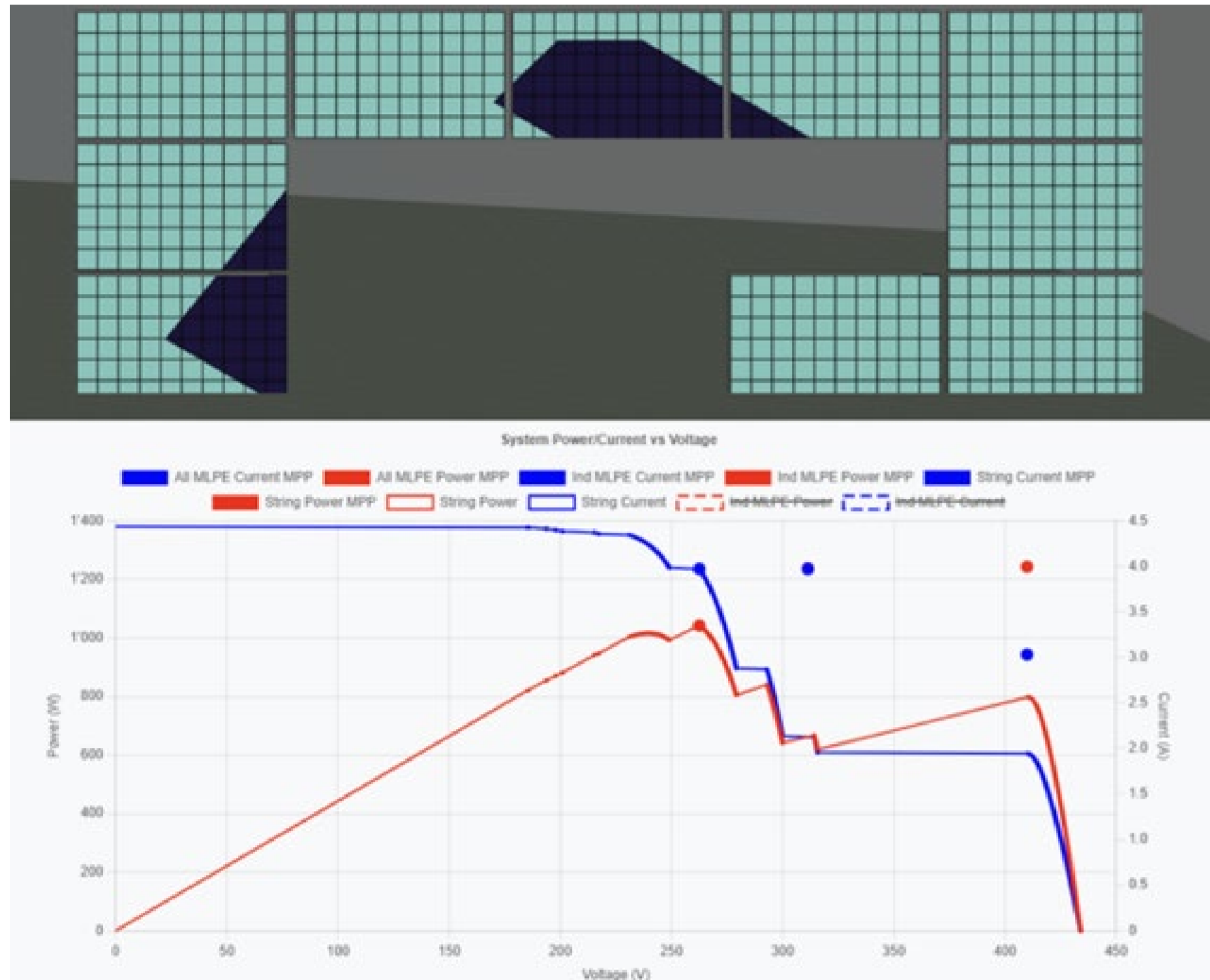
