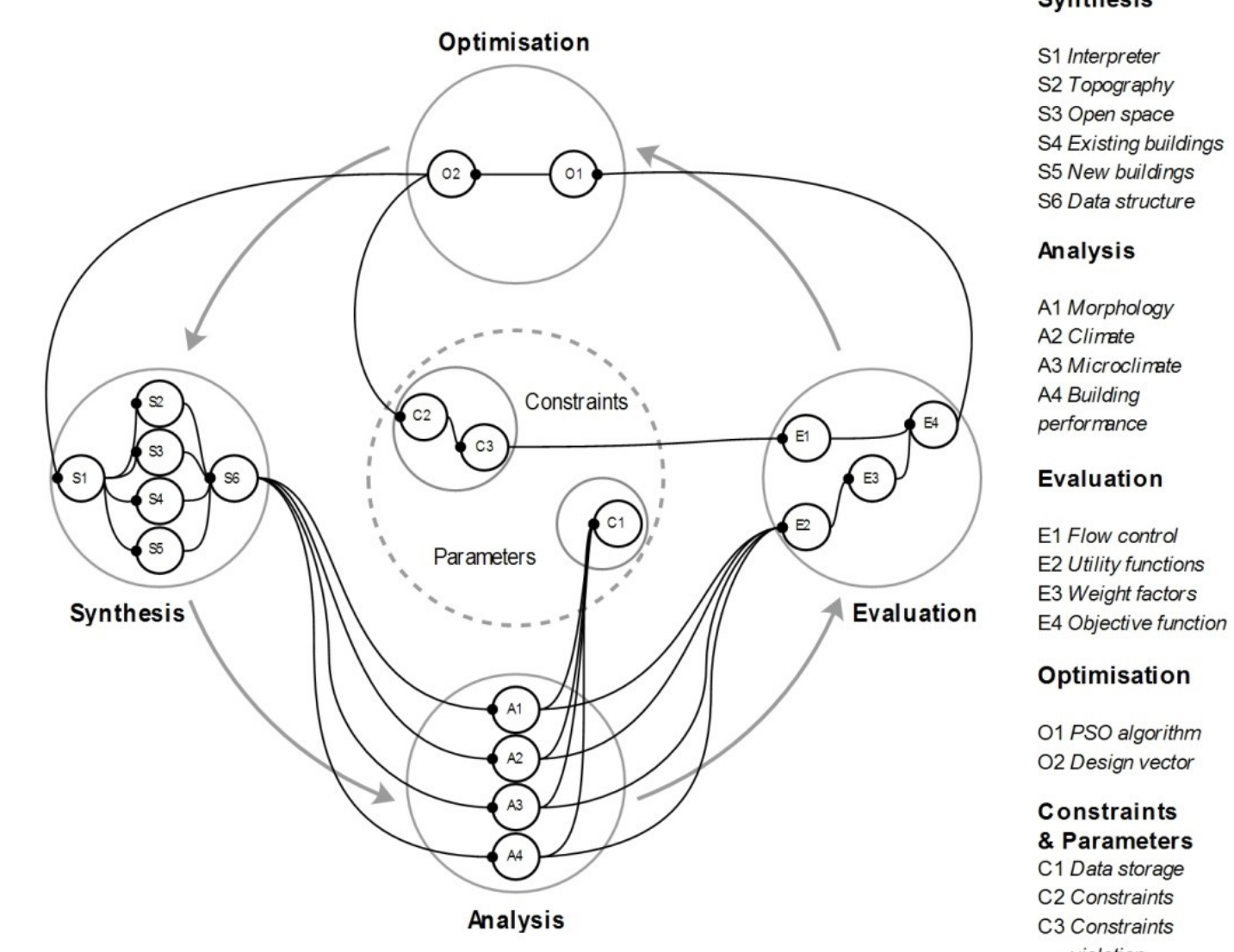


**Platform overview**  
 Rhino's viewport integrated user interface and urban 3D model



**Platform levels of transparency**  
 User interface, directed acyclic graph and textual code

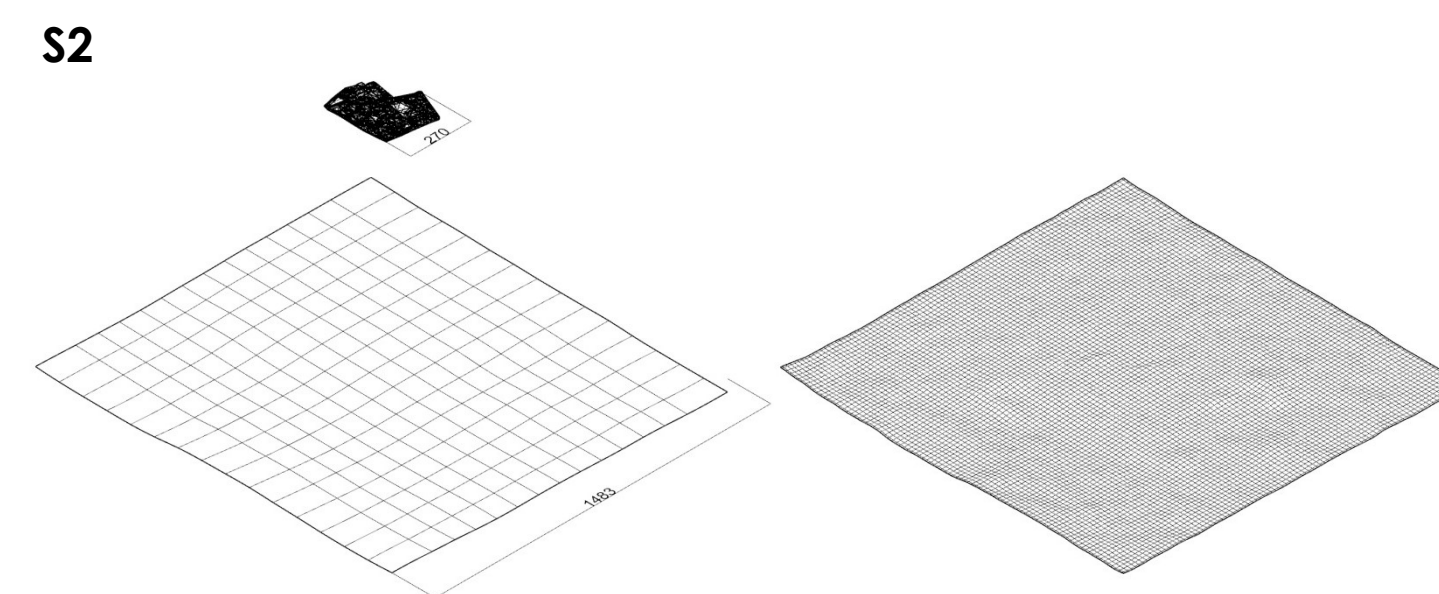
The **centralisation** of the synthesis, analysis, evaluation and optimisation **activities** in a single interface helps to support the integrated design concept. Data exchange and treatment allow **informing** both the simulation tools and the design process in terms of context and climate consideration.



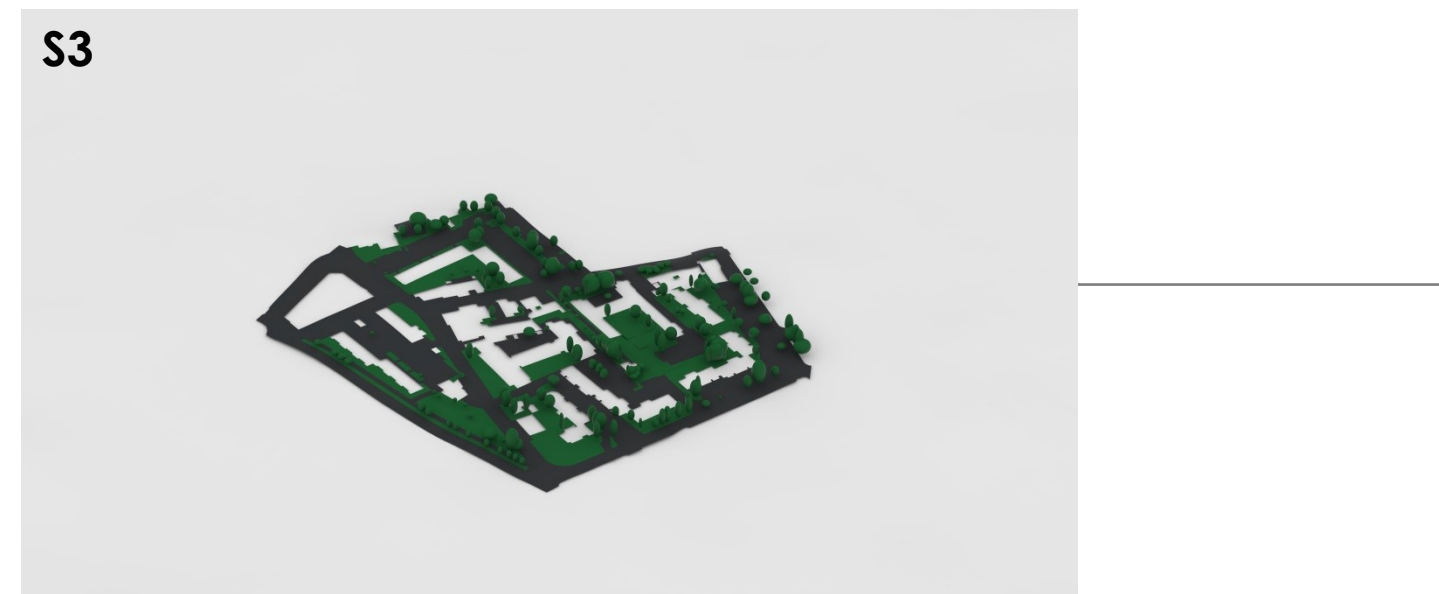
**Design framework**  
 The context and climate sensitive urban design framework

