SolUR | Solar Urban Ranking

- Creation of a vector **3D city model** including **buildings**, **vegetation** and **topography**
- Estimation of **building energy-generation** and **retrofit potential** using state-of-the-art models
- Generation of **multiple vegetation and weather scenarios**
- Calculation of a **score** representing the **priority** of intervention using **pairwise comparisons**
- **3D visualization** at multiple **spatial aggregation scales**

Data source:

SITN	SITN	SITN	Swisstopo	Meteoswiss	SIA 2024
3D cadastre	LiDAR point cloud	Digital Terrain Model (DTM)	Digital Elevation Model (DEM)	Long-term weather data	Standard load profiles

Modeling

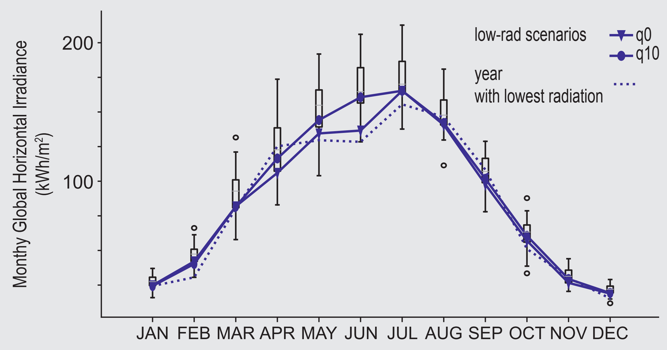
Surface discretization → PV-modules sensor grid; Simulation sensor grid

