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CONSULTING ENGINEERS FOR RENEWABLE ENERGY

Report

Rooftop Photovoltaic Energy Potential in Slovakia

An assessment of the theoretical potential of rooftop photovoltaic installations in Slovakia in terms of useable roof area, installed capacity, and the resulting annual energy yield.

Customer: Slovak Association of Photovoltaic Industry and RES (SAPI)

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Contents

1. Introduction

This report estimates the potential of electricity production by rooftop mounted photovoltaic (PV) installations in Slovakia. The estimate is based on data for the solar irradiation across the country and an inventory of buildings and parking lots in Slovakia. Typical, state-of-the-art rooftop installations are assumed for roofs of different sizes to quantify the roof area utilization and overall efficiency. The realizable PV potential is given in terms of installed DC and AC capacity and the resulting annual energy yield.

Parking lots have been included in this study. PV installations on parking lots do not utilize existing roofs but require the construction of support structures for the PV modules overhead of the parking places. PV installations on parking lots are however similar to rooftop PV installations as they build upon existing infrastructure and thus do not inflict additional land consumption.

This study is based on the current inventory of buildings in Slovakia and does not anticipate future trends in new construction and settlement development.

Gird capacity, economic feasibility and actual energy and electricity needs in Slovakia have not been taken into account for this study. The results presented herein are thus a purely technical and meteorological estimate and not connected to a realistic development scenario of rooftop PV installations in Slovakia.

1.1 Delimitation

Energiewerkstatt holds no responsibility for the accuracy of the input data that has been used for the present analysis. This in particular includes data on buildings and for the solar irradiation.

The authors conducted a thorough inspection of the input data, a careful selection of the modeling parameters, and consistency checks of the results. It is important to state, though, that numerical modeling of PV energy production necessarily requires simplification and idealization of the real-world conditions.

2. Results

This section presents the results for the Slovak rooftop photovoltaic energy potential in the form of the theoretical potential (Sect. 2.1) and of the realizable potential (Sect. 2.2). The former referring to the availability of resources, i.e. the available roof area and the irradiation on the roofs, the latter also assuming a practical utilization of the resources, i.e. assumptions for the type and the characteristics of PV installations. Detailed descriptions of the modeling parameters and assumptions that have been used to obtain the results are given in Sect. 3, Sect. 4, and Sect. 5.

2.1 Theoretical rooftop PV potential in Slovakia

The energy resource tapped with rooftop PV is the solar irradiation on the roof area of the existing buildings. For each of the 2.4 million buildings in Slovakia, the global horizontal irradiation at the building's position has been taken from the map as illustrated in Fig 2. The theoretical rooftop PV potential is then obtained as the product of the solar irradiation with the building's base area. The theoretical PV potential has been calculated for all buildings in Slovakia, regardless of the size of the building and of the technical suitability of the buildings. Only categories of buildings that are deemed unsuitable for PV utilization (such as non-permanent buildings, see Sect. 3) are excluded. This however accounts for only about 7700 buildings overall. Tab 1 lists the number of buildings, the total roof area and the total theoretical PV potential per kraj. A breakdown of the theoretical PV potential on okres level is given in Tab 9 in Appendix A.

Kraj	No. of buildings	Total surface area of buildings [m²]	Total irradiated energy on all buildings [GWh/yr]
Banskobystrický kraj	353 292	43 802 000	53 171
Bratislavský kraj	197 787	35 263 000	43 305
Košický kraj	292 216	42 177 000	50 942
Nitriansky kraj	324 891	50 027 000	63 060
Prešovský kraj	330 144	41 746 000	48 683
Trenčiansky kraj	258 805	36 207 000	42 980
Trnavský kraj	296 907	43 036 000	53 318
Žilinský kraj	346 768	41 129 000	46 364
Total	2 400 810	333 388 000	401 823

Tab 1: Theoretical rooftop PV potential per kraj. Areas are rounded to 1000 m².

The type and the practicability of rooftop PV installations very much depend on the size of the available roof area. Tab 5 therefore presents a breakdown of the theoretical PV potential on the size of the buildings. This illustrates that buildings with base areas between 50 m² and 500 m² contribute the largest fraction in terms of total area. Buildings smaller than 50 m² are, in comparison, much less important. Large buildings, greater than 500 m², though much less numerous than smaller buildings, still contribute a very significant fraction to the theoretical PV potential.

Size of building	No. of buildings	Total surface area of buildings [m²]	Total irradiated energy on all buildings [GWh/yr]
< 10 m²	52 869	334 000	400
10 m² - 50 m²	753 880	20 481 000	24 444
50 m² - 500 m²	1 508 620	200 477 000	241 366
500 m² - 10 000 m²	84 654	95 962 000	116 056
> 10 000 m²	787	16 133 000	19 557
Total	2 400 810	333 388 000	401 823

Tab 2: Breakdown of theoretical rooftop PV potential on building size. Areas are rounded to 1000 m².

