



SWEET Call 1-2020: SWEET EDGE

Deliverable report

Deliverable n°	D3.1
Deliverable name	Publication with the results of improved solar PV potential in the Alps
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Delivery date	10 2022 postponed to 01 2023

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Summary

This paper provides an overview of the distribution of the solar potential in Switzerland across different surface cover types. Considered are:

- Ski areas
- Grazing areas
- Other open alpine areas
- Parking lots
- Along (national) roads
- FPV on artificial lakes
- Dam mounted PV
- Roof tops
- Facades

Based on a detailed and spatially highly resolved GIS study that was combined with modelled production potential for the entire country, quantile-quantile maps are derived for each surface cover type. The results thus show:

- 1) The lumped, total production potential per surface cover type.
 - a. Annual total
 - b. Winter production
- 2) The distribution of production values within each category, i.e. which landcover types hold the most productive areas.

To calculate the production potential, our company developed SolarSherpa, an extensive upgrade from the original, academic SUNWELL model. SolarSherpa features many new capabilities, including raytracing, temperature dependent conversion efficiency, extremely high spatial resolution, consideration of multiple rows, inter-row spacing and the associated complex shading.



1 Introduction

Solar photovoltaics will play a central role in the Swiss Energy Transition. Until recently, politics followed the belief that roof-top installations would suffice and the existing subsidy structure strongly favoured rooftop installations with a high level of auto-consumption. It was practically impossible to receive a building permit for a free-standing installation outside the building zone, i.e. anywhere outside urban areas. Strong opposition from landscape and environmental protection further slowed the process. The lack of subsidies and low infeed-tariffs prevented economic viability.

But geopolitical conditions and the threat of a winter energy shortage have completely changed the game. With unprecedented speed and almost no opposition, an adaptation to the existing energy law was passed on September 30, 2022. It has come into practice on the 1st of October and will remain valid until 31.12.2025. With the exception of a few protected areas, utility scale PV installations can now be built outside the building zone and given certain conditions, will be subsidized with up to 60% of their CAPEX. They will be given priority over landscape protection and several other interests and are declared to be 'of national interest'. This change in legislation has precipitated an enormous rush amongst electricity companies, communities and private investors to initiate new PV projects.

The burning questions at the moment are thus:

- What type of areas are currently available for PV installations in Switzerland?
- Where are those areas and how large are they?
- What is their production potential and how much of it is produced in winter?

These questions are addressed in this publication.



2 Deliverable content

A. Hierarchical GIS analysis:

- Hard exclusion of: natural hazards zones and natural protection (conform to latest legislation EnG Art.71a)
- Optional criterion for accessibility: Buffer of 1 km around all navigable roads as long as the slope is $< 10^\circ$
- Land use criteria leading to subsetting into different categories

B. High-resolution production potential modelled with SolarSherpa:

- Based on raw MSG satellite data and high-resolution DEM
- Derives global horizontal incoming radiation based on state-of-the-art treatment of atmospheric transfer and specific attention to the discrimination of cloud and snow cover (very important for alpine areas)
- Splitting into diffuse and direct radiation and transposition into plane of array (POA) radiation for any tilt and aspect
- Consideration of high resolution (10 m) terrain and self-shading and high resolution (10 m) surface reflectance from the surrounding terrain including the temporal variability of surface albedo (presence and absence of snow)
- Computes production potential as sum of diffuse, direct and ground reflected POA radiation:
 - allowing bifaciality whenever possible
 - adjusting conversion efficiency for ambient conditions (air temperature, irradiance and wind speed)

C. Open source availability of SolarSherpa

Combining A and B will allow to plot distributions (histograms) of the production potential within each surface type category. These plots show what the production potential of each category looks like. More specifically, this will show which portion of the available land in each category has a high, intermediate and low production potential. And also, how much higher the prospective for winter production is in certain categories vs others.



3 Conclusion

To be completed upon submission.

Solar Sherpa is a new model that is particularly well suited to compute the solar PV production potential in complex terrain where the interaction of snow and radiation play an important role.

4 References

Maddalena, G., Hohermuth, B., Evers, F., Boes, R., **Kahl, A.** (2022). Photovoltaik und Wasserkraftspeicher in der Schweiz – Synergien und Potenzial, Fachzeitschrift des Schweizerischen Wasserwirtschaftsverbands: Wasser Energie Luft, 114. Jahrgang, Heft 3 www.swv.ch/wel/fachzeitschrift-wel/wasser-energie-luft-3-2022

Kahl, A., Dujardin, J., & Lehning, M. (2019). The bright side of PV production in snow covered mountains. Proceedings of the National Academy of Sciences of the United States of America PNAS, 116(4), 1162-1167.
<https://doi.org/10.1073/pnas.1720808116>

SwissAlti3D, <https://www.swisstopo.admin.ch/en/geodata/height/alti3d.html>

SwissTLM3D,
<https://www.swisstopo.admin.ch/de/geodata/landscape/tlm3d.html>

GIS maps of canton Graubünden: www.gr.ch

GIS maps of canton Wallis: Apart from the farms layer, everything comes from
<https://www.swisstopo.admin.ch/de/geodata/landscape/tlm3d.html>

The farms layer for Wallis (and all of Switzerland) comes from
https://geodienste.ch/services/lwb_nutzungsflaechen

Hazard maps of canton Wallis: <https://geodienste.ch/services/gefahrenkarten/>

GIS maps of areas of national importance according to Art. 18a NHG.
www.bafu.admin.ch

Federal Inventory of water and migrating birds:
<https://opendata.swiss/de/dataset/bundesinventar-der-wasserund-zugvogelreservate-von-internationaler-und-nationaler-bedeutung>

Satellite imagery of Meteosat Second Generation's SEVIRI Sensor:
<https://www.eumetsat.int/seviri>



Appendix