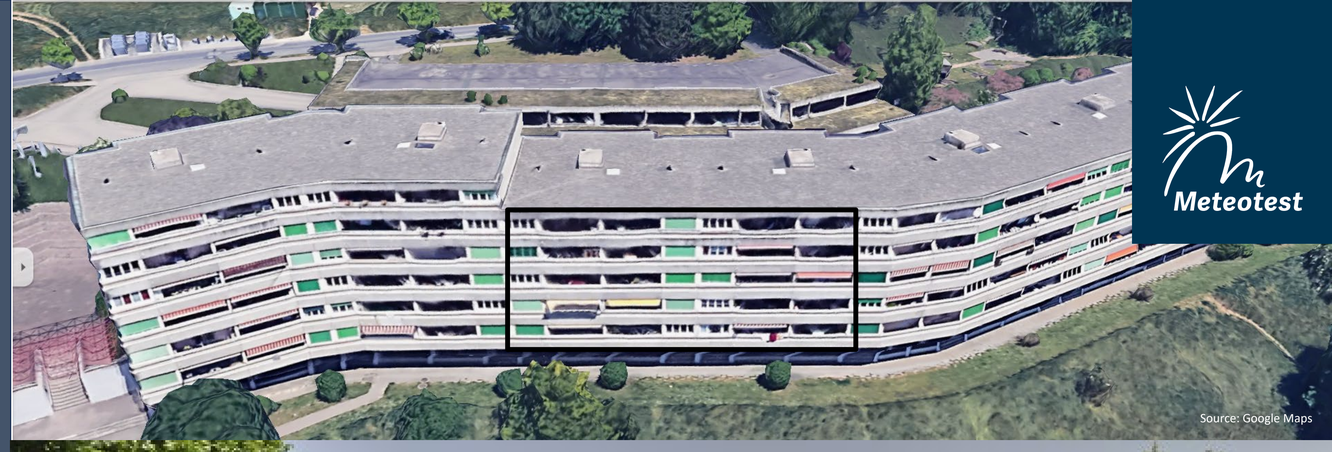
THE POTENTIAL OF BALCONY PLUG&PLAY PV SYSTEMS IN SWITZERLAND

Jan Remund[1], Anne-Kathrin Weber[1], Lukas Meyer[1], David Joss[2], Christof Bucher[2], Theo Zwahlen[2]
1 Meteotest AG; contact: jan.remund@meteotest.ch
2 Berner Fachhochschule BFH

The energy potential Plug&Play PV Systems in Switzerland is estimated. Based on the known potential for facade PV systems, a randomized sample with 950 facades of different building categories is used to investigate whether balconies are present and what their photovoltaic potential is. The potential is then extrapolated to Switzerland's building stock. The estimation shows a potential of approx. 1000 GWh.



Introduction

Plug-in photovoltaic systems for balconies are becoming increasingly popular. Due to this boom recognizable in Switzerland also, the question arises, how big the potential for such systems might be.
In Switzerland the solar potentials of all facades and roofs of all existing buildings are well known (www.sonnendach.ch, www.sonnenfassade.ch by the Swiss Federal Office of Energy). The total potential energy production of all facades is 50 TWh (the yearly electricity consumption in Switzerland is about 60 TWh). But this also includes doors, windows, balconies, and other areas, which are hardly usable for PV. Based on a short analysis the realizable potential was reduced by a factor of 3 to 17 TWh [1,2].

Method

Based on the known potential for facade PV systems, a randomized sample for different building categories is used to investigate the presence of balconies and their photovoltaic potential.
A sample dataset of 950 randomized facades was defined by an automatic algorithm as a starting point. A subset of facades was selected according to the following factors: irradiation (above 600 kWh/m^{2}y), usage (residential buildings), area (above 50 m^2) and number of floors (more than 1 floor). The facades have been analyzed by humans with the help of Swiss Topographic maps, Google Street View, Google Earth and Apple maps in order to assess their suitability for the potential study. The results of the 950 samples have been scaled up to the Swiss building stock.
The areas usable for Plug & Play PV systems on balconies have been defined based on the typical size of such installations. For the modules a nominal DC power of 400 W at STC was assumed with a module efficiency of 20% and a needed area of 1x2 m. Apart from the limit of 600 W per meter circuit no other requirements for the electrical installation and spatial planning aspects were taken into account in this analysis.