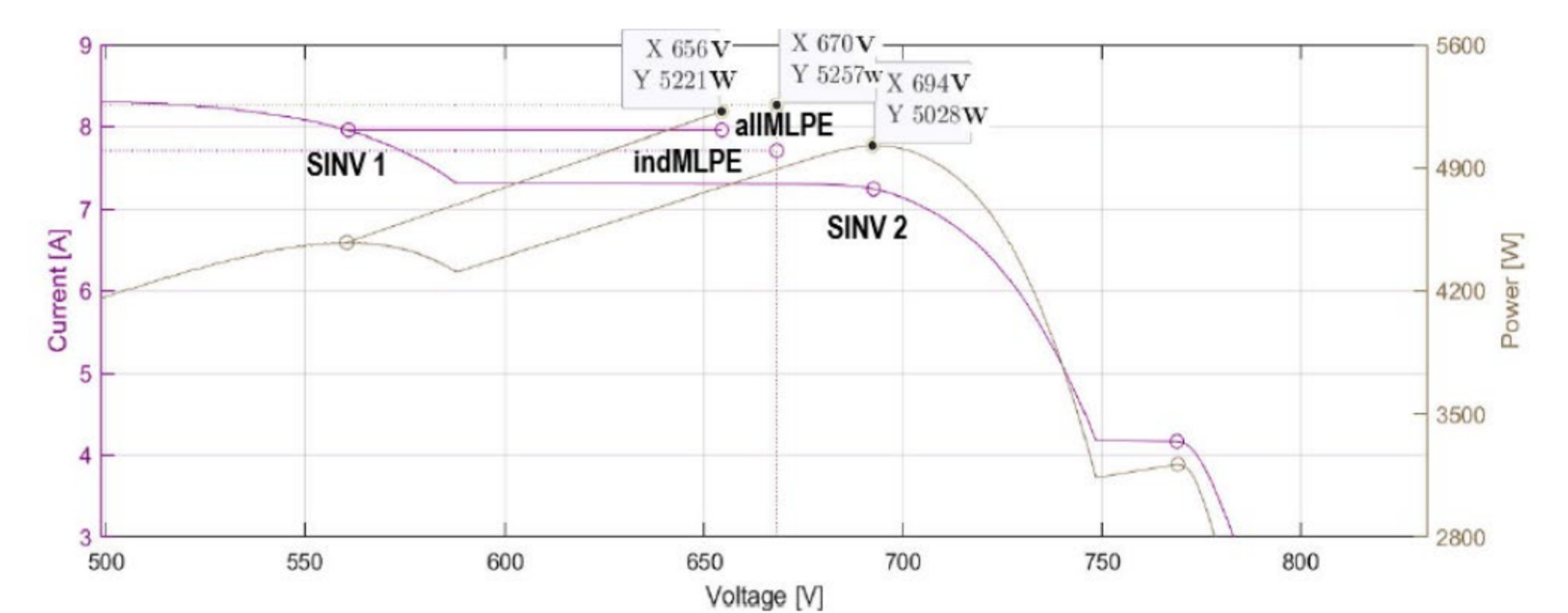