### SYNTHESIS

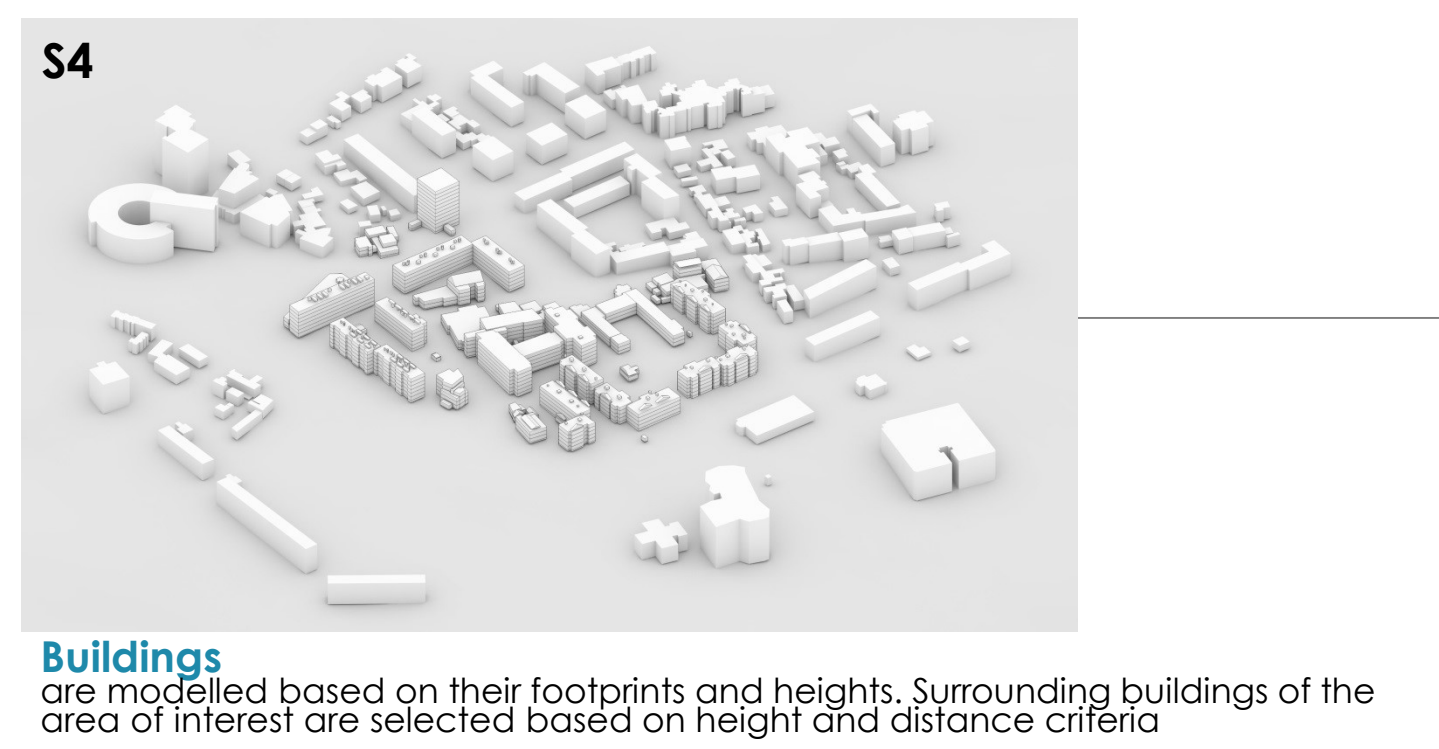
#### Parametric generation of the urban environment



**Topography**  
 A sampling script allows matching measured elevation (3m grid) of the studied area with larger satellite elevation of the surrounding terrain (SRTM 30m grid)

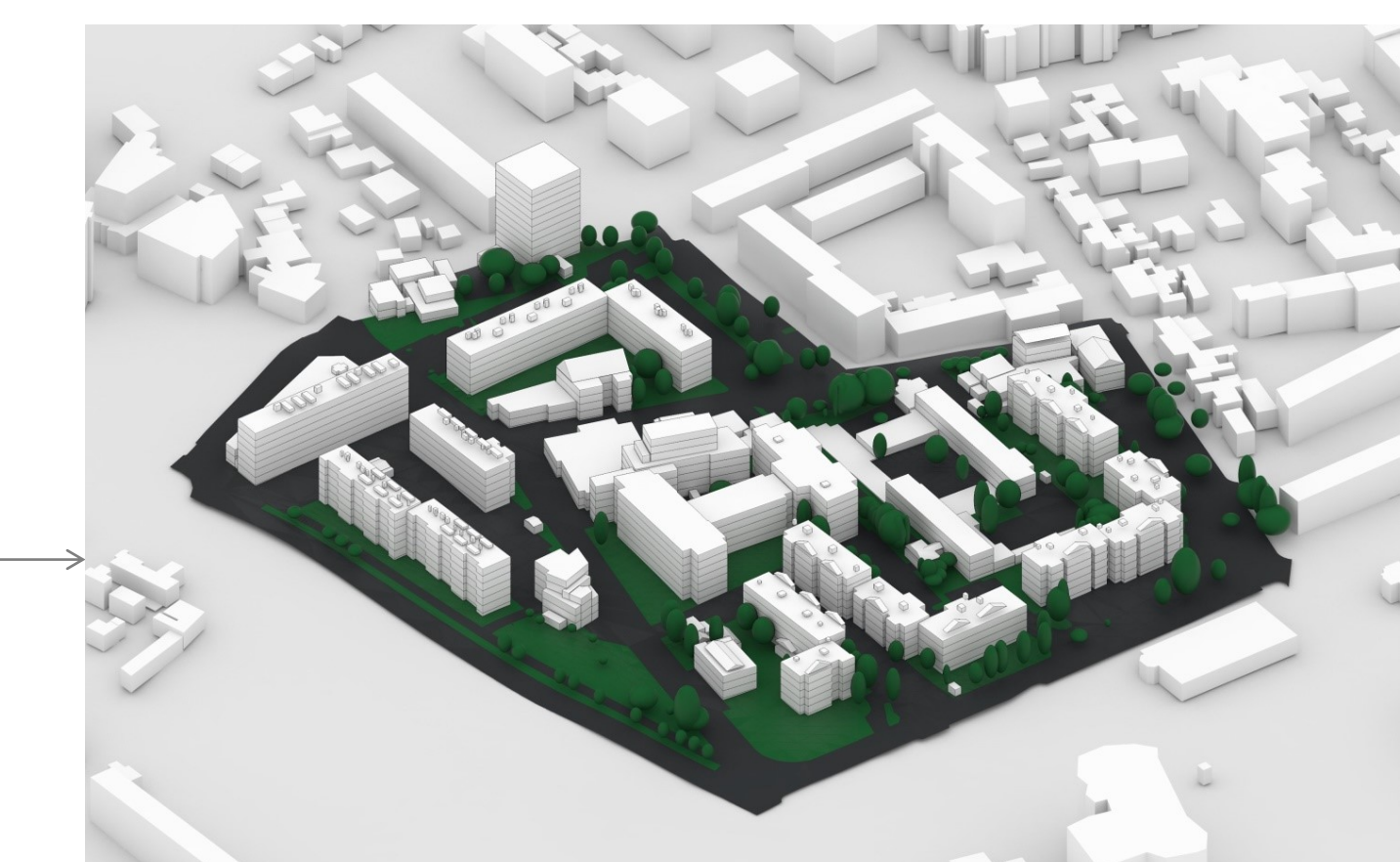


**Open spaces & natural elements**  
 are modelled based on measurements (or GIS data) of their boundaries. Trees are modelled as ovoids based on surveyed characteristics (height, width, density)



**Buildings**  
 are modelled based on their footprints and heights. Surrounding buildings of the area of interest are selected based on height and distance criteria

The parametric modelling capacities of the software pair Rhinoceros-Grasshopper are used to generate a synthesis model of **interrelated urban elements**. Topography, buildings, open spaces and natural elements are connected with each other in an algorithmic relation.



