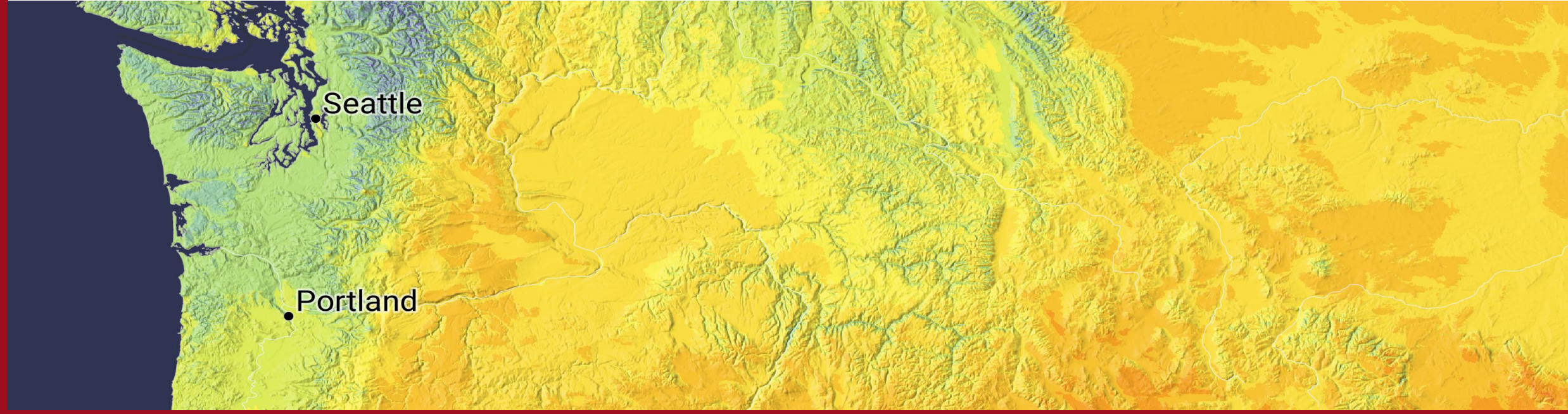


GLOBAL SOLAR ATLAS

Geo-dáta a online nástroje pre podporu rozvoja solárnej energetiky

Marcel Šúri, Juraj Beták, Tomáš Cebecauer, Michal Moravčík, Šimon Štassel, Konštantín Rosina, Artur Skoczek, Peter Orosi

Solargis s.r.o., Mýtna 48, 811 07 Bratislava, contact@solargis.com

GeoKarto 2020, 10-11 Sep, Košice

SOLARGIS

O čom budeme hovoriť?

1. Klimatické a meteorologické dáta
   v kontexte solárnej energetiky

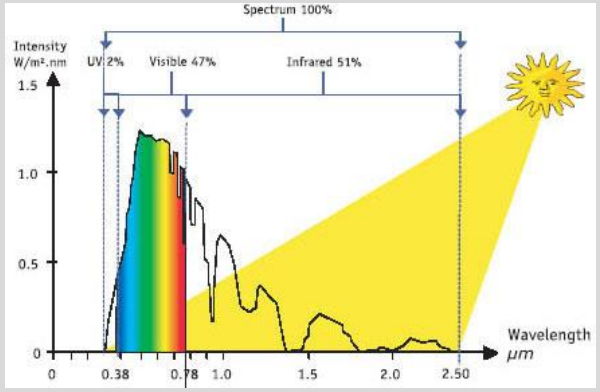
2. Čo nové ponúka **GlobalSolarAtlas.info** verzia 2