The following three **options** have been modelled:
1. 800 W $P_{DC\ STC}$ system (2 modules) with limitation to 600 W AC inverter nominal power
2. 1200 W $P_{DC\ STC}$ system (3 modules) with limitation to 600 W AC inverter nominal power
3. 1200 W $P_{DC\ STC}$ (3 modules) with no AC limitation

Results

The potential of all the referencing facades in the subset selected initially by the factors irradiation, usage, area, and number of floors sums up on a national scale to 21.611 TWh / year (Figure 1). 60% of all examined facades didn't have any balconies – a higher percentage than assumed.

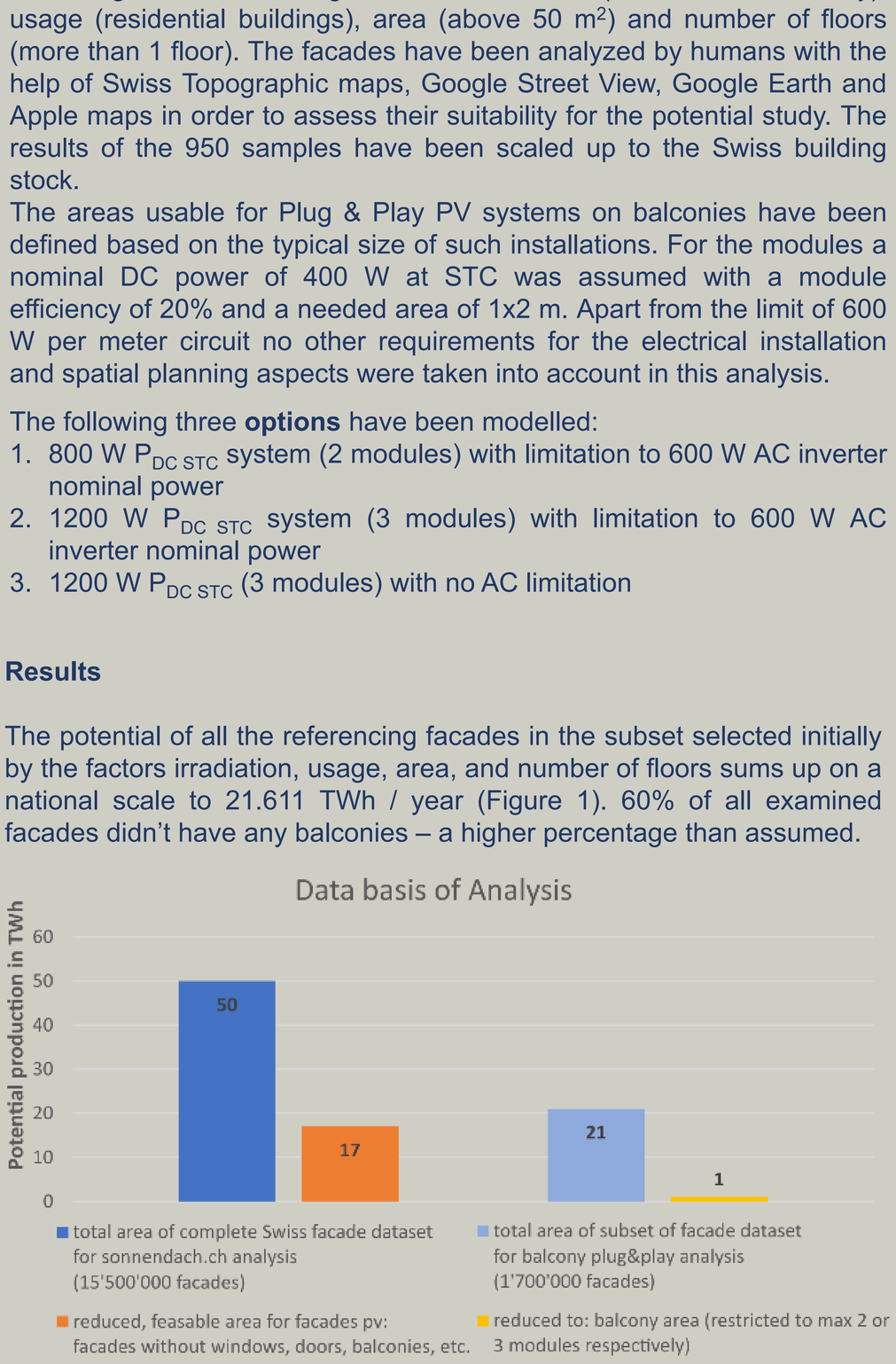


Fig. 1: Overview of the data basis and the resulting potentials. For the Plug & Play analysis a subset of facades of the total Swiss facade dataset was used and applied to the percentage of balcony areas taking into account the actual regulations of Plug & Play regulations (resulting a potential of 21 TWh).