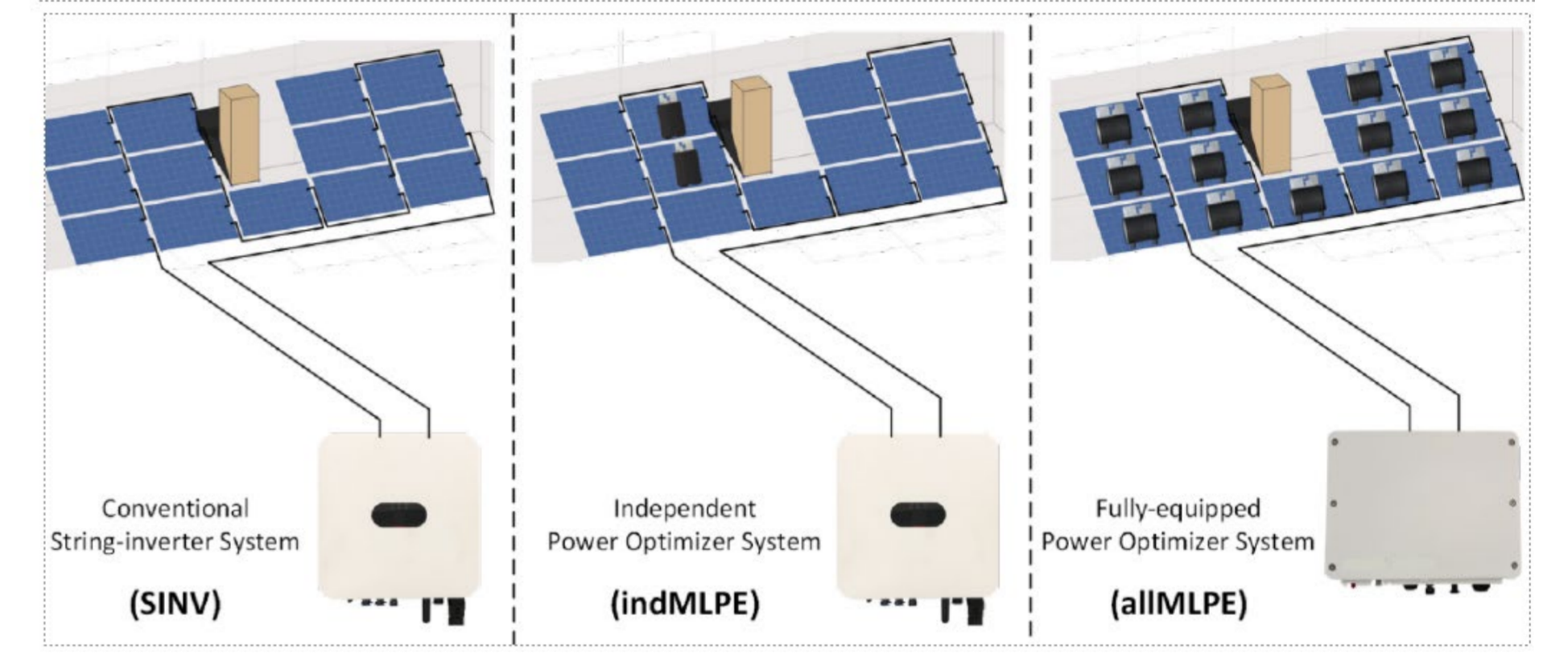