Alpha-shape triangulation → Vegetation scenarios

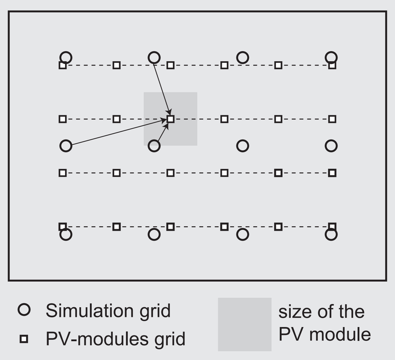
Delaunay triangulation → Terrain mesh

Skyline calculation → Far-field obstructions

Statistical sampling → Weather scenarios

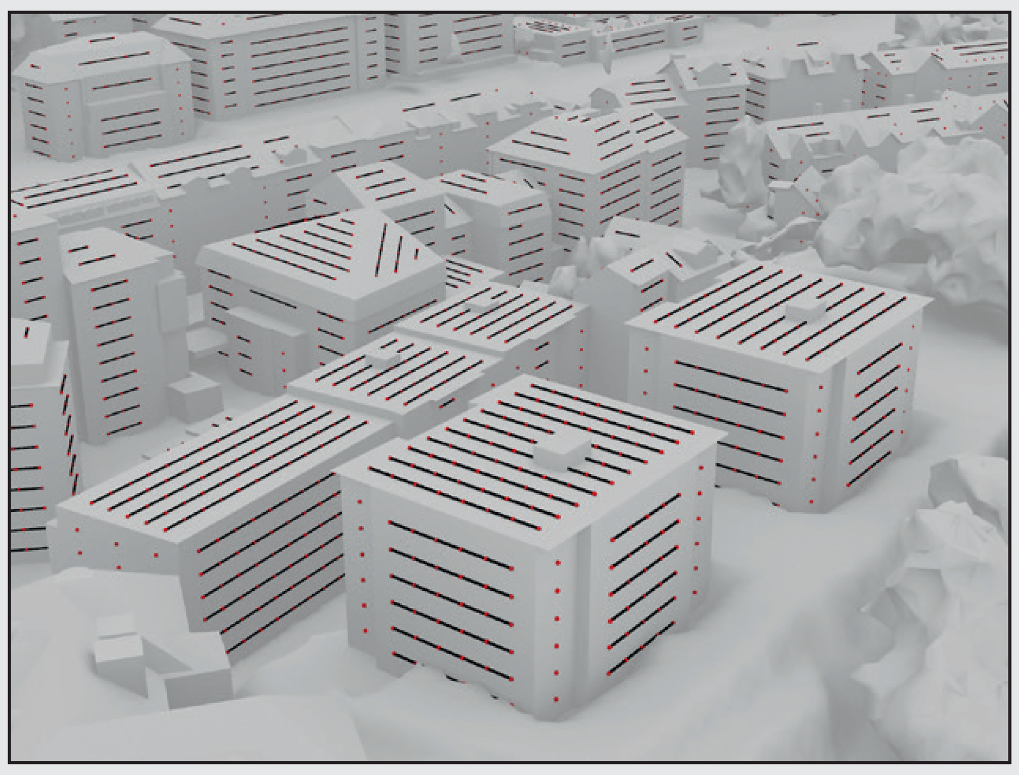


Weather scenarios



Discretization and grid remapping

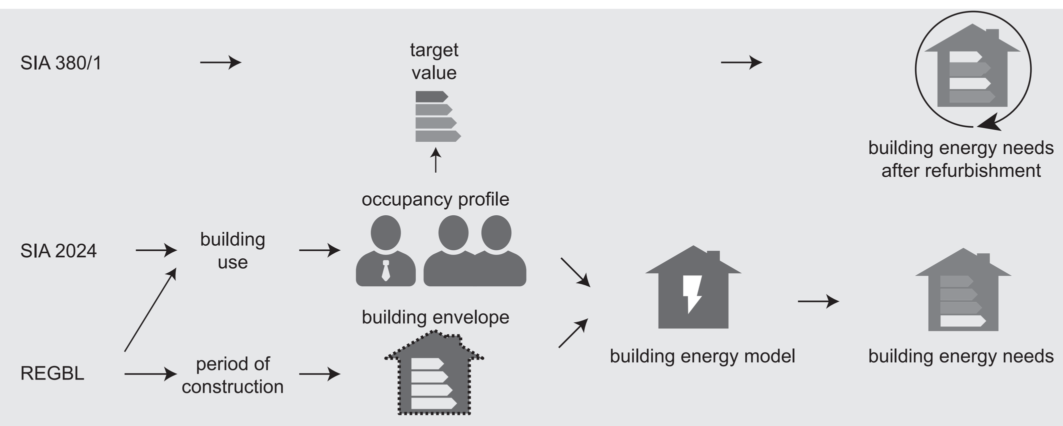
The modeling workflow is based on advanced geodata, in particular a 3D cadastre and LiDAR point cloud, composing a 3D city model including buildings (with overhangs and the main super-constructions), terrain and vegetation. The 3D cadastre is discretized into structured sensor grids that are used for the solar radiation simulation. The vegetation is reconstructed from the LiDAR point clouds using an alpha-shape algorithm. The geometrical model is completed by the far-field obstructions calculated on a 25-m resolution DEM. We also create different weather scenarios using 30-year datasets. Conservative (low-rad) weather scenarios are constructed concatenating months from different years.



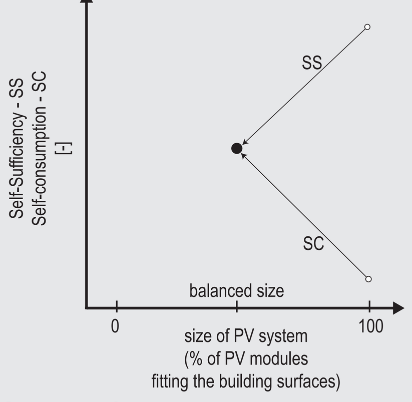
Simulation

Simulation of hourly irradiances → Grid remapping → Solar irradiation → Photovoltaic model → Geometric regularity check → System sizing → Electricity production

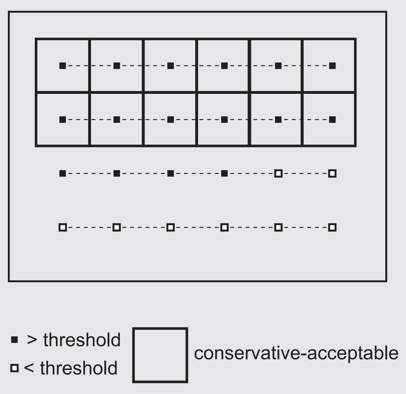
Building energy model → Building electricity demand → System sizing



