# Inter-comparison of spatial models for high shares of renewable electricity in Switzerland

**SWEET EDGE Work package 7**

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## 1 OBJECTIVES

- Model inter-comparison of three sub-national electricity system models: EXPANSE (UNIGE), Nexus-e (ETHZ), and OREES (EPFL)
- Understand the impact of model's structure and assumptions on key results
- Help modeling teams to learn from each other
- Enhance robustness of main findings for policy

## 2 CONTRIBUTION TO EDGE

- Assesses technology and regional implications of three Swiss electricity sector targets for 2035 (17 to 25 TWh/year from solar PV, wind, biomass, waste)
- Models of EDGE project are improved through lessons learned
- Model inter-comparison increases the credibility and usability of modeling results to inform decision-making for the energy transition of Switzerland

## 3 STUDY DESIGN

### 3.1 Harmonized scenarios

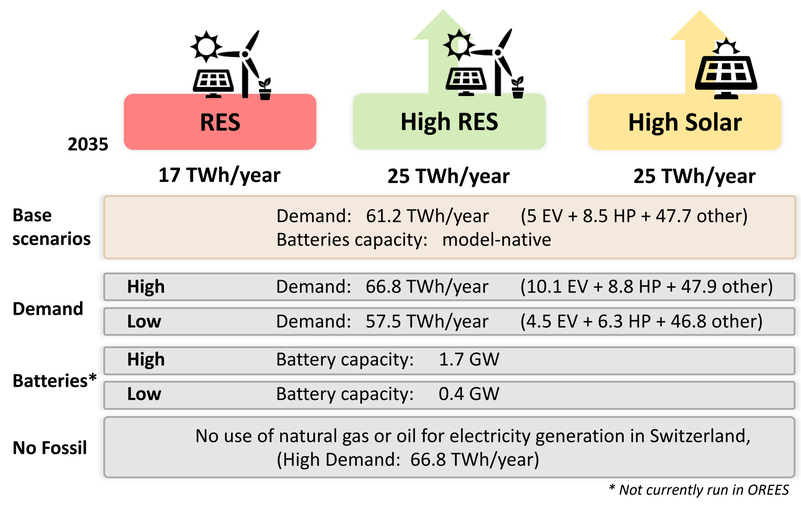


Figure 1: Matrix of 18 harmonized scenarios, depicting three main groups of scenarios (RES, High Solar, and High RES) and three dimensions of uncertainty

### 3.2 Three models

Table 1: Overview of three electricity system models used in this study

| | EXPANSE [1] | Nexus-e [2] | OREES [3] |
|---|---|---|---|
| General | | | |
| Model type | Linear optimization | Linear optimization | Evolution strategy (optimization) |
| Objective | Total costs minimization | Total costs minimization | Revenue maximization |
| Model environment | Python | Matlab, Python | Matlab |
| Spatial/Temporal | | | |
| Spatial resolution | Municipalities | Central: Nodes; Decentral: Cantons | 1.6 x 2.3km (PV); 1.1km (Wind) |
| Time resolution | 6 hours | 1 hour | 1 hour |
| Grid | | | |
| Nodes | 8 | 165 | 169 |
| Grid expansion | Yes | No* | No |
| Technologies | | | |
| Electricity generation | Solar PV (rooftop, facades), wind, hydro (dams, run of river), woody biomass, biogas, waste, nat. gas | Solar PV (rooftop), wind, hydro (dams, run of river), waste, natural gas | Solar PV (any location), wind, hydro (dams, run of river) |
| Storage | Pumped hydro, batteries, hydrogen | Pumped hydro, batteries | Pumped hydro |

### 3.3 Inter-comparison analysis

- Report input parameters and model outputs for harmonized scenarios
- Comparison of installed capacities and electricity generation at national and sub-national level
- Similarities and discrepancies assessed and explained with different model characteristics, set-ups, and inputs
- Two iterations of model inter-comparison
- First iteration for first analysis and to allow modeling teams to modify models
- Second iteration of model runs is considered final and is presented here

## 4 RESULTS

### 4.1 Results at the national level

- All three models align on high capacities of solar PV as the key technology to reach Swiss electricity sector targets
- Electricity interconnection with Europe is key to compensate high electricity demand or insufficient renewable capacity deployment with electricity import