Parking lots

The database of parking lots used for this study includes 18 459 individual lots totaling about 17 236 000 m². This includes multistory parking facilities, although they account for only a small minority (less than 1‰) of the total parking area. Tab 3 summarizes the theoretical PV potential for parking lots of different sizes.

Comparison with Tab 2 shows, that parking areas in Slovakia altogether amounts to about 5% of the area occupied by buildings. The theoretical energy potential from irradiation on parking areas is likewise about 5% of the theoretical rooftop PV potential on buildings.

Size of parking lot	No. of parking lots	Total area [m²]	Total irradiated energy on all areas [GWh/yr]
< 100 m²	2 230	147 000	178
100 m² - 1 000 m²	12 066	4 657 000	5 605
1 000 m² - 10 000 m²	4 038	9 820 000	11 838
> 10 000 m²	125	2 611 000	3 178
Total	18 459	17 236 000	20 799

Tab 3: Inventory of total area and theoretical PV potential total irradiation of parking lots. Areas are rounded to 1000 m².

2.2 Realizable rooftop PV potential in Slovakia

The realizable PV potential differs from the theoretical potential for several reasons:

- The total area of PV modules will be a significantly smaller than the total area of the roof they are mounted upon.
- Even under optimum conditions, a PV installation can only convert about 20% of the incoming solar radiation into electricity.

- The orientation of the PV modules is in general not at an optimum angle but is given by the geometry of the roof or by structural constraints of the racks holding the PV modules.

The determination of the realizable PV potential thus depends on assumptions for the type and the characteristics of the PV installation. A detailed description of the different PV installations that have been assumed for the calculation of the realizable PV potential is given in Sect. 5. The results for the realizable PV potential in Slovakia are listed in Tab 4 per kraj. Results on okres level are presented in Tab 10 in Appendix A. Comparison of the realizable PV potential with the theoretical potential in Sect. 2.1 shows that rooftop PV can recover about 9% of the irradiated energy on the total roof area.

Kraj	Total area of PV modules [m²]	Installed DC power [MW]	Installed AC power [MW]	Total energy yield [GWh/yr]
Banskobystrický kraj	22 585 000	4 881	4 067	4 714
Bratislavský kraj	17 959 000	3 881	3 234	3 827
Košický kraj	21 540 000	4 655	3 879	4 505
Nitriansky kraj	25 667 000	5 547	4 622	5 596
Prešovský kraj	21 580 000	4 663	3 886	4 329
Trenčiansky kraj	18 604 000	4 020	3 350	3 809
Trnavský kraj	22 090 000	4 774	3 978	4 725
Žilinský kraj	21 179 000	4 577	3 814	4 106
Total	171 204 000	36 997	30 831	35 611

Tab 4: Realizable rooftop PV potential per kraj. Areas are rounded to 1000 m².

The contributions of buildings of different size to the realizable PV potential are shown in Tab 5.

Size of building	Total area of PV modules [m²]	Installed DC power [MW]	Installed AC power [MW]	Total energy yield [GWh/yr]
< 10 m²	0	0	0	0
10 m² - 50 m²	9 358 000	2 022	1 685	1 700
50 m² - 500 m²	110 121 000	23 797	19 831	22 628
500 m² - 10 000 m²	44 280 000	9 569	7 974	9 655
> 10 000 m²	7 444 000	1 609	1 341	1 627
Total	171 204 000	36 997	30 831	35 611

Tab 5: Breakdown of realizable rooftop PV potential on building size. Areas are rounded to 1000 m².

Parking lots

Installation of PV modules on parking lots requires elaborate support structures that, on the one hand, have to carry the weight of the modules as well as snow and wind loads and, on the other hand, should not obstruct vehicle traffic and access to the parking places. Additional requirements are a connection to the electrical grid and structures housing the inverter and other electrical installations. Furthermore, shading from nearby buildings and vegetation is much more of an issue on parking lots than for rooftop PV. Thus, whereas rooftop PV can be installed on a large majority of the buildings, PV installations on parking lots should be limited to a subset of suitable parking areas, in particular to large and unobstructed ones.

No PV utilization has been assumed for parking areas smaller than 1000 m². To exclude single-row parking lines along roads and other irregularly shaped parking lots, the compactness of parking areas has been assessed from the ratio of area/perimeter. Parking areas with a ratio of area/perimeter smaller than six have been deemed unsuitable for a PV utilization. These two criteria reduce the total area available for PV utilization to about 11 647 000 m², which corresponds to about 68% of the total area given in Tab 3.

Particulars for the type and characteristics of PV installations on parking lots are given in Sect. 5.

To allow for shading and other restrictions, the area thus obtained has been reduced by additional 33 %, i.e. it is assumed that even for the larger and unobstructed parking areas, actual installation of PV is only possible in two thirds of the cases. Altogether, a PV utilization is thus assumed for roughly 46% of all parking areas in Slovakia.

