

PVGIS: a free online solar photovoltaic calculator tool to optimise light harvesting in viticulture



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The screenshot displays the PVGIS web interface with several key components:

- Map View:** Shows a map of Europe with location markers for 'Fondazione Edmund Mach' (1) and 'ARC Infruitec-Nietvoorbij' (2).
- PV Estimation Panel:** Includes options for 'Performance of Grid-connected PV', 'Radiation database', 'PV technology', 'Installed peak PV power', and 'Estimated system losses'. It also features 'Fixed mounting options' (Slope, Azimuth) and 'Tracking options' (Vertical axis, Inclined axis, 2-axis tracking).
- Output options:** Includes 'Show graphs', 'Show horizon', 'Web page', and 'PDF'.
- Graphs:** Two graphs labeled (A) show 'Astronomic and topographic sunpath on May 17, 2017' for the two locations, plotting Zenith angle (DEG) against Azimuth (DEG). The graphs compare solar elevation, topographic sunpath, and PVGIS topographic mask.
- Table:** A table below the graphs provides sunrise and sunset data for both locations.

Location	Latitude	Longitude	Altitude (m)
Fondazione Edmund Mach	46.190	11.141	46.193
ARC Infruitec-Nietvoorbij	-33.915	18.863	33.915

The Photovoltaic Geographical Information System (PVGIS) ©European Communities, 2001–2017) had been developed from solar radiation data estimated from satellite using the Satellite Application Facility on Climate Monitoring (CM SAF) models, representing the period 1996-2011. In areas North of 58° N the data are derived from ground station measurements collected within the European Solar Radiation Atlas and interpolated spatially.

The PVGIS service allows to simulate the photovoltaic potential of a PV system, according to the site location and horizon mask, the PV technology, installed peak power, yield and energy losses, as well as mounting options like slope (0=horizontal 90=vertical) and azimuth (-90=oriented to the East, 0= to the South, 90 to the West, + or -180 to the North). Several web-tools, available from the PVGIS online service, can be used in viticulture. In particular, the “Show horizon” (A) option allows the calculation of both the astronomic and topographic sunrise, sunset, maximum potential day length, on a sunny day with no cloud cover [1-2].

Moreover, the “Daily radiation” (B) tool offers the possibility to calculate the monthly irradiance on the PV surface. Therefore, the PVGIS service can be used to simulate the monthly irradiance on the canopy surface using slope=90 (vertical) and the row orientation angle as azimuth value.

Finally, the “PV Estimation” service (C) provides the estimation of the optimum inclination and orientation of the PV module (i.e. canopy) as affected by the horizon mask, to maximize the annual light interception.

PVGIS services and queries can also be embedded into new tools [2] (both local and online) to support the site selection and a proper vineyard design (row direction, row and vine spacing, trellis system, etc.).

References

- Hunter, J. J., Volschenk, C. G., & Zorer, R. (2016). Vineyard row orientation of *Vitis vinifera* L. cv. Shiraz/101-14 Mgt: Climatic profiles and vine physiological status. *Agricultural and Forest Meteorology*, 228, 104-119.
- Zorer, R., Volschenk, C. G., & Hunter, J. J. (2017). Integrating Geographic Information Systems and hemispherical photography in the assessment of canopy light profiles in a vineyard. *Agricultural and Forest Meteorology*, 232, 672-681.

The screenshot shows the 'Daily radiation' tool interface. It includes a graph of 'daily irradiance according to row orientation in March' with irradiance (kWh/m²) on the y-axis and time on the x-axis. The graph shows curves for different row orientations: 16°, 45°, 90°, 135°, and 180°. Below the graph is a photograph of a vineyard with rows of grapevines and a PV panel installed in the foreground.

Row orientation trial at Robertson Experiment Farm of ARC Infruitec-Nietvoorbij Breede River Valley, Robertson, South Africa, (33°5' S/19°54' E 159 m a.s.l.).

The screenshot shows the 'PV Estimation' tool interface. It displays 'PVGIS estimates of solar electricity generation' for a location at 46°11'31" North, 11°8'18" East, Elevation: 259 m a.s.l. The tool provides solar radiation database used (PVGIS-CM SAF), nominal power of the PV system (1.0 kW), and estimated losses due to temperature and low irradiance (10.8%). It also shows estimated losses due to angular reflectors (2.4%) and other losses (cables, inverter etc.): 14%. The combined PV system losses are 24.7%.

Month	E_p	E_m	H_p	H_m
Jan	1.83	56.8	2.31	71.7
Feb	2.86	80.0	3.60	103.
Mar	3.84	114.	4.66	144.

The screenshot shows the 'PV Estimation' tool interface for a location at 33°54'54" South, 18°53'45" East, Elevation: 157 m. It provides solar radiation database used (PVGIS-bioclim), nominal power of the PV system (1.0 kW), and estimated losses due to temperature and low irradiance (10.8%). It also shows estimated losses due to angular reflectors (2.5%) and other losses (cables, inverter etc.): 14%. The combined PV system losses are 27.2%.

Month	E_p	E_m	H_p	H_m
Jan	5.11	158.	7.08	218.
Feb	5.11	143.	7.06	217.
Mar	4.80	149.	6.90	213.