PVShade simulation tool to analyze optimizer/MLPE gain*



- Comparison of PV systems with String Inverter (SINV), MLPE at all modules (allMLPE) and at some modules only (IndMLPE), based on measured MLPE efficiencies
- Published MLPE efficiency data are often not reflecting the actual operating conditions but are based on maximum values
- The gain from MLPEs over string inverters remains, even under heavy partial shading, within the mid single-digit percentage range for the investigated scenarios
- The gain is considerably lower than what is typically advertised (partly >30%)
- For large and weakly shaded systems, the cumulative DC/DC losses of MLPE can result in slightly lower yields compared to string inverters



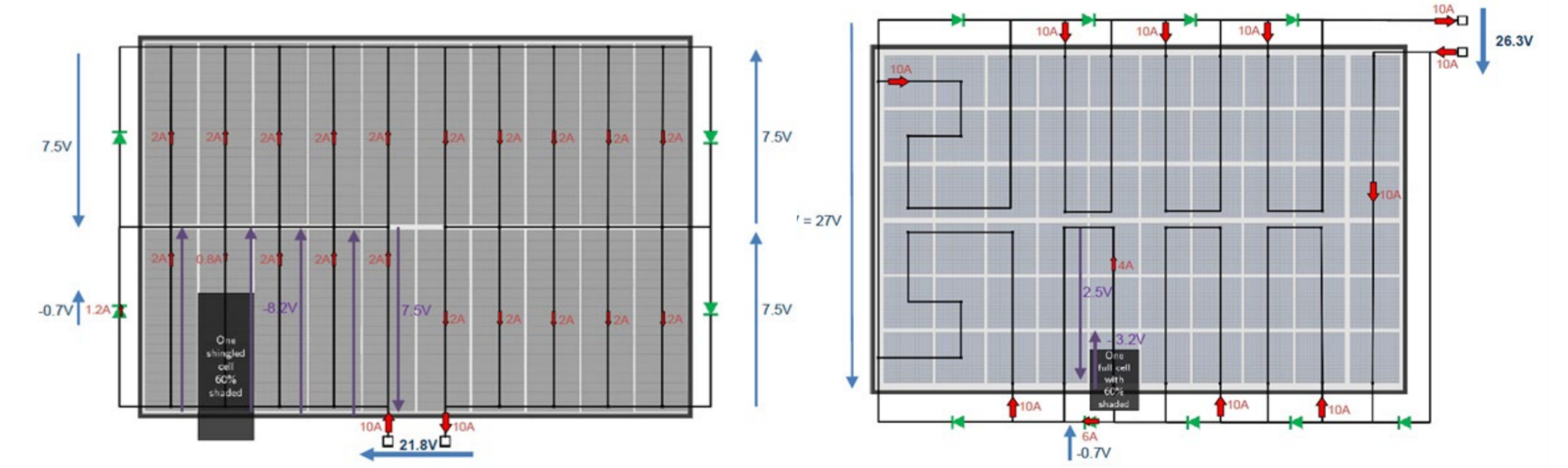
Visualization of optimizer gains*

Scenario	SI	SINV	allMLPE	indMLPE
Flat roof with flagpoles (south side) and superstructures	15.6 %			
SA-η [%]		90.4	95.5	93.0
SA-η rel. to best [%]		-5.5	0.0	-2.5
AC-kWh rel. to reference [%]		57.7	61.1	59.5
Large shading object near south roof 30° with chimney and dormer window	12.7 %			
SA-η [%]		91.3	95.9	94.1
SA-η rel. to best [%]		-4.6	0.0	-1.8
AC-kWh rel. to reference [%]		73.9	77.6	76.2
Urban environment in front of south roof 30° with chimney and dormer window	10.2 %			
SA-η [%]		93.1	96.4	95.3
SA-η rel. to best [%]		-3.3	0.0	-1.1
AC-kWh rel. to reference [%]		83.5	86.5	85.5
South roof 30° with chimney and dormer window	10.0 %			
SA-η [%]		93.1	96.4	95.3
SA-η rel. to best [%]		-3.9	0.0	-1.0
AC-kWh rel. to reference [%]		84.7	88.3	87.4
South roof 30° with central chimney	7.9 %			
SA-η [%]		94.1	96.5	96.1
SA-η rel. to best [%]		-2.4	0.0	-0.5
AC-kWh rel. to reference [%]		88.7	90.9	90.5
South roof 30° with dormer near gable	1.5 %			
SA-η [%]		96.8	96.7	96.5
SA-η rel. to best [%]		0.0	-0.1	-0.3
AC-kWh rel. to reference [%]		97.7	97.6	97.4
South roof 30° with chimney near gable	1.3 %			
SA-η [%]		97.4	96.7	96.5
SA-η rel. to best [%]		0.0	-0.3	-0.5
AC-kWh rel. to reference [%]		98.1	97.7	97.6
South roof 30° (reference with SINV)	0 %			
SA-η [%]		97.6	96.7	96.5
SA-η rel. to best [%]		0.0	-0.9	-1.0
AC-kWh rel. to reference [%]		100.0	99.1	99.0