Size of parking lot	Total area of PV modules [m²]	Installed DC power [MW]	Installed AC power [MW]	Total energy yield [GWh/yr]
< 100 m²	0	0	0	0
100 m² - 1 000 m²	0	0	0	0
1 000 m² - 10 000 m²	3 104 000	671	559	675
> 10 000 m²	897 000	194	162	197
Total	4 001 000	865	721	872

Tab 6: Realizable PV potential on parking lots. Only parking areas with a ratio of area/perimeter greater than six are considered. Areas are rounded to 1000 m².

3. Buildings data

This study uses the current inventory of buildings in Slovakia and does not try to anticipate future changes from new construction or demolition of buildings. Open Street Map data has been adopted for the database of buildings in Slovakia. Comparison with aerial photography confirms a good quality with regard to the outline of the buildings and the completeness of the database. In some instances, it became apparent, that the cartographic coverage is somewhat lagging behind with regard to new construction or demolition, but this should not significantly affect the overall results.

The following categories of buildings, that can be assumed to be unsuitable for the installation of rooftop PV, have been removed from the database:

- Non-permanent buildings: e.g. containers, caravans, houseboats, etc.
- Ancient and preserved buildings: churches, monasteries, castles, etc.
- Silos and storage tanks
- Greenhouses
- Buildings in unsuitable condition: ruins, abandoned, etc.

As the buildings-database does not have attributes for all buildings, the deletion of these categories of buildings is likely incomplete. As this affects only a small fraction of the buildings, this should only have a minor effect on the results.

In addition to the removal of these definitive categories, an overall fraction of 10% of the buildings has been assumed to be unsuitable for the installation of rooftop PV. This percentage is meant to cover (1) buildings with structurally unsuitable roof construction or roofs in poor condition, and (2) historical buildings that must not be used for PV installation for conservational reasons.

Greenhouses can be used for the installation of PV plants by integrating the PV modules into the roof structure of the greenhouse. As some light transmission into the greenhouse is necessary, this results in lower efficiencies than in conventional rooftop PV installations. Because of the unique type of PV installation and the small fraction of greenhouses as compared to other buildings[1], greenhouses have not been considered separately in this study.

Fig 1 illustrates the locations of the about 2.4 million buildings in Slovakia, reflecting the urban centers and Slovak settlement structure.

[1] In the database used for this study, greenhouses account for about 1‰ in ground area as compared to other types of buildings. This database is likely incomplete, in particular for very small greenhouses. On the other hand, small greenhouses used for private gardening would not be considered suitable for PV installation, anyway.

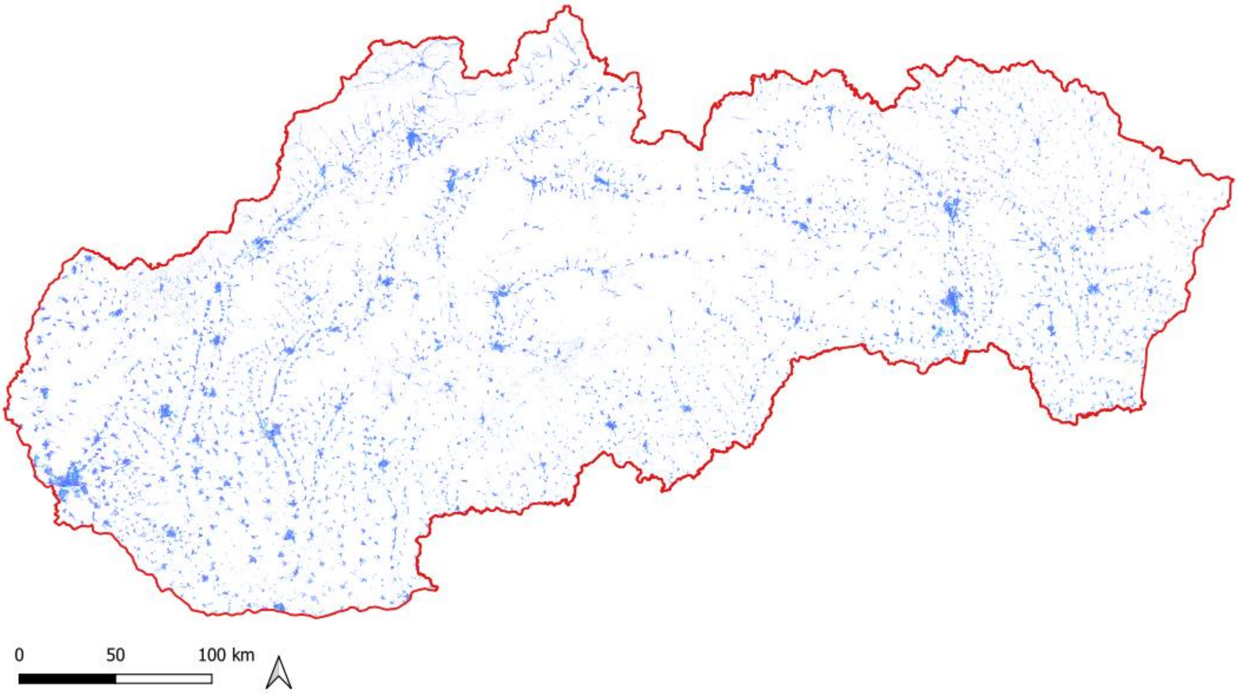


Fig 1: Buildings in Slovakia.