3. Vybrané aspekty/funkcionality/implementácie
   zaujímavé pre GeoKarto komunitu

SOLARGIS

Solárna radiácia

Viditeľné spektrum



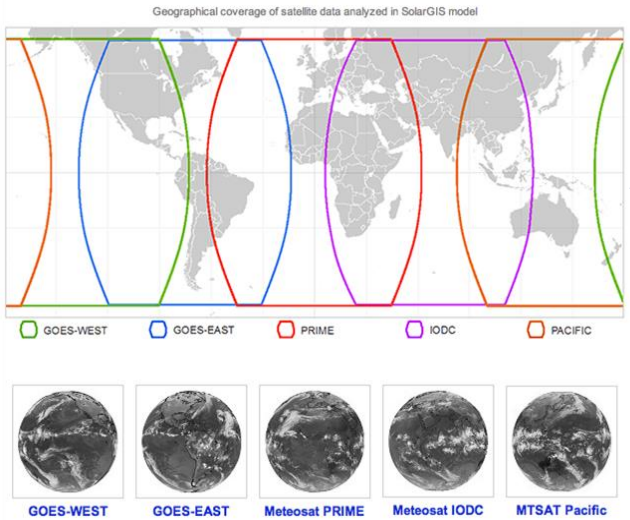
Meranie

vs

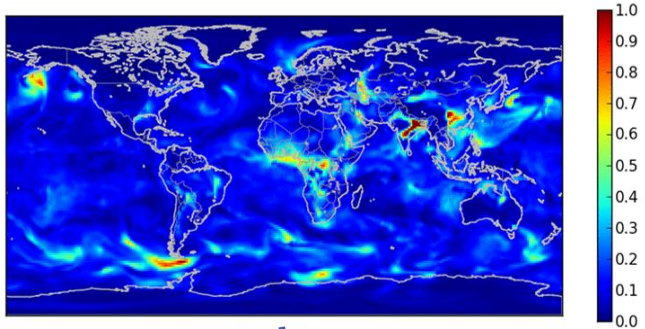
Modelovanie

Solargis model

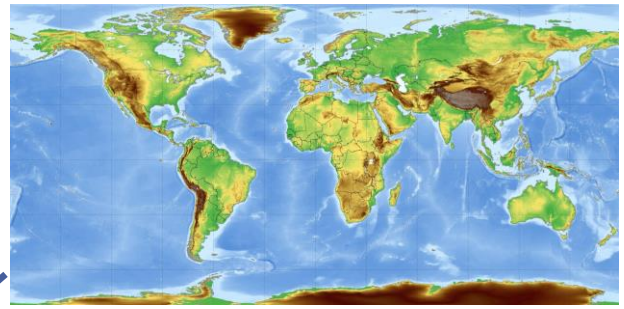
Meteorologické satelity



Atmosférické modely



Terén a iné dáta

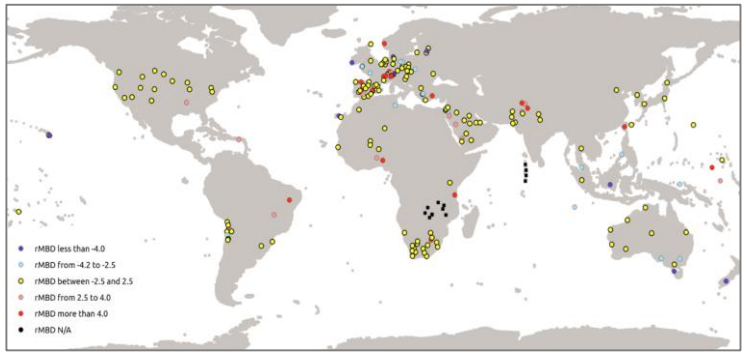


GHI
DNI
DIF

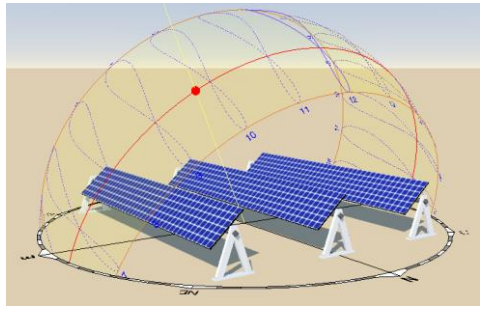
(CSP elektrárne)
DNI: Direct Normal Irradiance

GTI Global Tilted Irradiance
(PV elektrárne)