**Combined urban 3D model**  
 Vauban neighbourhood, case study located in St-Denis, La Réunion

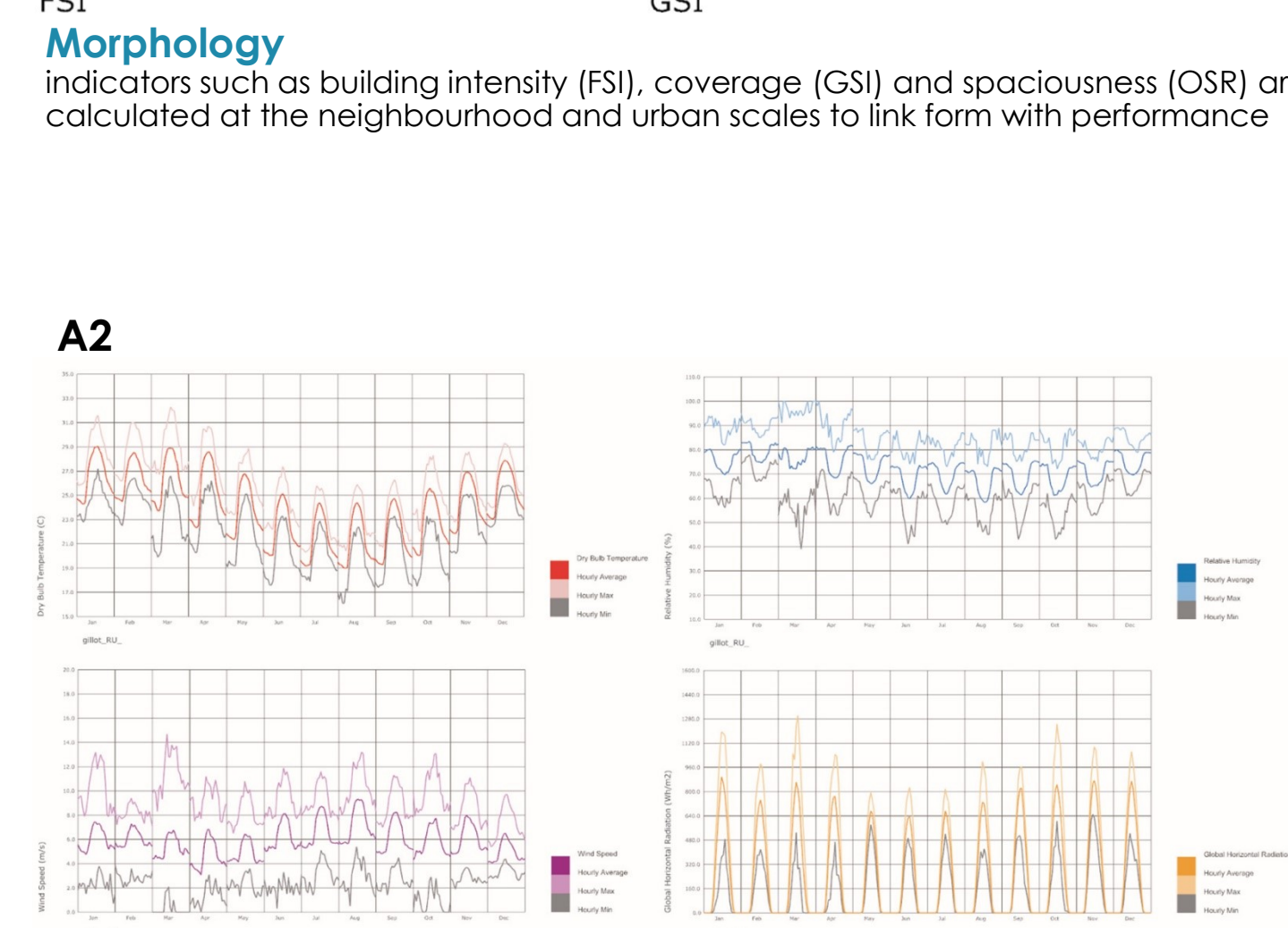
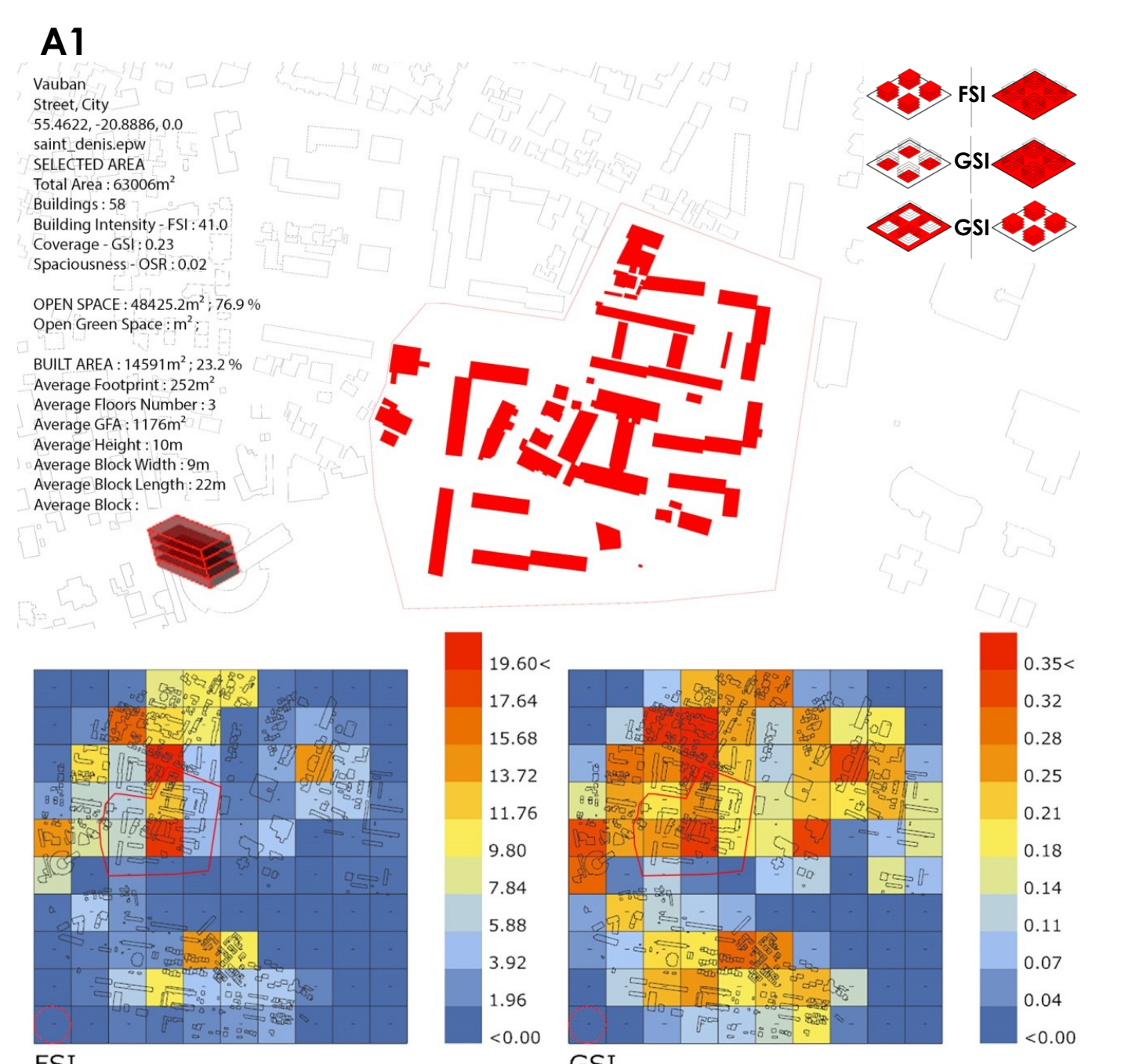


**Bioclimatic strategies & new building blocks**  
 Generative definitions of context sensitive blocks and urban interventions are integrated and can be optimised