Definition of the building energy model



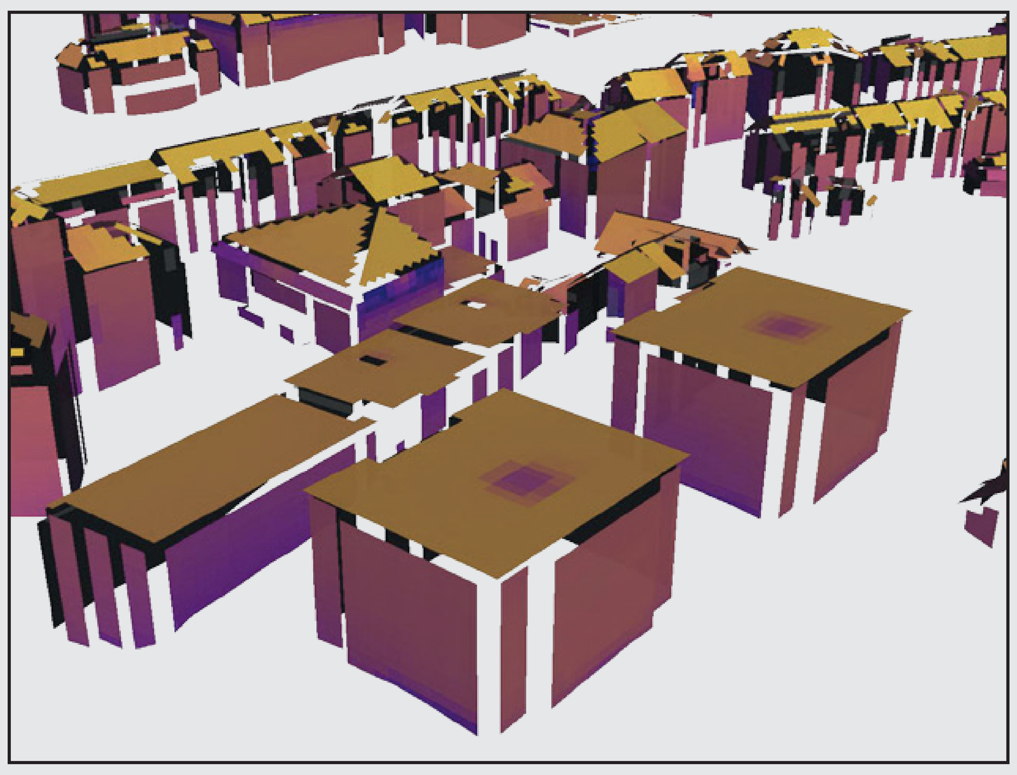
Sizing of the PV system



Geometric regularity check

The workflow couples state-of-the-art tools (Daysim, CitySim and PVLIB) to simulate the electricity production of the PV modules under real installation conditions and the building energy demand. The building energy model assumes the use of a heat pump for space heating and domestic hot water. Other electricity loads (e.g. appliances) are estimated using normative values. The PV system is sized by balancing the building Self-Consumption and Self-Sufficiency, taking into consideration the actual energy demand of the building at a hourly resolution.

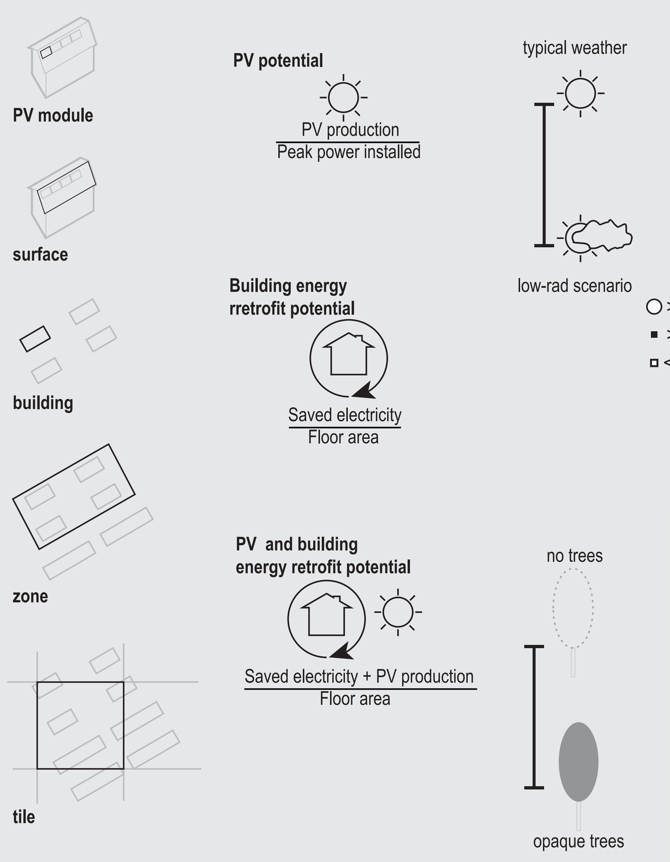
A geometric regularity algorithm is introduced to select only the PV modules forming a compact shape, as prescribed by the Federal Planning Ordinance.