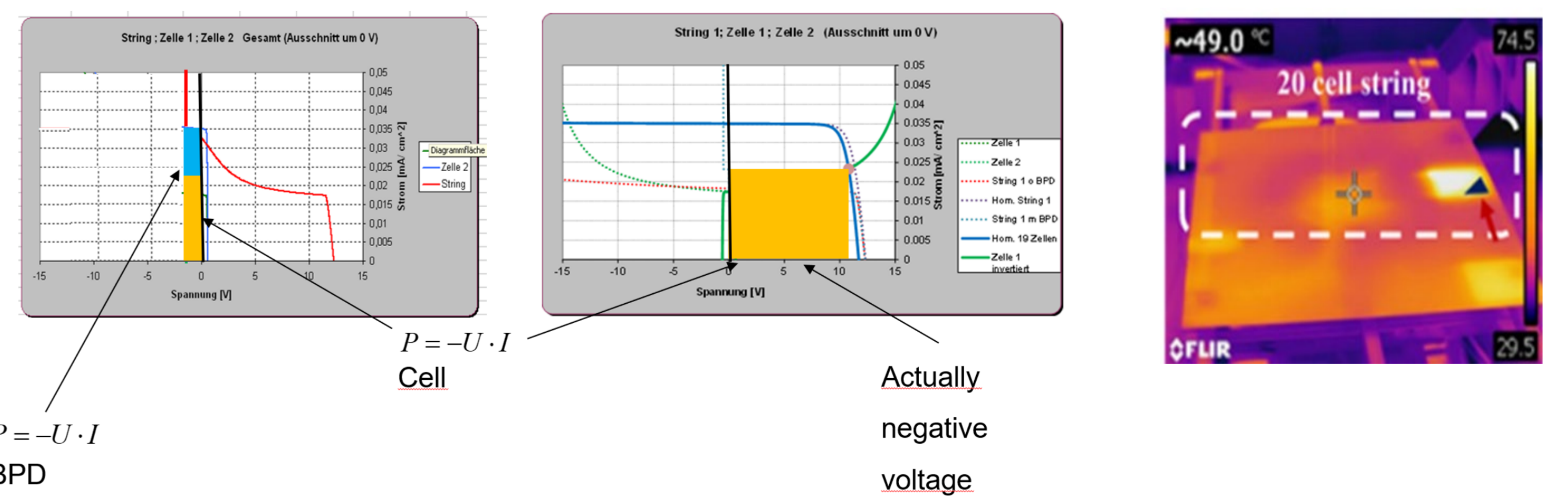
Annual simulation with varying shading for the same string configuration. The relative difference in shading-adapted efficiency compared to the best of the three variants (green) is highlighted in color (right).

Now: Also “shading-tolerant” modules

- New project: Systems under partial shading: Schweizerische Eidgenossenschaft Confédération suisse Confederazione Svizzera Confederaziun svizra Bundesamt für Energie BFE Office fédéral de l'énergie OFEN
- Joint BFE-project “ShadyPV” with SUPSI and BFH “Shady PV SI_503024-01_VT”
- Integration of the models into the existing simulation tool for the analysis of “optimizers”
- Shading tolerant module layouts have the same objectives than MLPE ⇒ mitigate partial shading effects
- To what extent does the module layout affect the output of a partially shaded PV system?



- Investigation of the heating of solar cells and bypass diodes under partial shading ⇒ “Reliability”
- Include reverse IV-curves, also for IBC-cells with “inherent” BPD and thermal models



* Some comprehensive information and access to visualization tool

Energieschweiz project «WebPVShade»: SH/8100380-02-01-46
Visualization tool: <https://srv-lab-t-574>. and final report also of BFE-Projekt «EFFPVSHADE» – (SI/502247-01)

Baumgartner, Franz 2025, Mehr Elektronik aufs Dach?; Electrosuisse Bulletin.ch, 2025 No 6

Performance of Partially Shaded PV Generators International Energy Agency Report IEA-VPVS T13-27:2024; ISBN 978-3-907281-64-2