Validácia pomocou solárnych meraní



24 / 7 / 10 alebo 15 min časový krok



PVOUT
Výroba elektriny z fotovoltiky

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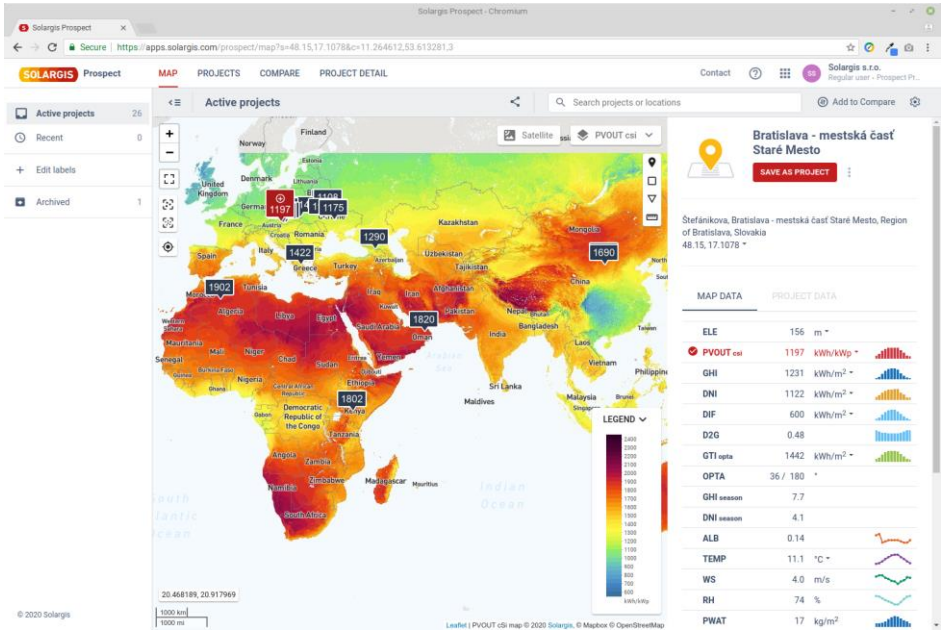
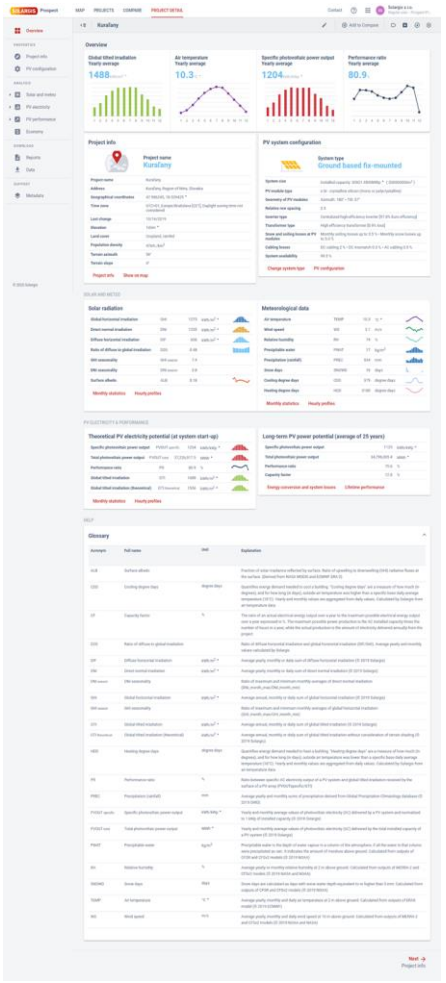
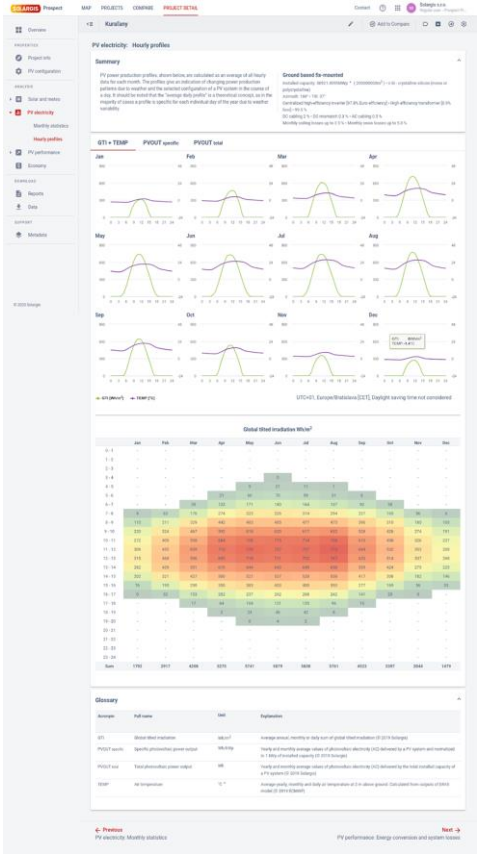
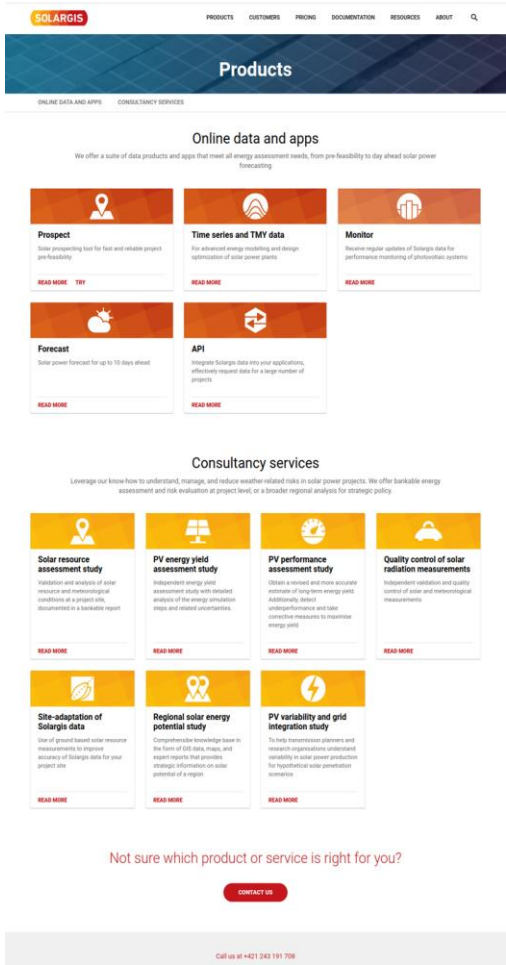
Publikácia dát