4. Solar irradiation data

Solar irradiation on a site depends on the geographical latitude (inclination, duration), obstruction from the terrain (shadows), and the typical meteorological conditions (clouds, haze). Solar Irradiation can be separated into direct solar irradiation and diffuse radiation from atmospheric scattering. Both components contribute to the PV potential; examples for almost pure diffuse irradiation are the light conditions in a shade or under a cloud cover. A measure for the total irradiation, including both the direct and the diffuse components, is the global horizontal irradiation (GHI).

A two-step approach has been used for the modeling of the production of PV installations throughout Slovakia. First, energy production has been calculated based on time series for the typical meteorological year (TMY; in one-hour intervals) including direct and diffuse irradiation as well as meteorological information. In a second step, scaling with the total irradiation (i.e. using the GHI as a proxy) has been used to apply the results of this detailed modeling to all buildings in Slovakia.

TMY data, provided by the Photovoltaic Geographical Information System (PVGIS), has been used from nine distinct points in Slovakia, which give a good coverage of the range of irradiation conditions and geographic variability. In terms of global horizontal irradiation, these nine points cover a range from 1029 kWh/m²/yr to 1315 kWh/m²/yr. Fig 2 shows the locations of these points as black dots. No point has been placed in mountainous regions (e.g. Tatra mountains), because in such regions, irradiation is dominated by the shadows cast by the mountains that can vary on very small length scales. Small spatial offsets or differences in the numerical grid can thus cause large deviations between the different data sources for the TMY and the GHI data.

The dataset for the global horizontal irradiation, illustrated in Fig 2, has been adopted from the Global Solar Atlas and covers the whole of Slovakia with a spatial resolution of about 200 m.

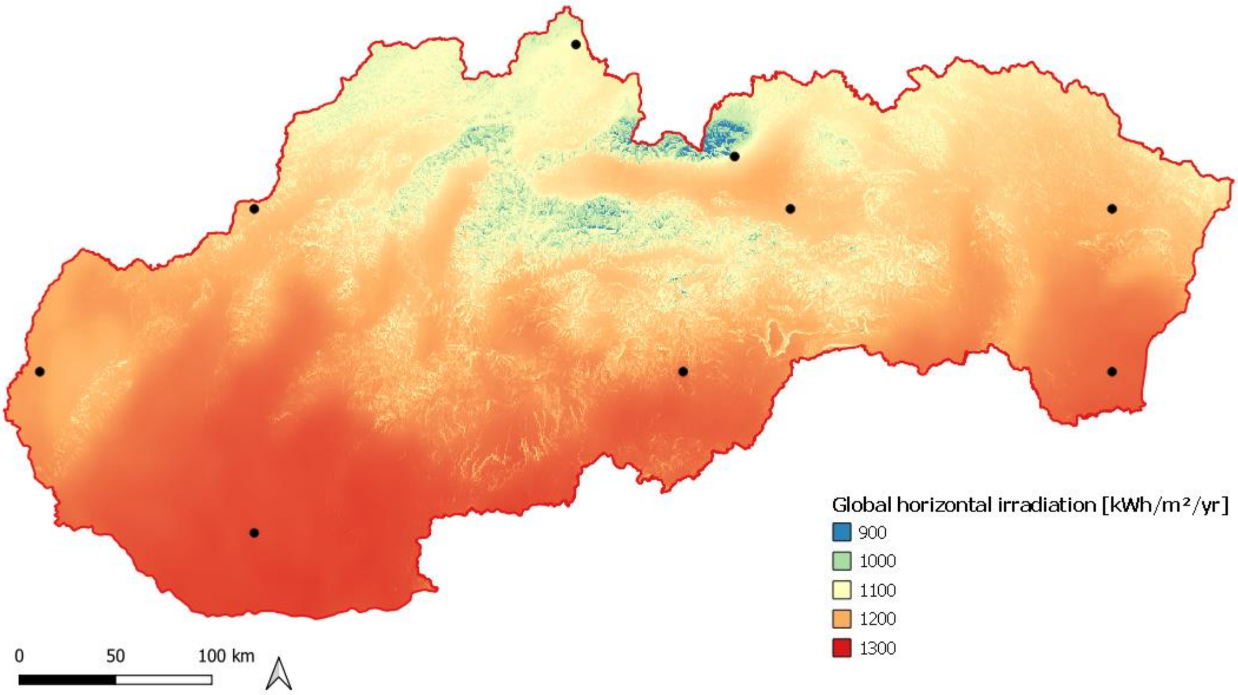


Fig 2: Global horizontal irradiation in Slovakia according to Global Solar Atlas. The black dots indicate the nine locations of the typical meteorological year (TMY) datasets.