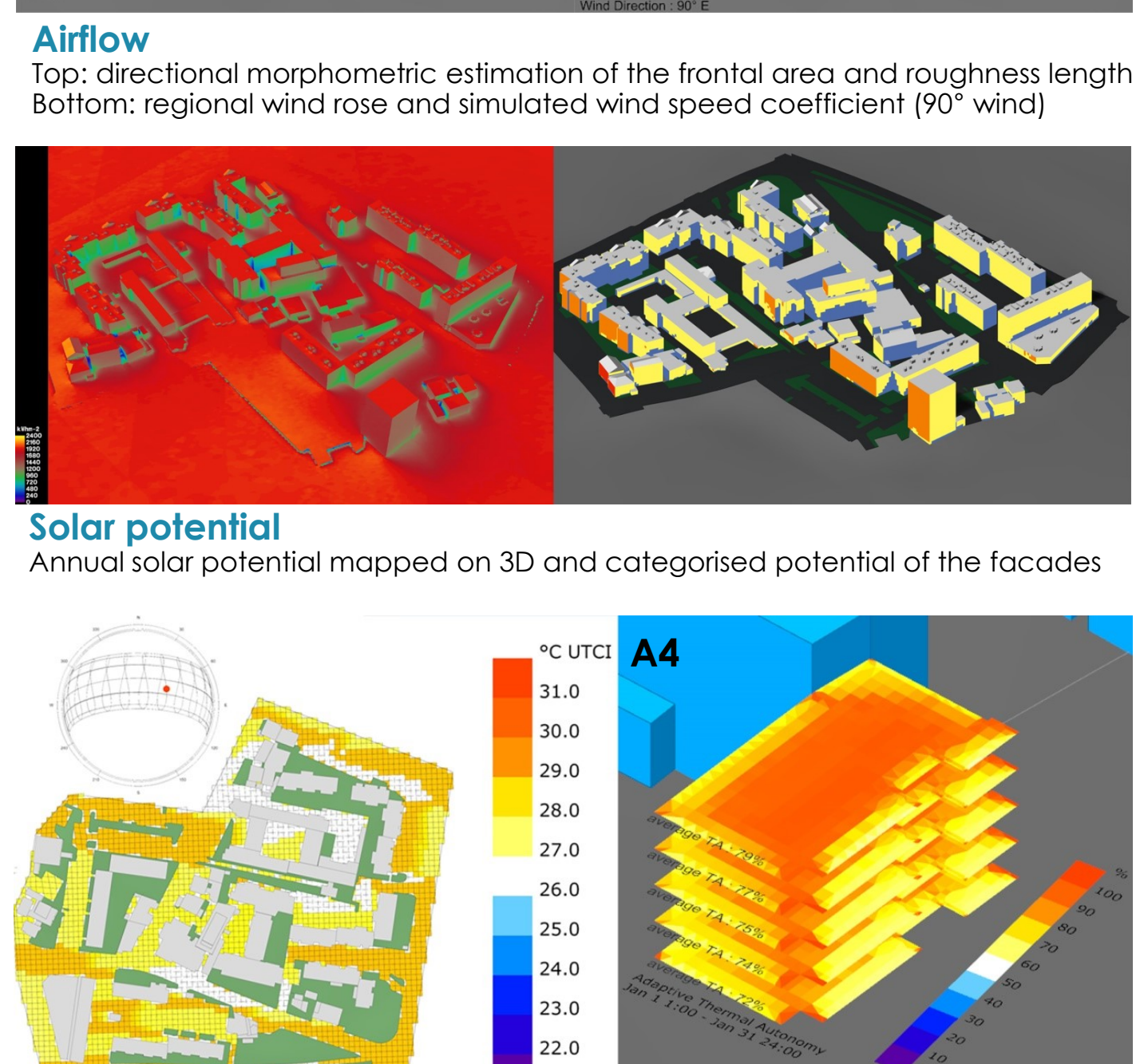
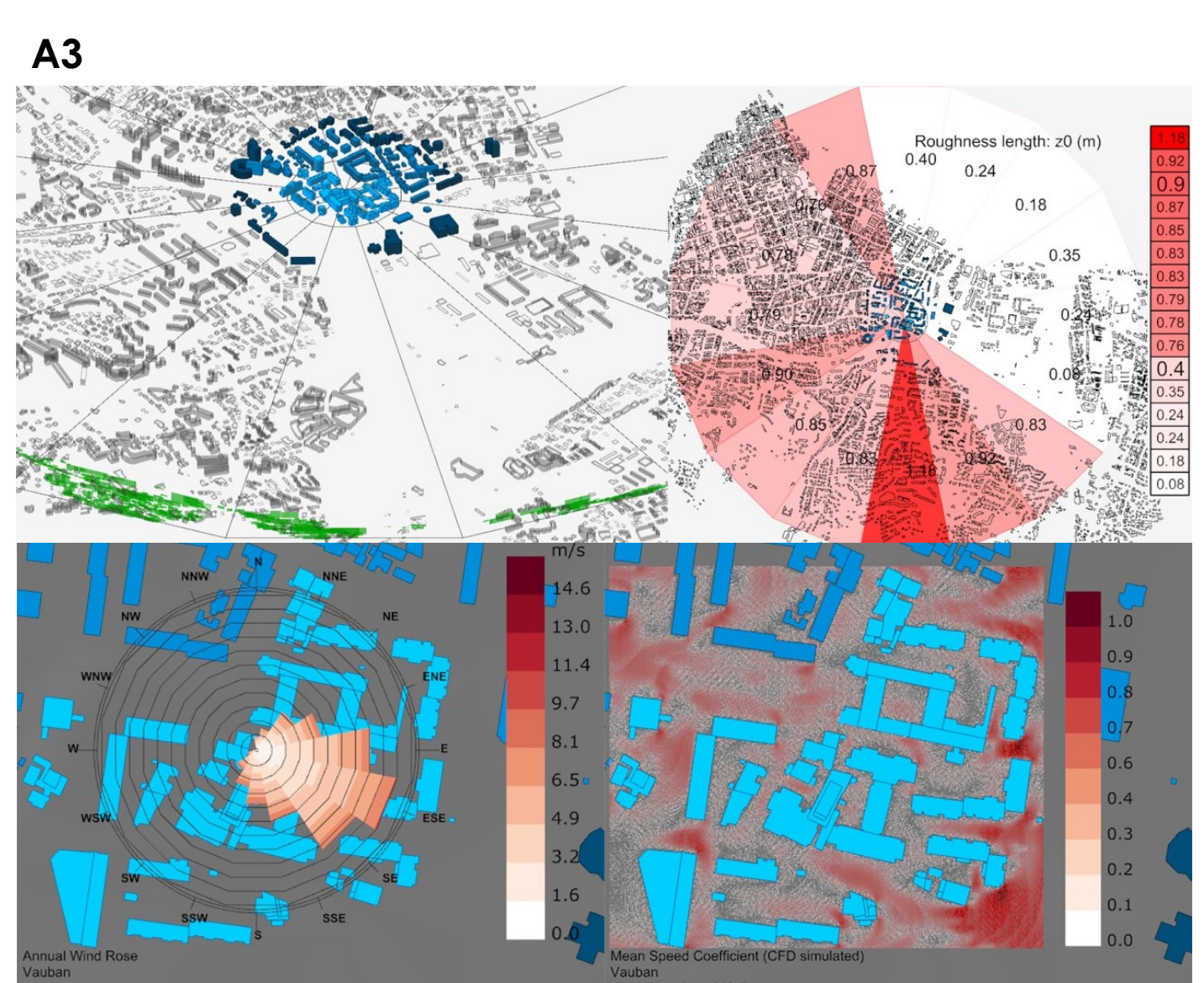
### ANALYSIS

#### & simulation of the outdoor and indoor conditions

The **complex relationships** between **form** and **environmental performance** are analysed thanks to several mathematical models with different level of fidelity. All analysis models use the unique parametric synthesis urban model so that any **morphological, topological** or data change will influence the whole data.