solargis.com Komerčná platforma pre profesionálnych klientov









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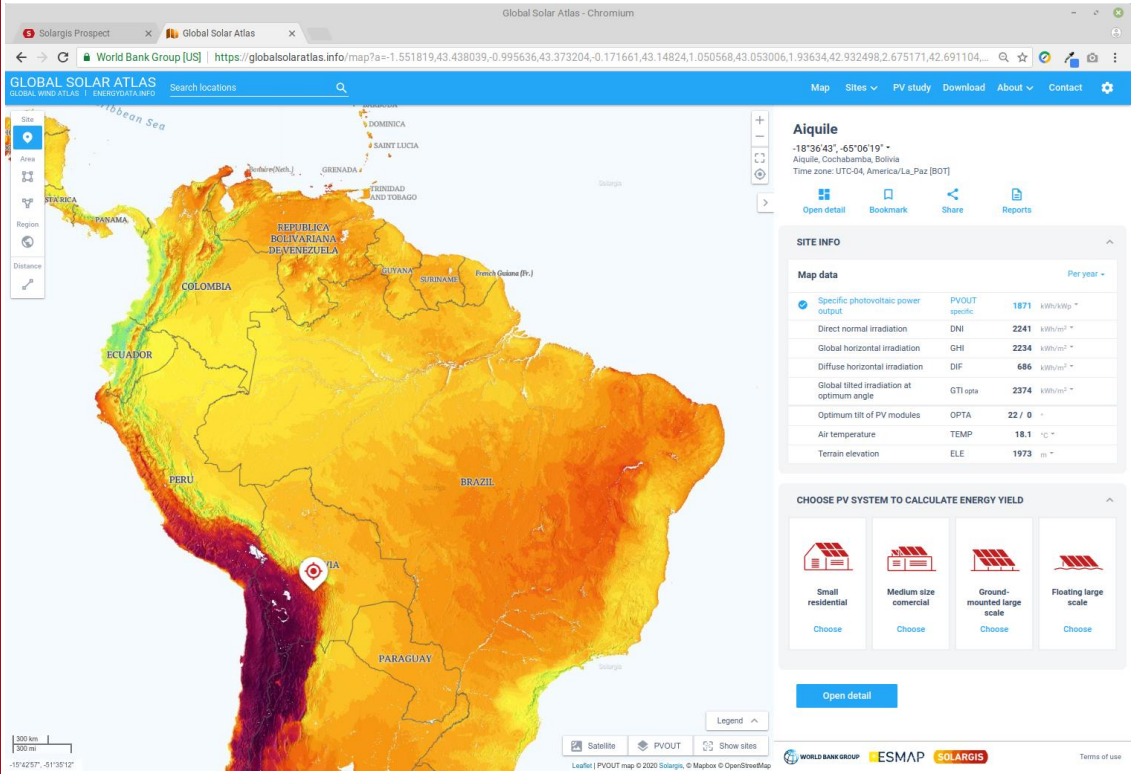
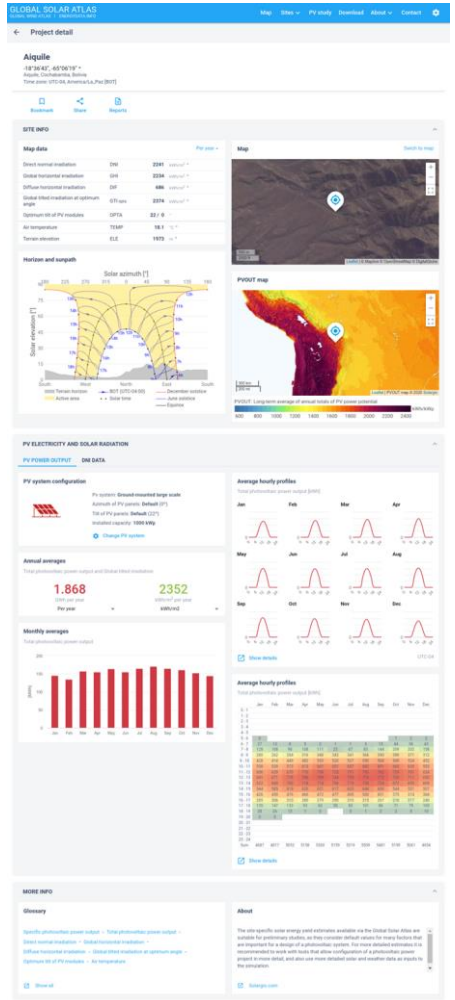
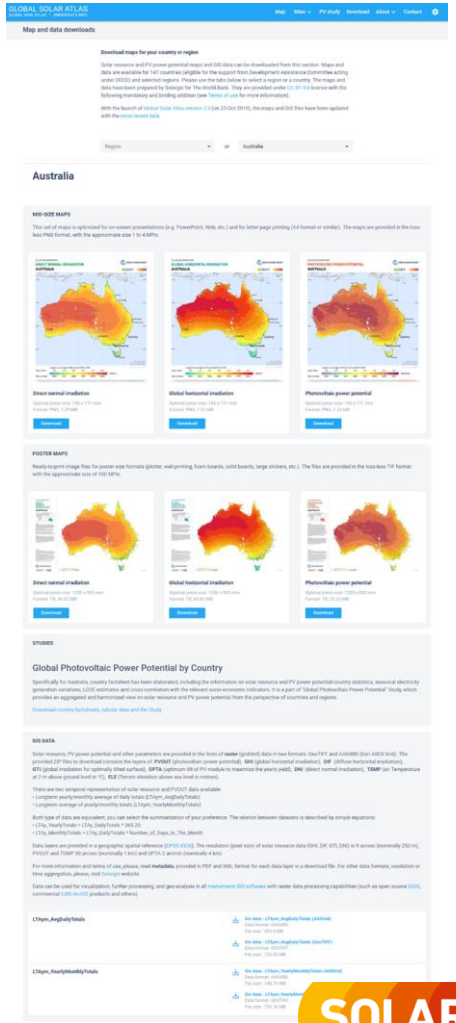
Publikácia dát