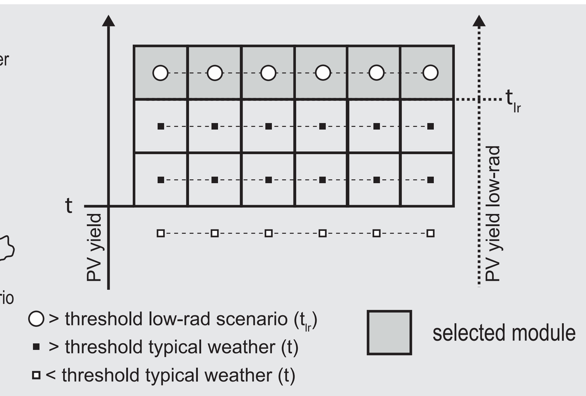
Evaluation

Low-yield avoidance → Spatial aggregation → Risk-averse preference model → Ranking by pairwise comparisons

Spatial aggregation

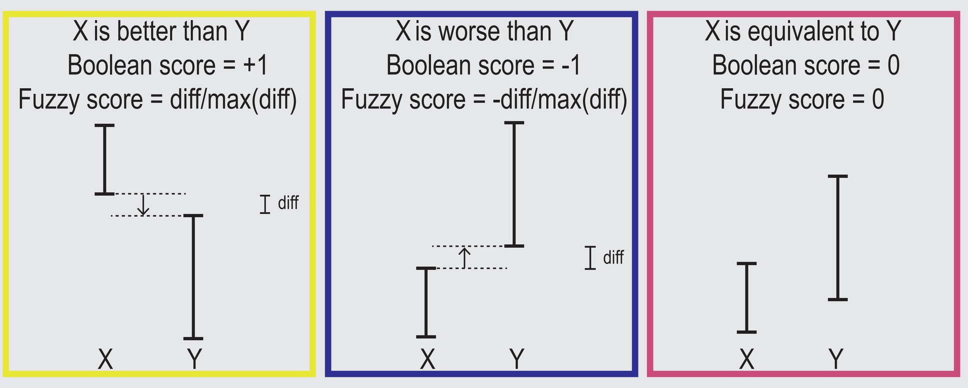


Scales | Indicators | Scenarios

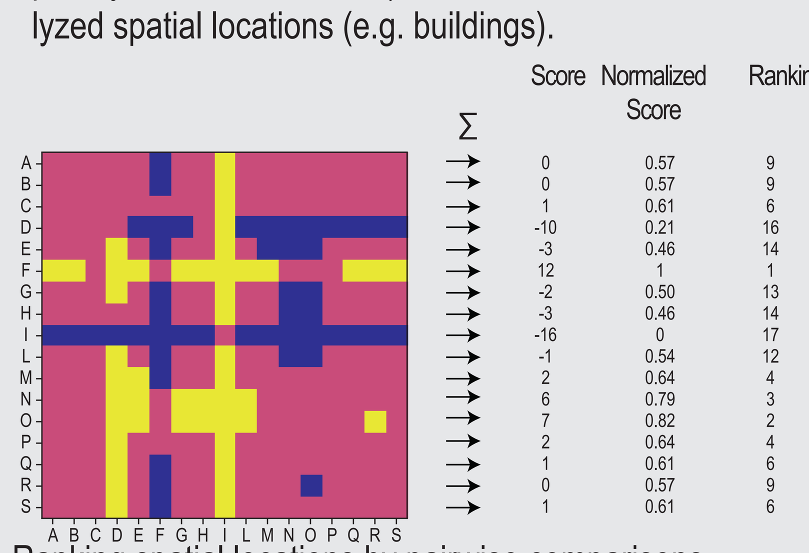


Low-yield avoidance

The evaluation worflow aims at comparing the building energy potential under uncertain environmental conditions through risk-averse scenarios. We considered two crucial yet underestimated uncertainty factors: weather (through the low-yield avoidance model) and vegetation (through the risk-averse preference model). The results are aggregated at different scales and, for each scale, the spatial locations are ranked through pairwise comparisons according to the relevant energy indicators. The output is a robust ranking (or priority list of intervention) of the analyzed spatial locations (e.g. buildings).