5. Modeling of PV installations

5.1 Types of PV installations

The PV utilization of buildings and the suitable types of PV installations very much depend on the shape and on the construction of the roofs. There are, however, some general trends and typical types of roofs depending on the size of the building. For example, a large fraction of residential buildings with a ground area of around 100 m² can be assumed to have a pitched roof. On the other hand, a building with a ground area of 10 000 m² will most likely possess a flat roof. Therefore, in an average sense, typical types of PV installations have been assumed depending on the size of the building:

Building smaller than 10 m²

Buildings with a ground area of less than 10 m² are assumed to be too small to justify the installation of PV.

Assumed PV utilization: None.

Buildings from 10 m² to 50 m²

These buildings are frequently auxiliary building, garages or sheds and are assumed to possess a flat roof. Buildings in this category are often part of a larger compound of buildings (e.g. rows of garages), that are well suited to PV utilization. Since such buildings can be expected to possess a low height and frequently will be located in the vicinity of larger buildings or vegetation, shading is a likely source of additional losses which has been estimated to amount for 10% on average.

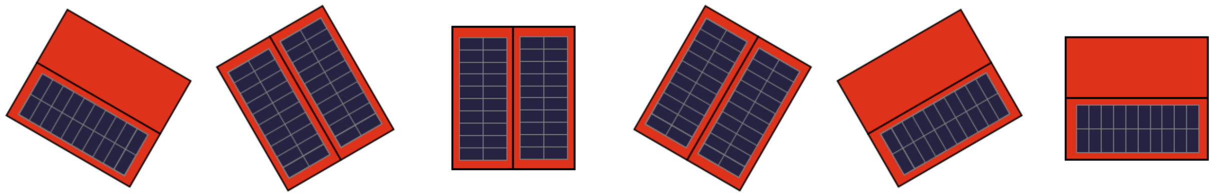
Assumed PV Utilization: Flat-mounted PV modules (10° East-West), covering 50% of the roof area.

Buildings from 50 m² to 500 m²

This range covers the typical size of residential buildings that are assumed to possess pitched roofs. For the average slope of the roof, an inclination of 35° has been adopted.

Assumed PV Utilization: Surface mounted PV modules (i.e. inclination of modules is the slope of the roof). Depending on the orientation of the roof ridge, modules are assumed to be mounted on the southern-facing section of the roof only, or on both roof sections, when the roof sections are roughly in an east-west orientation. In either case, the PV modules are assumed to cover 2/3 of the respective roof section (see Tab 7)

For the application of this utilization scheme for pitched roofs to the inventory of Slovak buildings, it has been assumed that the roof ridge is aligned to the main axis of the building’s ground area. To do so, the main axes of all buildings have been derived from the buildings’ outlines in the database of buildings.



Compass orientation of roof ridge					
300°	330°	0°	30°	60°	90°
PV utilization					
Only southern facing roof section	Both roof sections	Both roof sections	Both roof sections	Only southern facing roof section	Only southern facing roof section
Ratio: module area to total roof area					
1/3	2/3	2/3	2/3	1/3	1/3

Tab 7: Schematics of PV utilization of pitched roofs depending on the orientation of the roof ridge.

Buildings larger than 500 m²

This category mainly comprises large residential buildings or building blocks and commercial and industrial buildings. These buildings typically possess flat roofs.

Assumed PV Utilization: Two different types of PV installations have been considered for buildings in this category.

- Flat-mounted PV modules (10° East-West), covering 50% of the roof area.
- Flat-mounted PV modules oriented in southern direction and tilted at 15°, covering 50% of the roof area.

For buildings larger than 500 m², it is thus assumed that one of these two types of installations is employed, depending on local conditions and the outline of the roof. As these installations give somewhat different energy yields (see Fig 3), an average value has been used for the inventory of buildings in that category.

The coverage ratio of 50% in these PV installations is intended to allow for restrictions in the use of the roof area such as:

- Skylights and other rooftop installations (chimneys, antennae, ventilations, heat exchangers of air conditioning or refrigerating equipment)
- Access for maintenance work on the roof such as sealing of leaks
- Access ways for the maintenance of the PV installation

Parking lots

Mounting of PV modules above a parking lot involves covering a large horizontal area and in that sense resembles a PV utilization of a flat roof. The module area that can be mounted depends on the layout and the construction of the support structure and the compromises with regard to parking spaces and vehicle traffic. Overall, it is assumed that the total area of the PV modules accounts for 50% of the total area of the parking lot. The PV utilization of parking lots is thus modeled in the same way as for large flat roofs.

Assumed PV Utilization:

- Flat-mounted PV modules (10° East-West), covering 50% of the area of the parking lot.
- Flat-mounted PV modules oriented in southern direction and tilted at 15°, covering 50% of the area of the parking lot.