globalsolaratlas.info

Free (CC BY 4.0) dáta a nástroje pre predbežné plánovanie, strategické rozhodovanie, decíznu sféru, výskum a edukácia







Global Solar Atlas is provided by the World Bank Group, financed by ESMAP and created by Solargis

SOLARGIS

Global Solar Atlas

Global Solar Atlas is provided by the **World Bank Group**, financed by **ESMAP** and created by **Solargis**

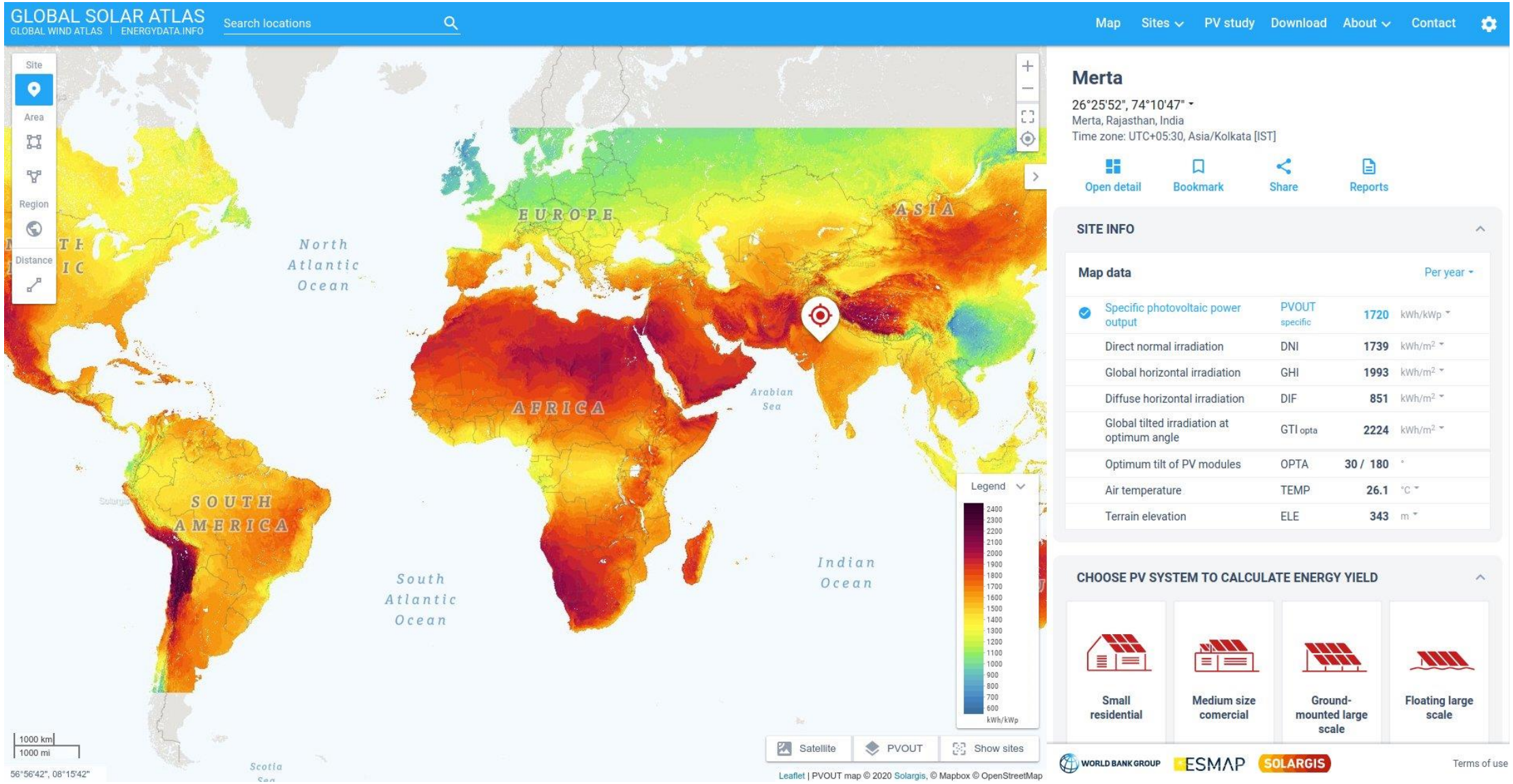
Verzia 1

- Publikácia v roku 2017 (prezentácia GeoKarto 2018)

Verzia 2

- Publikácia 2019/2020
- Update klimatických dát (časový rad o +3 roky)
- Architektúra aplikácia na AWS (v spolupráci s ableneo.com)
- Nový koncept UI (v spolupráci s 001studio)
- Nové funkcionality
- Dokumentácia a štúdijný materiál