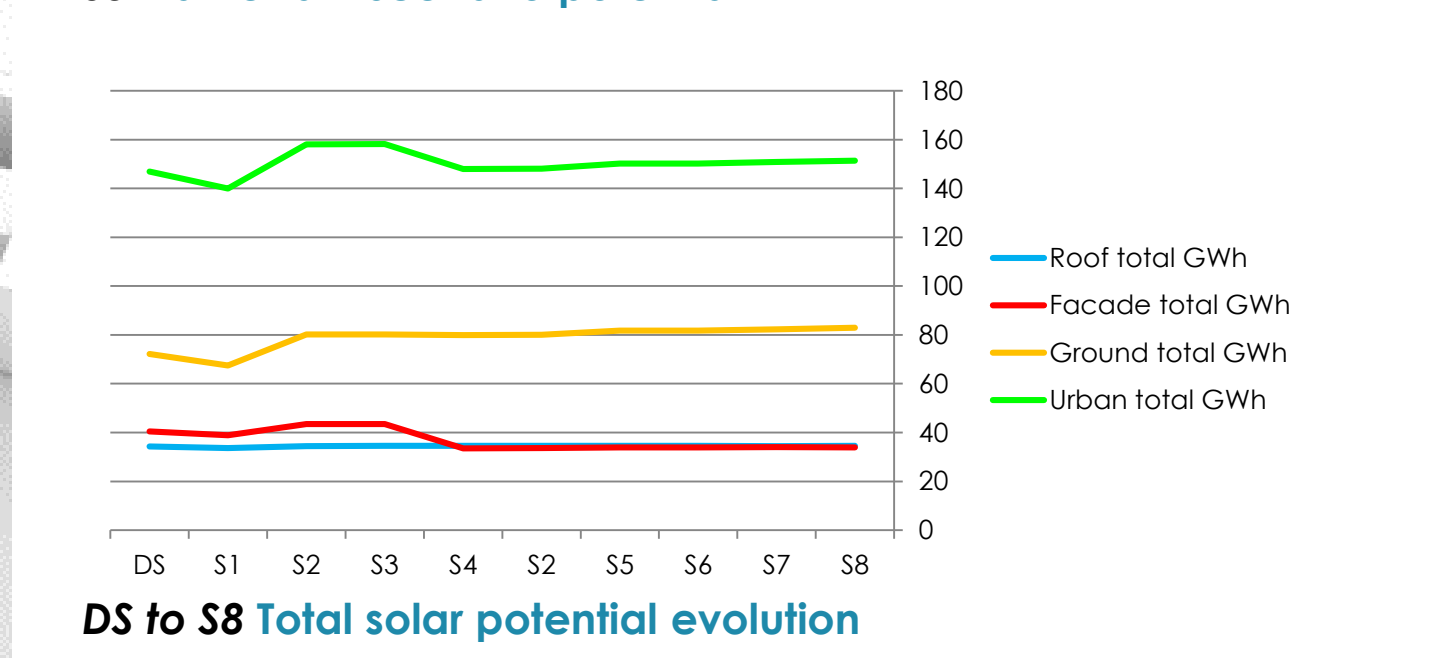
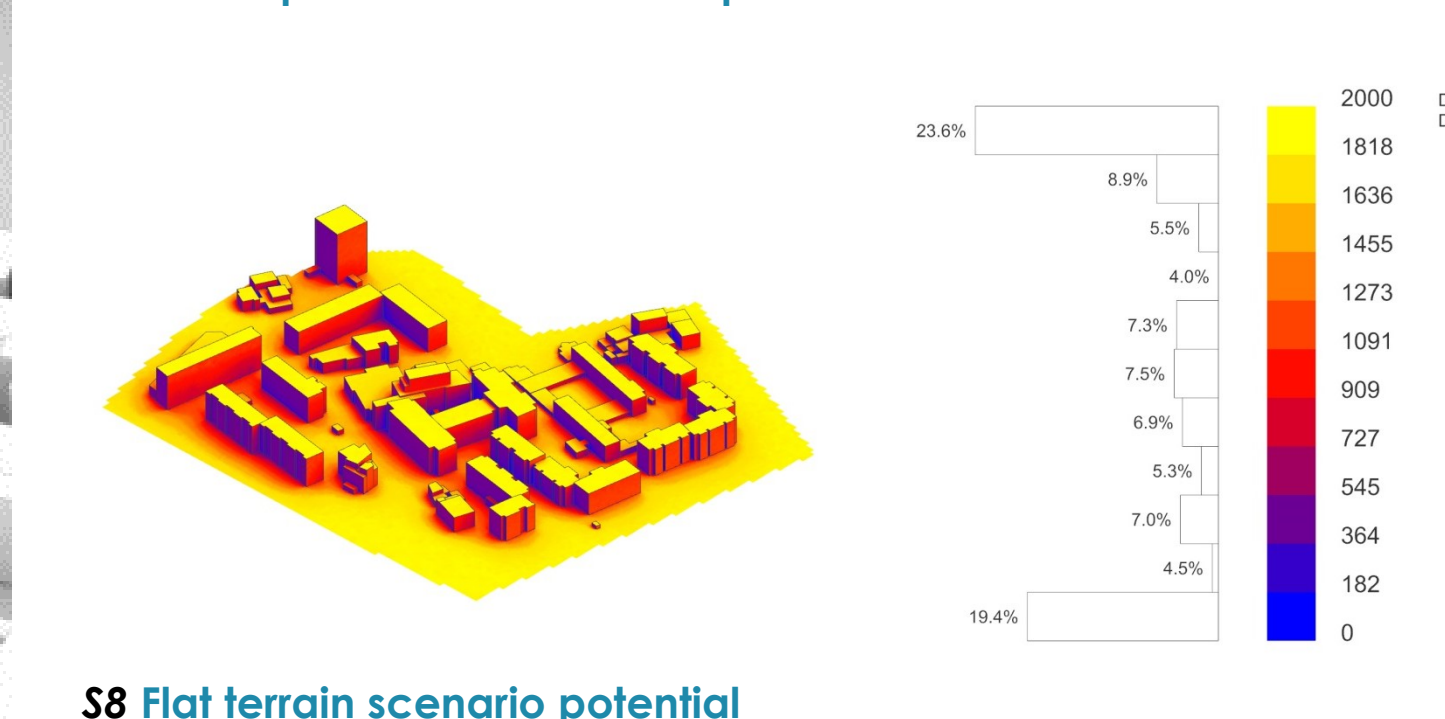
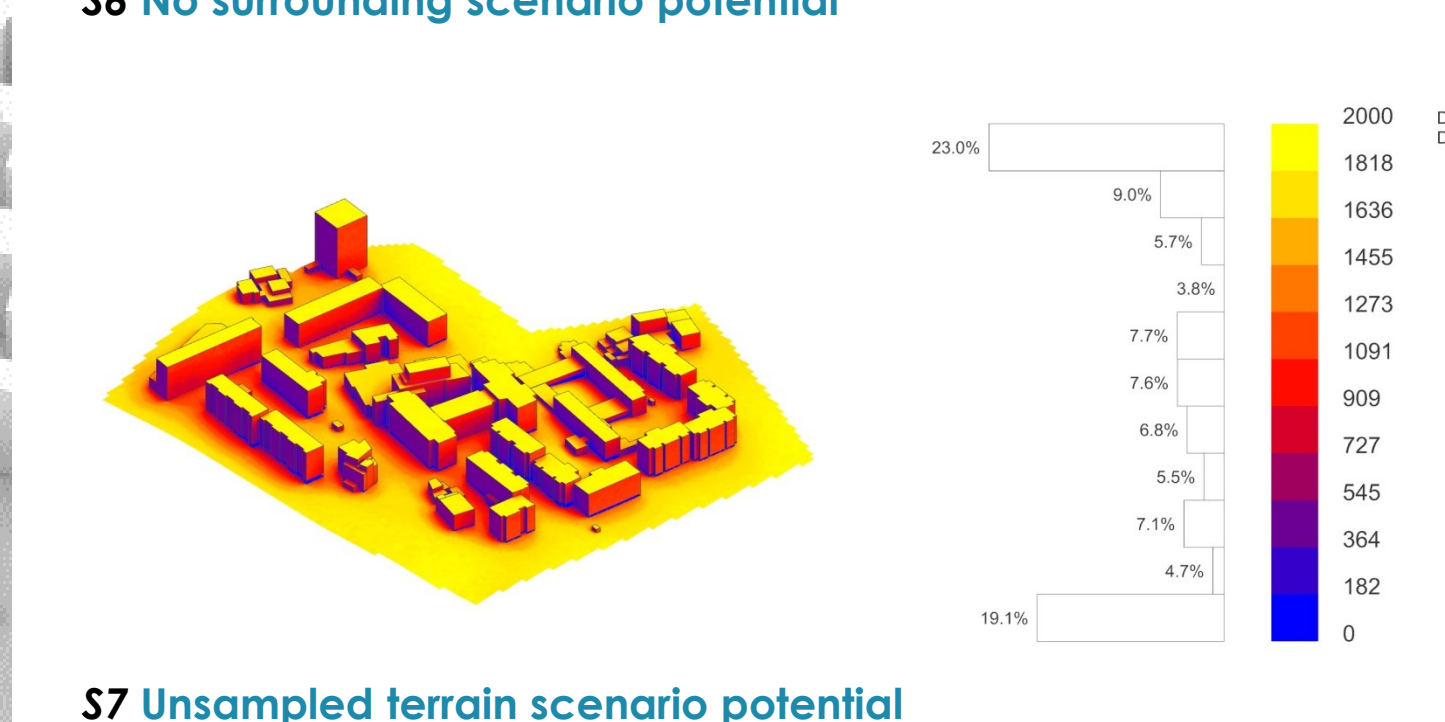
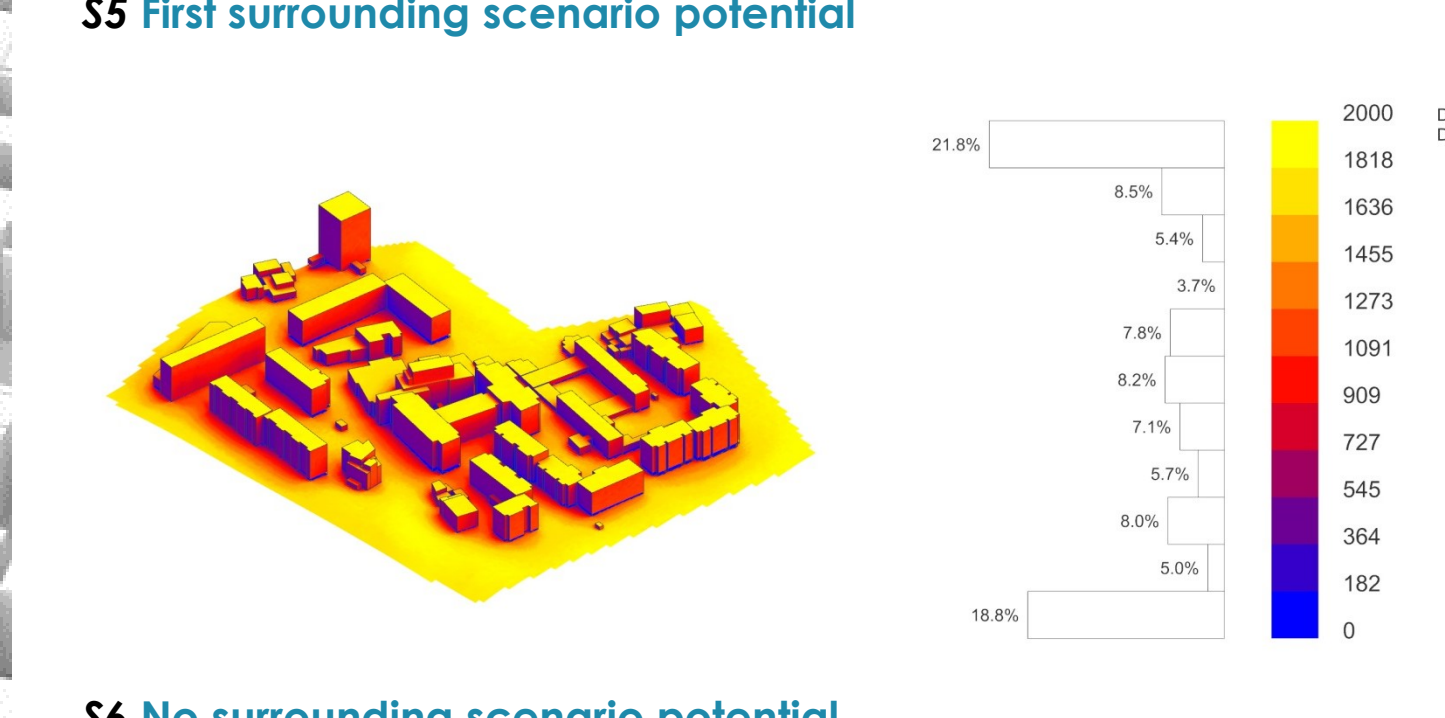
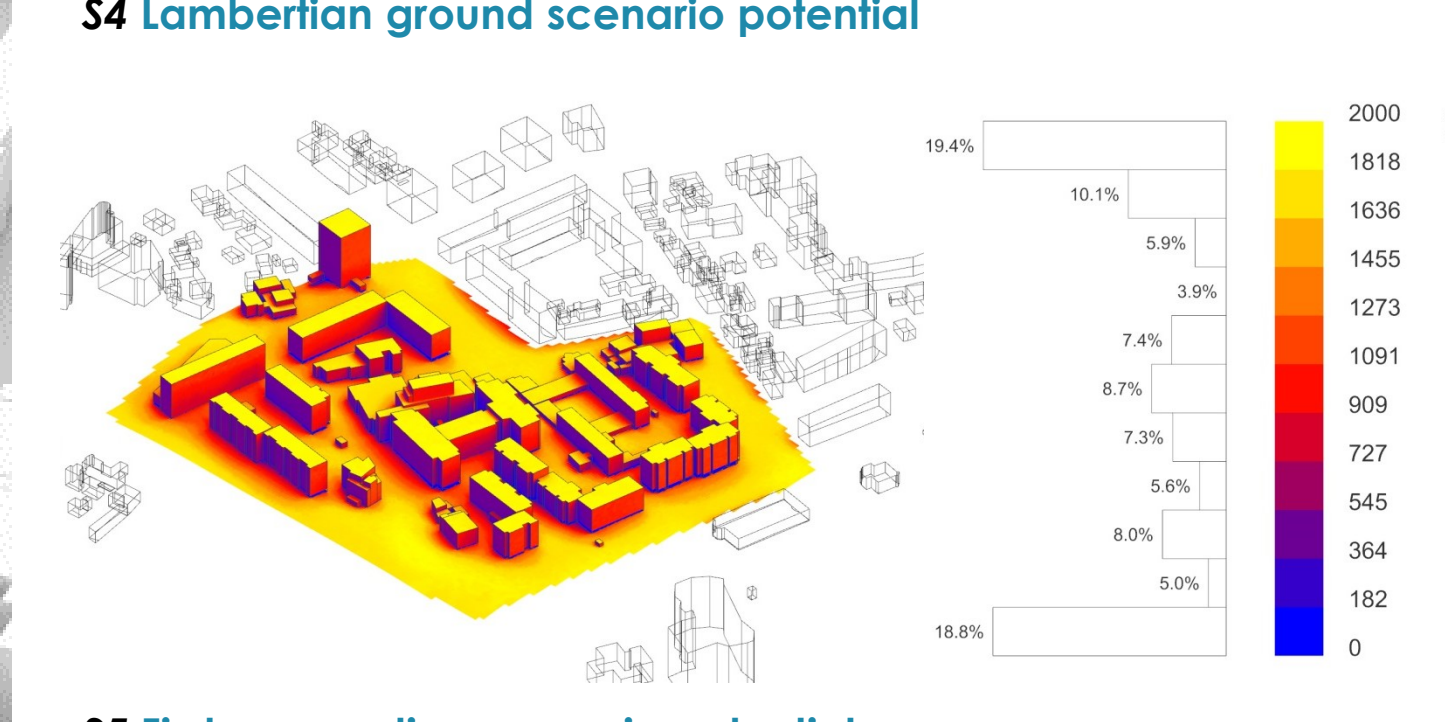