Risk-averse preference model for spatial locations

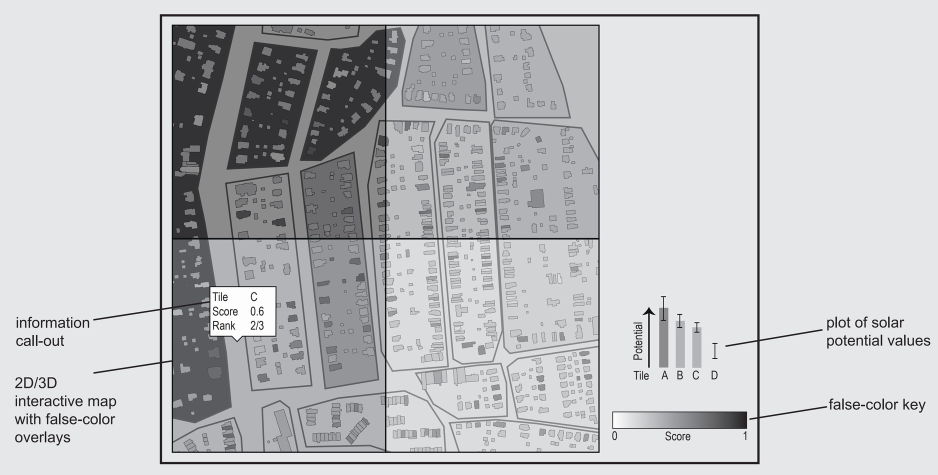


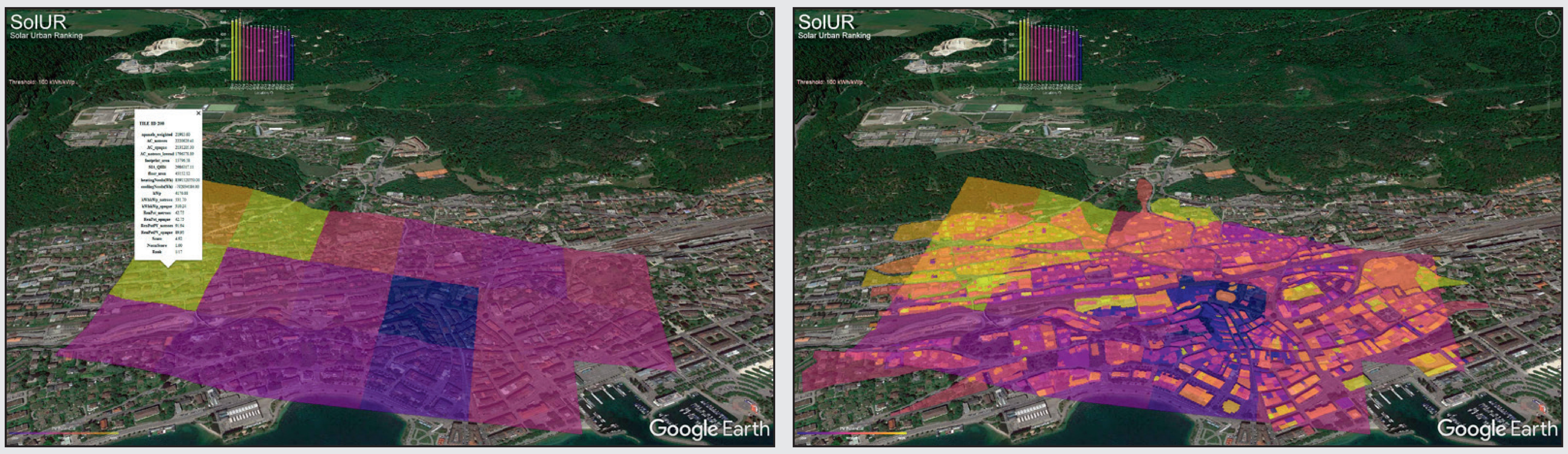
Ranking spatial locations by pairwise comparisons

single scenario
multiple scenarios

Visualization

Spatial overlay of aggregated results





Visualization concept (above)
and implementation (right) using KML files in Google Earth.
The results displayed here are for visualization demonstration purposes only.

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70 NRP Energy Turnaround
National Research Programme

This work has been conducted in the framework of the ACTIVE INTERFACES research project, which is part of the National Research Programme "Energy Turnaround" (NRP 70) of the Swiss National Science Foundation (SNSF). Further information on the National Research Programme can be found at http://www.nrp70.ch.
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