globalsolaratlas.info – prehľad



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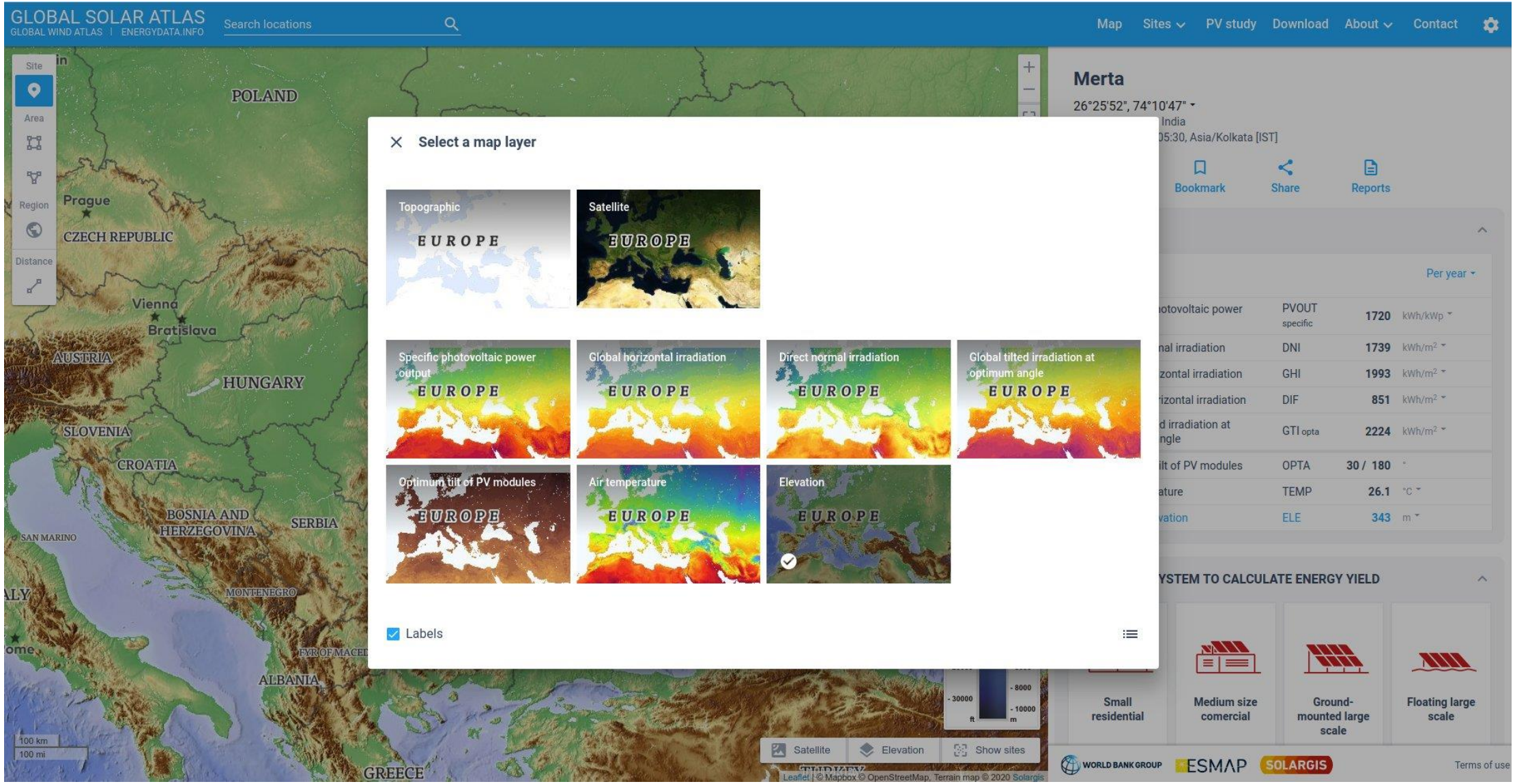
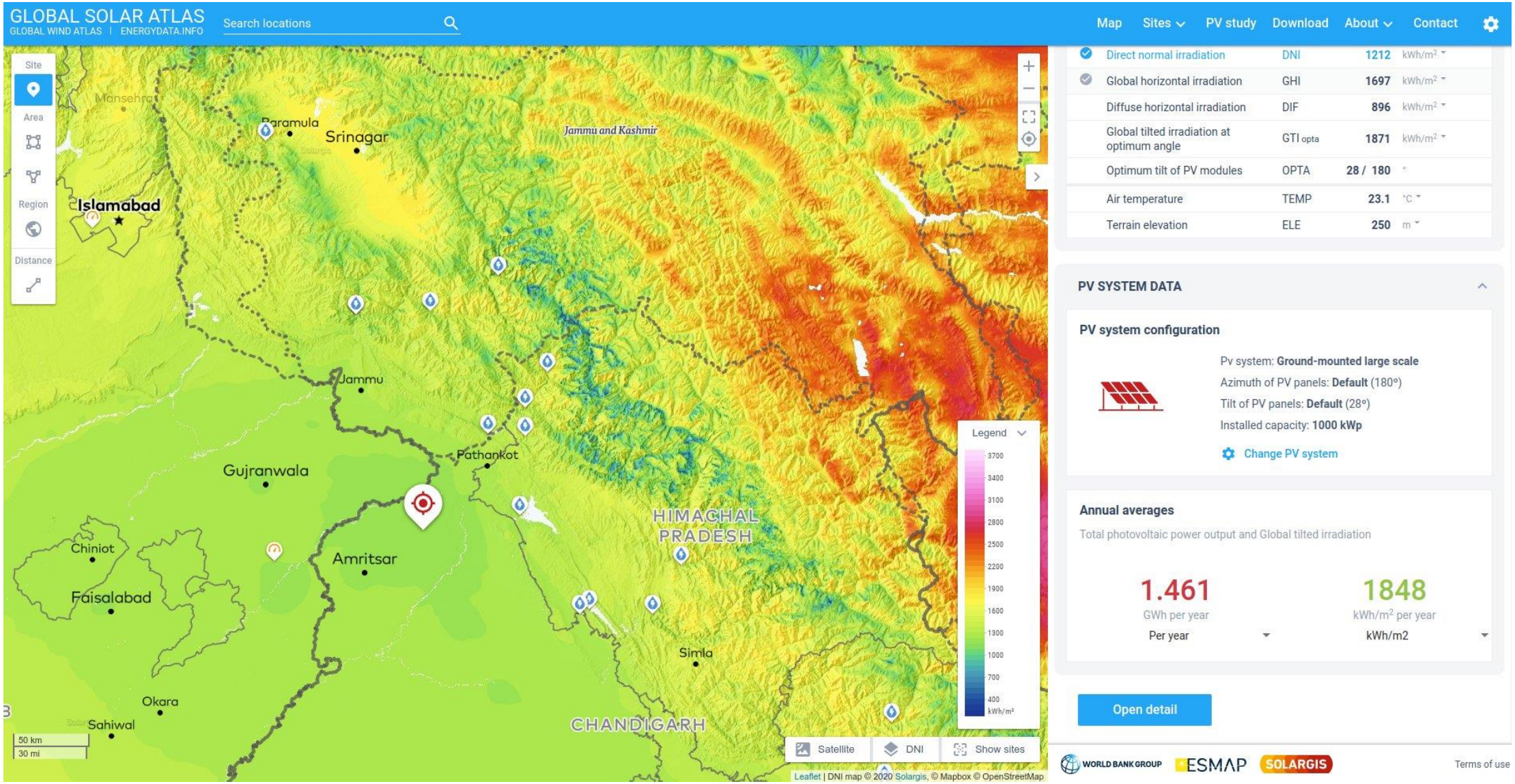
global**solar**atlas.info – prehľad