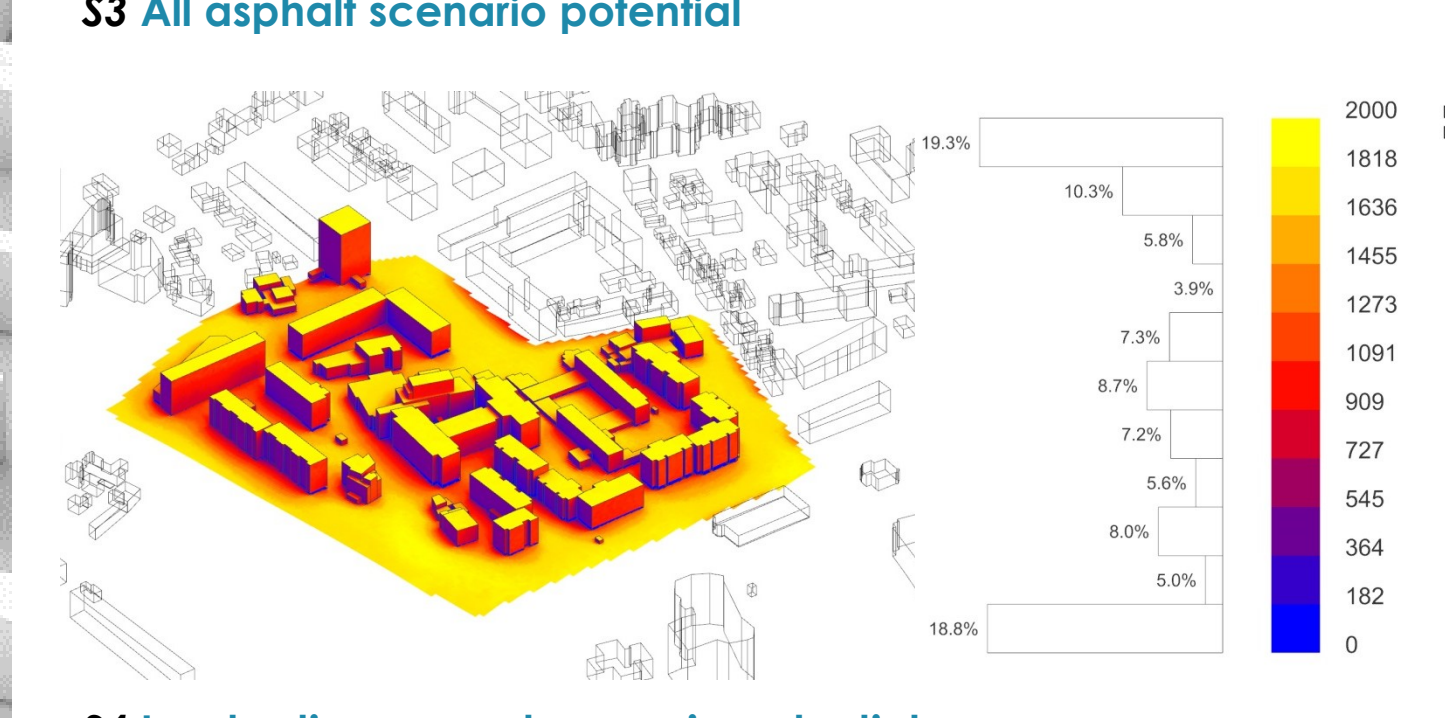
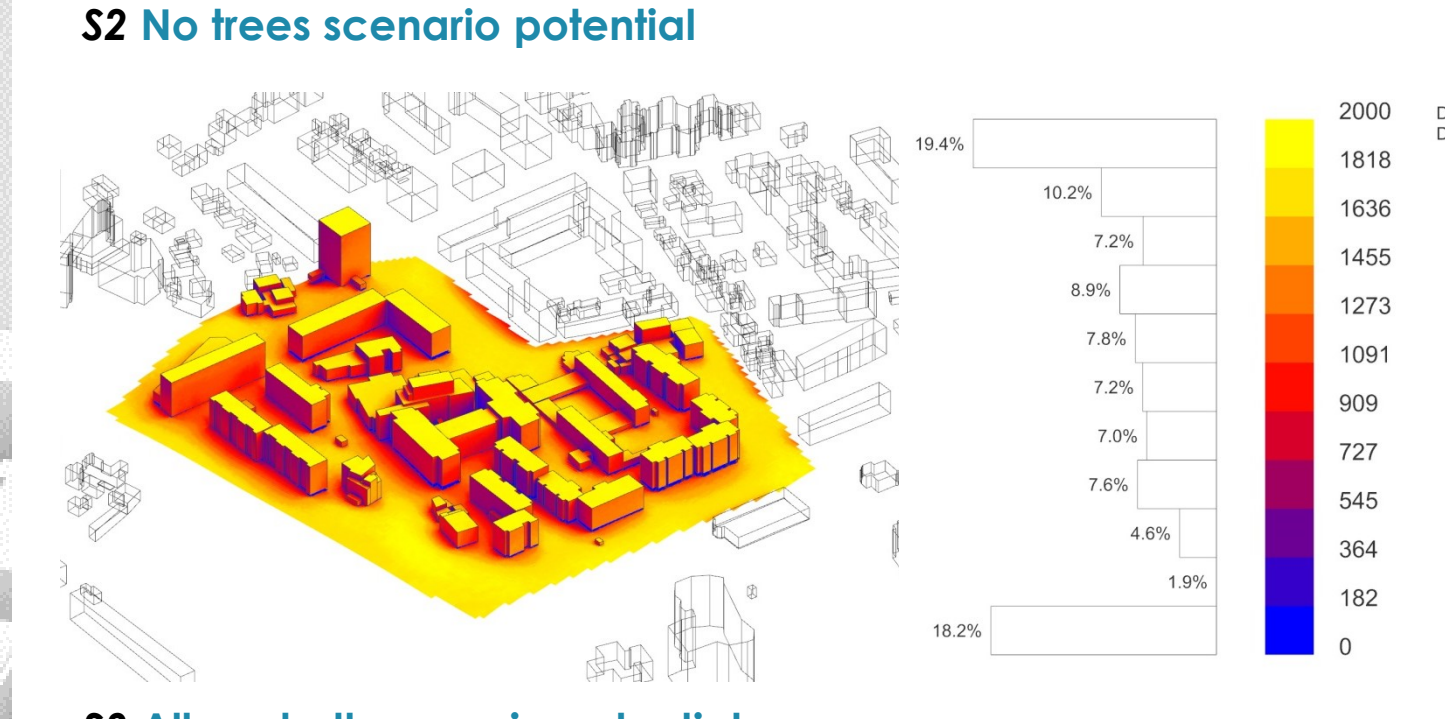
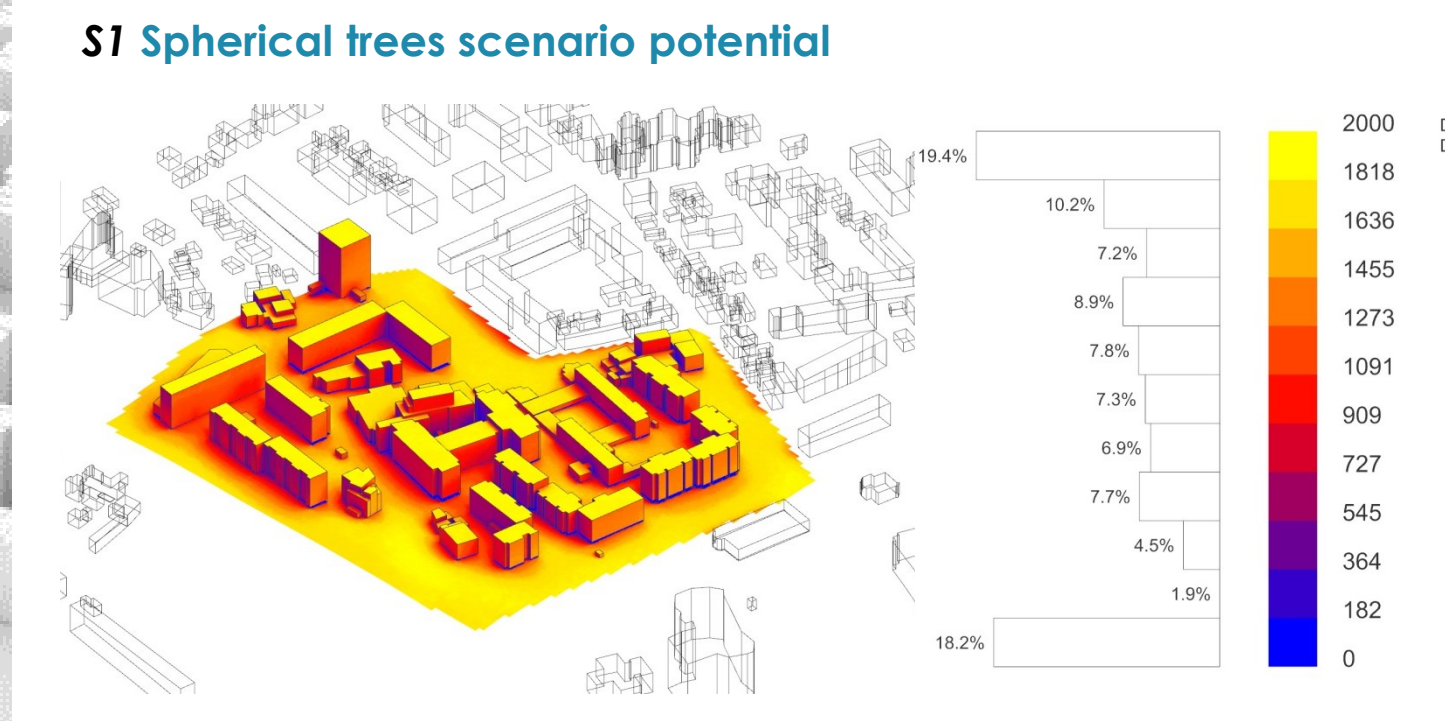
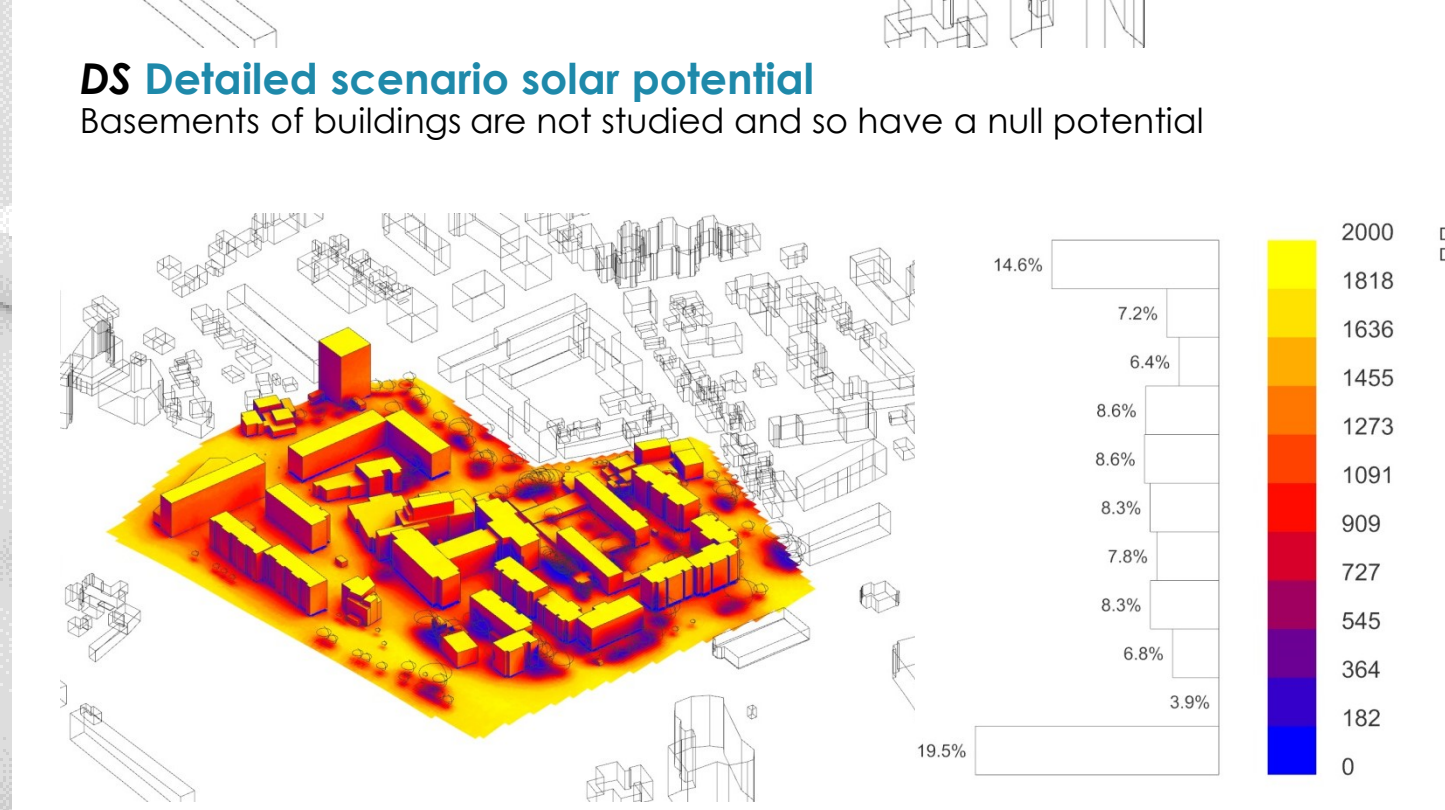
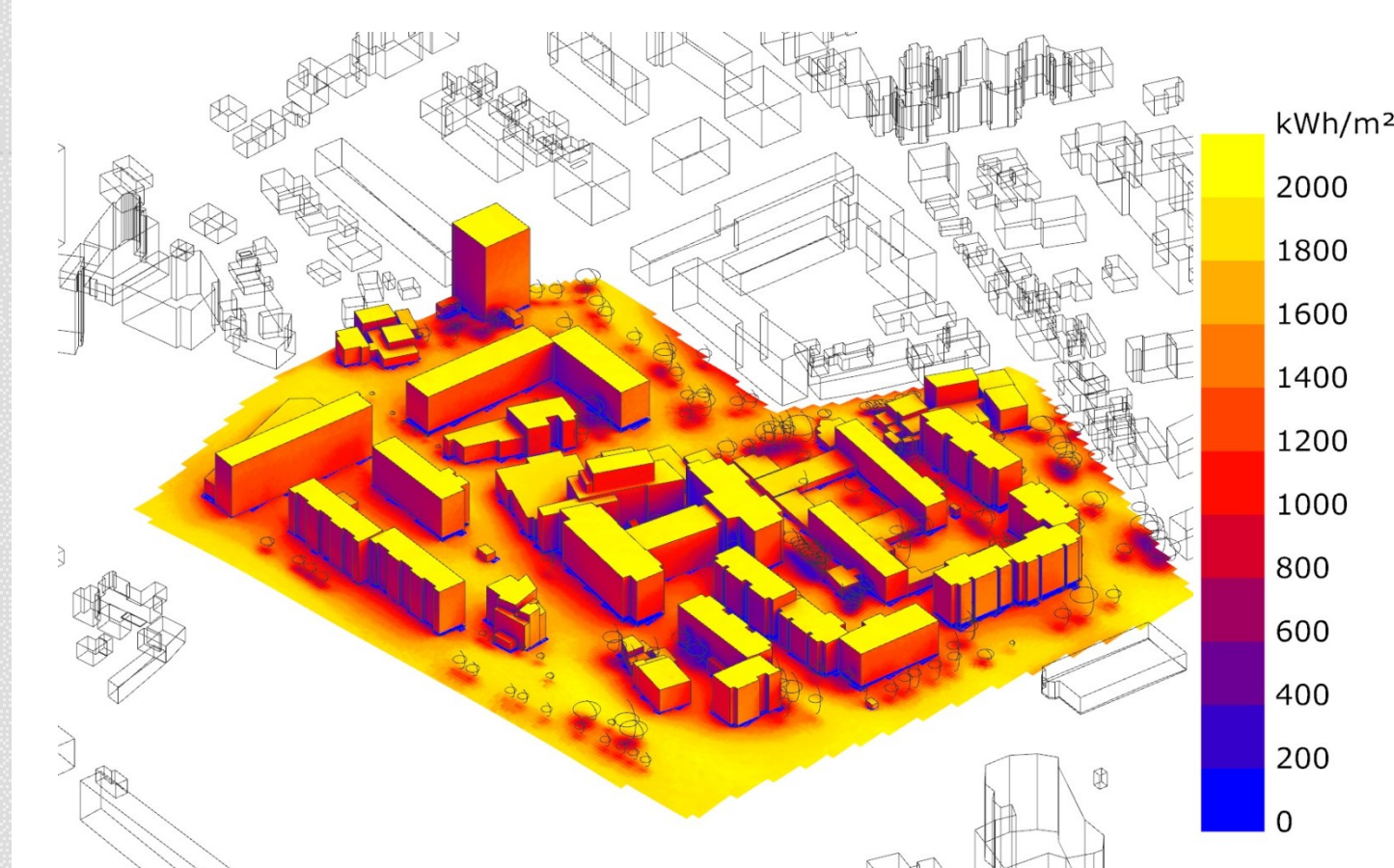
The **dynamics of the urban microclimate** and its effects on outdoor and indoor conditions is captured by using **specific simulation tools** (UrbaWind for the CFD airflow, Radiance for solar irradiation, EnergyPlus for indoor and outdoor thermal conditions)