5.2 Technical modeling

The main technical parameters used for the modeling of the PV installations are summarized in Tab 8. The parameters are meant to represent average characteristics of rooftop PV installations in Slovakia. Thus, the average age of the PV installations is taken as half of the installations' life time, which is assumed to be 20 years. The values for the module degradation and soiling in Tab 8 therefore represent an average age of 10 years.

The efficiencies of PV modules are likely to further improve in the future. In Tab 8, the current state-of-the-art value has been used, in the understanding, that this efficiency is a reasonable estimate for average properties of new and old PV installations in the future.

Parameter	Value
PV module type	Monocrystalline silicon, monofacial
Nominal module efficiency	21.5%
Weighted inverter efficiency	97.5%
DC/AC ratio	1.2
Technical availability	98%
Soiling losses	3%
Snow losses	none
Average degradation of modules	5%
Module mismatch	2%
Diode and connection losses	0.5%
DC wiring losses	2%
AC losses	1%

Tab 8: Some general PV modeling assumptions and parametrizations.

Each type of PV installation mentioned above in Sect. 5.1 has been modeled for the nine sets of typical meteorological year (TMY) time series distributed throughout Slovakia (Fig 2) and covering a range in global horizontal irradiation (GHI) between 1029 kWh/m²/yr and 1315 kWh/m²/yr. The results of these simulation runs have been evaluated in terms of the produced energy versus the total irradiation available on the roof area. This efficiency per horizontal roof area corresponds to the ratio of the realizable PV potential to the theoretical PV potential.

The illustration of the modeling results in Fig 3 shows that the efficiencies of PV installations are almost constant for the different TMY time series. The different characteristics of direct and diffuse irradiation at the selected locations in Slovakia thus do not have a significant effect. The calculation of the energy yield for buildings throughout Slovakia based on the map of GHI in Fig 2 is thus confirmed to be a valid and adequate approach.