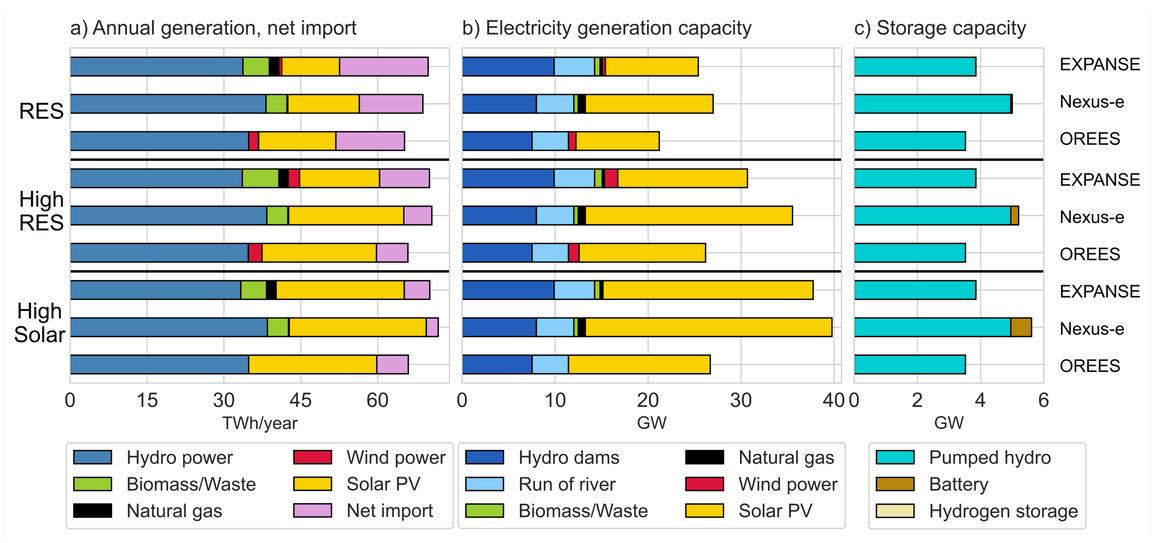


Figure 2: (a) Annual generation and net imports, installed capacity of (b) electricity generation technologies, and (c) storage technologies in the base scenarios (RES, High RES, and High Solar scenarios), for all three models.

### 4.2 Technology distribution at a high spatial resolution

- Spatial differences between models indicate flexibility of where solar PV capacities can be placed to achieve targets: on roofs, facades or also on land

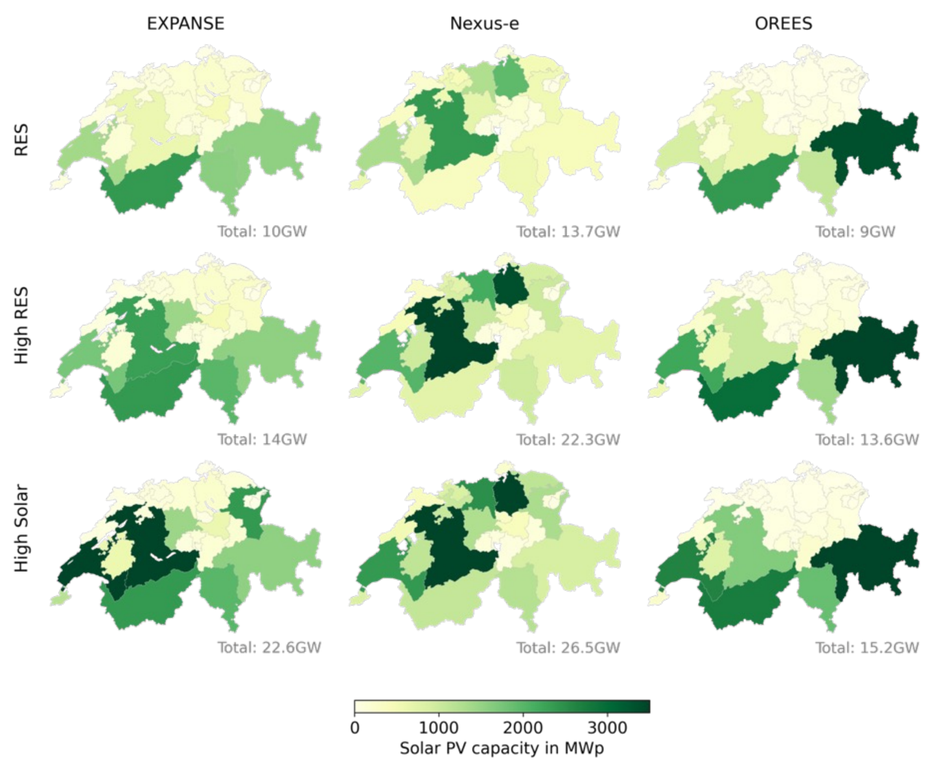


Figure 3: Spatial distribution of solar PV capacity with a cantonal resolution, for the three base scenarios (i.e., RES, High RES, High Solar) and the three models EXPANSE, Nexus-e and OREES.

## REFERENCES

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