



6G-VERSUS showcases this demo with Matlab simulations of the energy modeling of a self-sustainable base station. Multiple different selections of equipment for renewable energy sources (solar panels, wind turbines, batteries) to provide sufficient energy for an open radio access network (O-RAN) base station for the whole year with extremely varying weather conditions in Oulu, Northern Finland can be evaluated



Energy Modeling Objectives

- ✓ Develop an energy model for a self-sustainable O-RAN remote unit with microwave link as wireless fronthaul
- ✓ Evaluate whether solar, wind, battery storage, and hydrogen can support year-round off-grid operation
- ✓ Estimate the required renewable energy assets for harsh Arctic conditions.
- ✓ Use simulation results to guide the real 6G-VERSUS Finnish pilot testbed.

INPUT PARAMETER	VALUE
Starting month	May
Communication to idle ratio for O-RU	25%
Power consumption in addition to O-RU and heating	81.3 W
Number of solar panels	8
Solar panel model	Trina Vertex 415 W
Wind power plant model	SkyPower 5kW Vertical
Location of the remote unit	Linnanmaa, Oulu, Finland
Battery model	Victron LFP-51,2V/100Ah/5120Wh
Number of batteries in the battery bank	17 (87 kWh)
The age (cycle life) of the batteries	New (100% capacity)
Starting charge of the batteries	80%
Minimum temperature maintained in the battery box	15 °C
Thickness of the insulation for the battery box	13 cm
Hydrogen fuel cell model	PowerUP UP400 (400 W)
Min temperature maintained in the hydrogen cell box	5 °C
Thickness of the insulation for the hydrogen cell box	13 cm
Insulation foam material for the walls of the boxes	Polyurethane (k: 0.026 W m ⁻¹ K ⁻¹)

Datasets Used

- University of Oulu rooftop solar production measurements.
- VTT Oulu hourly wind speed measurements.
- FMI weather observations for temperature and environmental conditions.
- Manufacturer power curves for the 5 kW vertical wind turbines.
- Hourly simulation data for the full year 2024.

Key Simulation Results

- Total yearly energy consumption: 1463 kWh.
- Solar energy production: 2288 kWh/year.
- Wind energy production: 1057 kWh/year.
- Total yearly renewable production: about 3347 kWh.
- December solar production was only 1 kWh, showing the winter challenge in Northern Finland.
- Wind production supported winter operation when solar energy was very low.
- For the 17-battery case, hydrogen was needed only in late January, producing 2.2 kWh.

Energy Modeling of a Self-Sustainable Base Station
Juho Markkula, Sanna Tuomela, Hamid Malik, Antti Pauanne
University of Oulu, Finland

34 Partners | 10 countries
13 academic and/or research organizations
10 industrial partners
9 SMEs
2 NGOs



Follow us!



www.6g-versus.eu