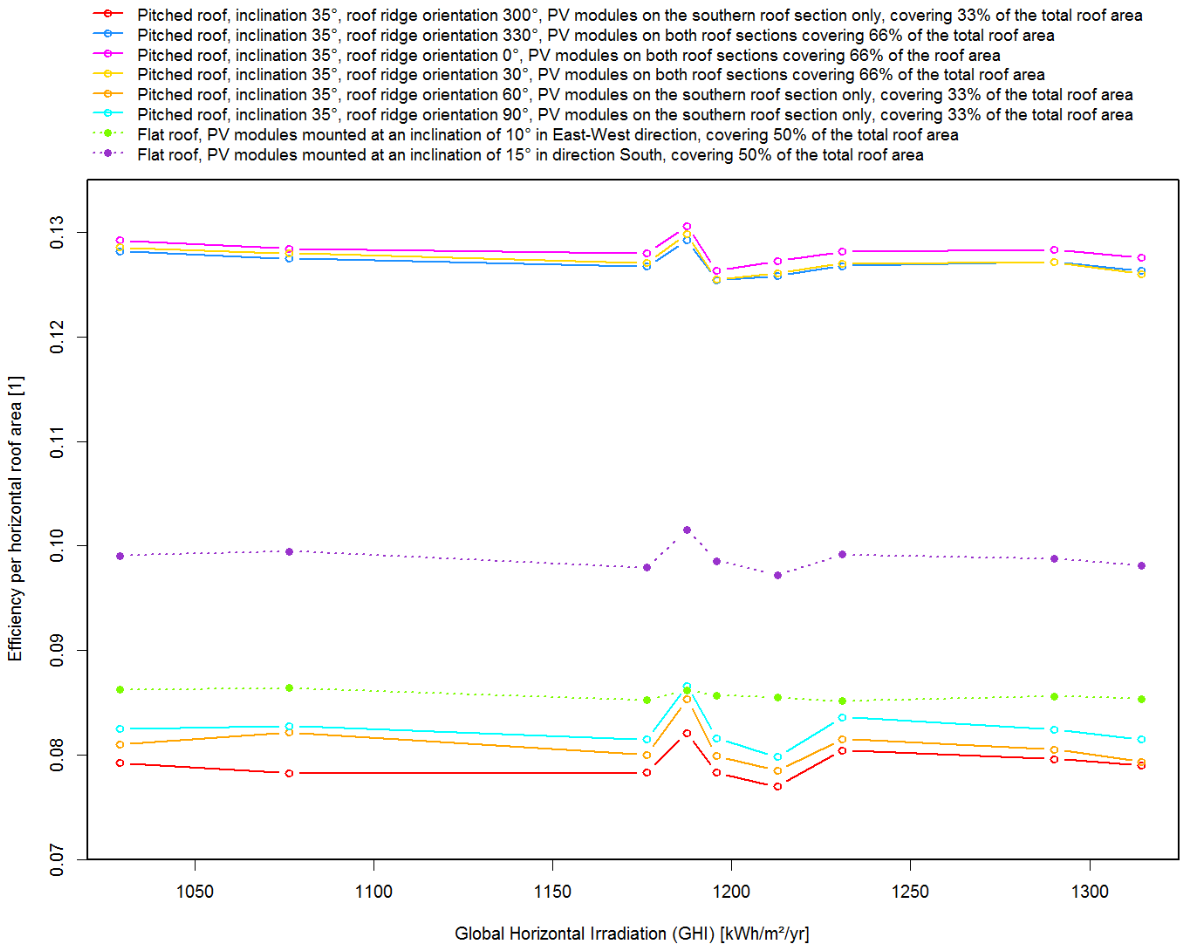


Fig 3: Efficiency per horizontal roof area for different types of PV installations versus Global Horizontal Irradiation (GHI). The nine different levels of GHI (symbols on the lines) correspond to the nine different TMY datasets throughout Slovakia. The illustrated efficiency gives the fraction of the realized PV potential with a certain type of PV installation to the theoretical PV potential available on the total roof area.

6. References and data sources

Geographic information on buildings: Open Street Map (www.openstreetmaps.org), licensed under ODbL v1.0 (www.opendatacommons.org/licenses/odbl/1-0/)

Solar irradiation maps: Global Solar Atlas (globalsolaratlas.info), licensed under CC 4.0 (www.creativecommons.org/licenses/by/4.0/)

Typical meteorological year data (hourly): Photovoltaic Geographical Information System, PVGIS, European Commission, Joint Research Centre (re.jrc.ec.europa.eu/pvg_tools), licensed under CC 4.0 (www.creativecommons.org/licenses/by/4.0/)

Appendix A: Tables with results on okres-level

Okres	No. of buildings	Total surface area of buildings [m²]	Total irradiated energy on all buildings [GWh/yr]
Bánovce nad Bebravou	17 411	2 452 000	2 986
Banská Štiavnica	12 575	1 288 000	1 556
Banská Bystrica	44 356	5 659 000	6 704
Bardejov	34 669	3 804 000	4 317
Bratislava I	8 484	1 954 000	2 403
Bratislava II	26 946	4 973 000	6 153
Bratislava III	21 543	4 364 000	5 347
Bratislava IV	17 283	4 154 000	5 084
Bratislava V	7 921	2 414 000	2 994
Brezno	40 859	4 161 000	4 828
Bytča	21 769	1 918 000	2 160
Čadca	43 475	4 635 000	5 073
Detva	19 875	2 200 000	2 670
Dolný Kubín	21 794	2 432 000	2 701
Dunajská Streda	75 151	10 152 000	12 817
Galanta	43 931	7 232 000	9 088
Gelnica	16 192	1 643 000	1 876
Hlohovec	19 285	3 087 000	3 837
Humenné	25 040	3 241 000	3 871
Ilava	22 865	3 511 000	4 120
Kežmarok	24 151	3 207 000	3 730
Košice - okolie	54 612	7 464 000	9 022
Košice I	16 705	2 377 000	2 859
Košice II	13 228	3 290 000	3 989
Košice III	3 925	442 000	535
Košice IV	14 387	3 062 000	3 712
Komárno	49 043	7 575 000	9 632
Krupina	16 575	2 240 000	2 771
Kysucké Nové Mesto	14 756	1 592 000	1 775

Levice	64 470	9 969 000	12 572
Levoča	16 509	2 002 000	2 335
Liptovský Mikuláš	43 915	5 597 000	6 449
Lučenec	40 478	4 875 000	6 074
Malacky	39 905	5 978 000	7 214
Martin	39 307	5 547 000	6 387
Medzilaborce	8 490	911 000	1 051
Michalovce	4 5541	7 346 000	9 039
Myjava	17 190	2 396 000	2 882
Námestovo	29 371	3 404 000	3 753
Nitra	66 278	11 314 000	14 240
Nové Mesto nad Váhom	33 215	5 047 000	6 081
Nové Zámky	69 987	9 879 000	12 519
Púchov	22 764	2 916 000	3 351
Partizánske	19 224	2 704 000	3 312
Pezinok	31 495	4 265 000	5 200
Piešťany	28 302	4 359 000	5 353
Poltár	16 172	1 782 000	2 187
Poprad	35 998	5 119 000	6 006
Považská Bystrica	27 638	3 210 000	3 645
Prešov	58 082	8 603 000	10 121
Prievidza	55 696	7 401 000	8 821
Revúca	18 294	2 320 000	2 793
Rimavská Sobota	42 002	5 534 000	6 841
Rožňava	37 427	4 257 000	5 055
Ružomberok	35 997	3 622 000	4 034
Sabinov	25 478	2 695 000	3 090
Šaľa	21 825	3 298 000	4 168
Senec	44 210	7 162 000	8 910
Senica	46 706	5 436 000	6 548
Skalica	24 097	3 274 000	3 934
Snina	19 771	2 254 000	2 647
Sobrance	16 567	1 990 000	2 437
Spišská Nová Ves	32 672	3 959 000	4 591