The share of the summed production of the Plug & Play systems divided by the summed production of the whole facades subset is 4.1% for option 1. Applying this percentage to the Swiss facade potential, a total of 895 GWh is calculated (Table 1).

	Option 1	Option 2	Option 3
Nr. modules	2	3	3
DC	800 W	1200 W	1200 W
Max. AC	600 W	600 W	no limit
Share of curtailed energy	0%	12.7%	0%
Potential production	895 GWh	1002 GWh	1048 GWh
Winter half year share	37.7%	37.8%	37.5%

Table 1: Monthly distribution of balcony PV Plug & Play Potential with all three options

The curtailment rate for option 2 has been calculated based on Meteonorm with one-minute datasets for Bern for typical façade orientations.
Option 2 and 3 with 3 modules resulted in higher production – but not as much as assumed based on the number of modules alone. The main reason is that for many balconies only 2 modules can be attached due to limited space. Like this the theoretical curtailment share of 12.7% has a relatively small impact on the potential.
Figure 2 shows the monthly distribution of the PV production for options 1-3. In all three options the winter energy share is around 37 %.

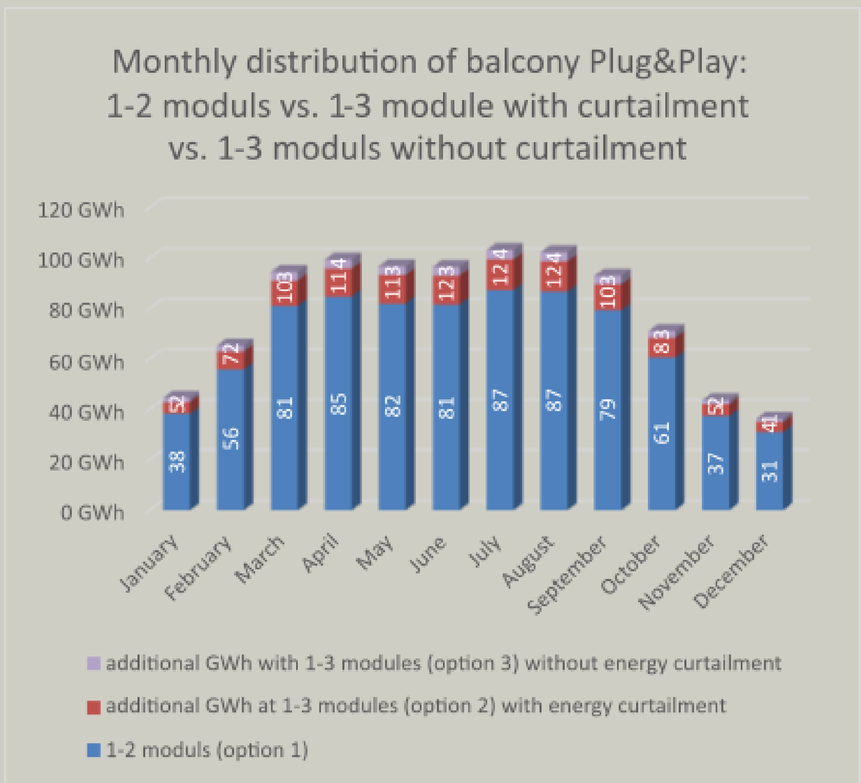


Fig. 2: Monthly distribution of balcony PV Plug & Play Potential with all three options

Conclusions

The potential of balcony Plug & Play PV systems in Switzerland was calculated to 900-1000 GWh. In comparison to the total roof potential of 50 TWh on roofs and 17 TWh on facades respectively, this figure is rather small, but still significant.
Adding a well distributed 1 TWh would be useful, especially producing around 0.37 TWh electricity during winter half year. Additionally, the advantage of this potential is that these systems can be built by anyone. No trained specialists are required. They therefore contribute to a broader and more democratic support of the energy transition. In addition, they are not in direct competition with roof and facade systems, as they do not affect their potential.

Literature:

[1] Remund, J., Albrecht, S., & Stickelberger, D., 2019. Das Schweizer PV-Potenzial basierend auf jedem Gebäude. Photovoltaik Symposium Bad Staffelstein. http://www.sonnendach.ch/
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Acknowledgement

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