### PARAMETRIC STUDY

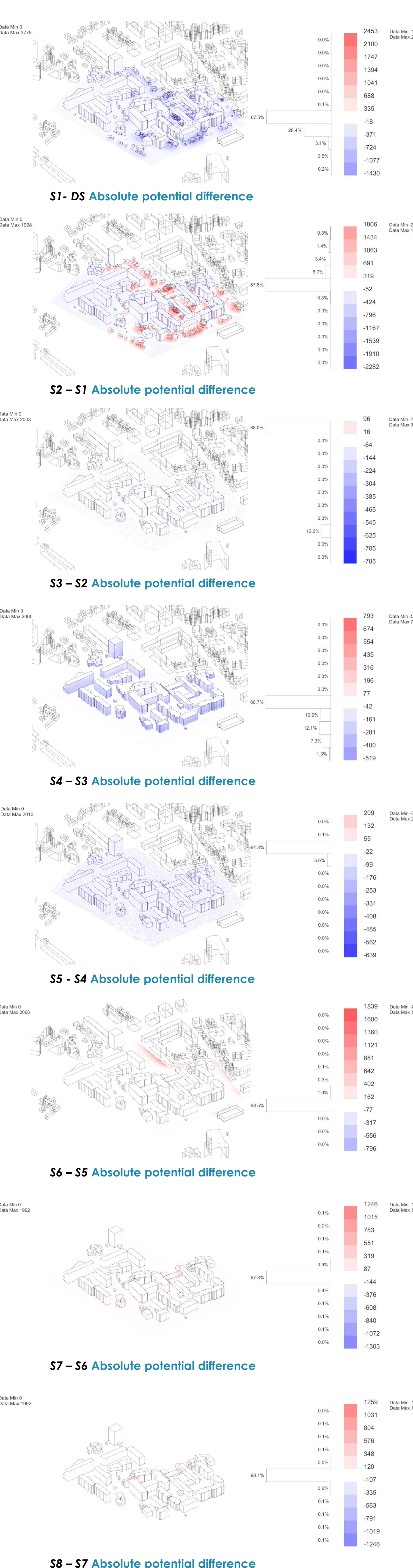
#### Impact of modelling simplification on solar potential

The **parametric generation** of the urban environment and its constitutive elements allows running similar simulation with various scenarios. Here the most detailed 3D model is simplified gradually to assess the **impact of each modelling scenario on the solar potential of more detailed ones**.



Radiance parameters	ab=2, ad=1000, as=16, ar=98, grid size=1m
DS Detailed scenario	Ovoid trees, detailed ground materials distribution (asphalt/grass), extended surrounding, sampled topography
S1 Spherical trees	DS with simple trees instead of ovoid trees
S2 No trees	S1 with trees removed
S3 All asphalt	S2 with all asphalt ground instead of the asphalt/grass distribution
S4 Lambertian ground	S3 with 20% reflective Lambertian ground instead of all asphalt
S5 First surrounding	S4 with extended surrounding removed, only first radius of surrounding buildings kept
S6 No surrounding	S5 with no surrounding buildings
S7 Unsampled terrain	S6 with SRTM (30m precision) terrain instead of 3m sampled terrain
S8 Flat terrain	S7 with flat terrain instead of SRTM terrain

**Radiance and geometric parameters of the simulated scenarios**



This parametric study demonstrates how the conjunction of simulation and parametric modelling can **inform** a digital design process with **precise mapping of microclimatic conditions**. Here the link between form, materiality and solar potential is sequentially represented and shows the importance of modelling practice. From this case, the integration of **trees** and appropriate **ground material** could represent **significant strategies to reduce the local UHI effects** due to solar collection.