Stará Ľubovňa	23 538	2 658 000	2 985
Stropkov	11 957	1 223 000	1 422
Svidník	15 358	1 770 000	2 031
Topoľčany	31 902	4 802 000	5 954
Trebišov	40 960	6 347 000	7 827
Trenčín	42 802	6 570 000	7 782
Trnava	59 435	9 497 000	11 741
Turčianske Teplice	13 177	1 497 000	1 768
Tvrdošín	17 642	2 255 000	2 517
Veľký Krtíš	28 680	3 831 000	4 806
Vranov nad Topľou	31 103	4 259 000	5 076
Žarnovica	18 528	2 064 000	2 473
Žiar nad Hronom	24 369	3 202 000	3 827
Žilina	65 565	8 630 000	9 747
Zlaté Moravce	21 386	3 191 000	3 975
Zvolen	30 529	4 646 000	5 643

Tab 9: Theoretical rooftop PV potential per okres. Areas are rounded to 1000 m².

Okres	Total area of PV modules [m²]	Installed DC power [MW]	Installed AC power [MW]	Total energy yield [GWh/yr]
Bánovce nad Bebravou	1 255 000	271	226	264
Banská Štiavnica	678 000	147	122	139
Banská Bystrica	2 912 000	629	524	593
Bardejov	1 979 000	428	356	384
Bratislava I	986 000	213	178	211
Bratislava II	2 474 000	535	446	535
Bratislava III	2 174 000	470	392	464
Bratislava IV	2 073 000	448	373	444
Bratislava V	1 201 000	260	216	261
Brezno	2 130 000	460	384	424
Bytča	987 000	213	178	189
Čadca	2 462 000	532	443	459
Detva	1 148 000	248	207	238

Dolný Kubín	1 266 000	274	228	241
Dunajská Streda	5 239 000	1 132	944	1 137
Galanta	3 713 000	802	669	808
Gelnica	860 000	186	155	168
Hlohovec	1 575 000	340	284	339
Humenné	1 641 000	355	295	340
Ilava	1 773 000	383	319	360
Kežmarok	1 682 000	363	303	335
Košice - okolie	3 866 000	836	696	807
Košice I	1 195 000	258	215	249
Košice II	1 612 000	348	290	344
Košice III	217 000	47	39	46
Košice IV	1 519 000	328	274	323
Komárno	3 897 000	842	702	856
Krupina	1 146 000	248	206	245
Kysucké Nové Mesto	813 000	176	146	156
Levice	5 112 000	1 105	921	1 115
Levoča	1 032 000	223	186	207
Liptovský Mikuláš	2 857 000	617	515	568
Lučenec	2 506 000	541	451	537
Malacky	3 101 000	670	558	645
Martin	2 829 000	611	509	563
Medzilaborce	461 000	100	83	92
Michalovce	3 707 000	801	668	794
Myjava	1 258 000	272	227	260
Námestovo	1 771 000	383	319	336
Nitra	5 751 000	1 243	1 036	1 258
Nové Mesto nad Váhom	2 596 000	561	467	541
Nové Zámky	5 121 000	1 107	922	1 118
Púchov	1 482 000	320	267	294
Partizánske	1 393 000	301	251	294
Pezinok	2 209 000	477	398	464
Piešťany	2 231 000	482	402	475
Poltár	927 000	200	167	195

Poprad	2 632 000	569	474	532
Považská Bystrica	1 626 000	351	293	318
Prešov	4 435 000	958	799	902
Prievidza	3 829 000	828	690	785
Revúca	1 200 000	259	216	249
Rimavská Sobota	2 871 000	620	517	610
Rožňava	2 222 000	480	400	451
Ružomberok	1 858 000	402	335	355
Sabinov	1 409 000	304	254	276
Šaľa	1 685 000	364	303	369
Senec	3 740 000	808	673	802
Senica	2 846 000	615	513	587
Skalica	1 703 000	368	307	351
Snina	1 169 000	253	211	235
Sobrance	1 030 000	223	186	217
Spišská Nová Ves	2 034 000	440	366	406
Stará Ľubovňa	1 377 000	298	248	265
Stropkov	637 000	138	115	126
Svidník	909 000	196	164	180
Topoľčany	2 463 000	532	444	528
Trebišov	3 279 000	709	590	701
Trenčín	3 392 000	733	611	693
Trnava	4 782 000	1 033	861	1 028
Turčianske Teplice	780 000	169	141	158
Tvrdošín	1 205 000	260	217	229
Veľký Krtíš	1 976 000	427	356	427
Vranov nad Topľou	2 217 000	479	399	455
Žarnovica	1 079 000	233	194	221
Žiar nad Hronom	1 639 000	354	295	337
Žilina	4 351 000	940	784	852
Zlaté Moravce	1 638 000	354	295	353
Zvolen	2 372 000	513	427	498

Tab 10: Realizable rooftop PV potential per okres. Areas are rounded to 1000 m².