globalsolaratlas.info – prehľad



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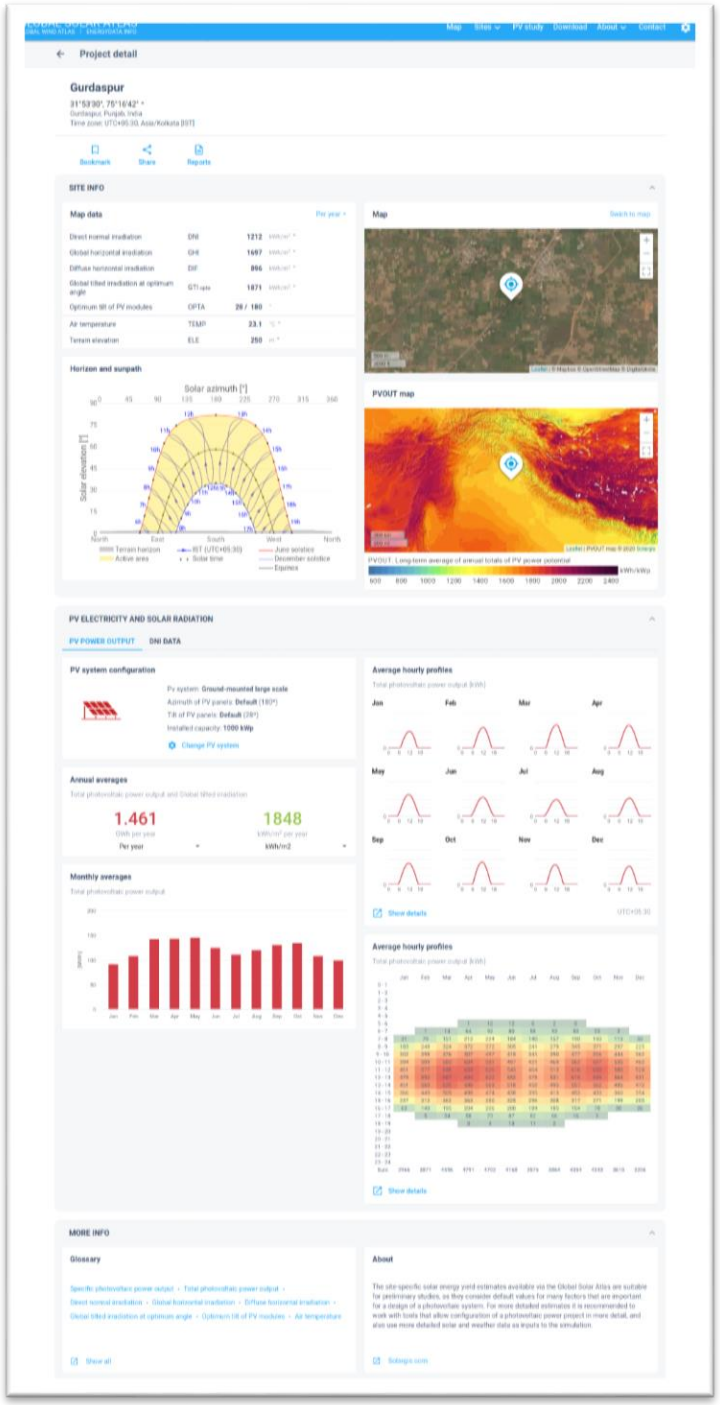
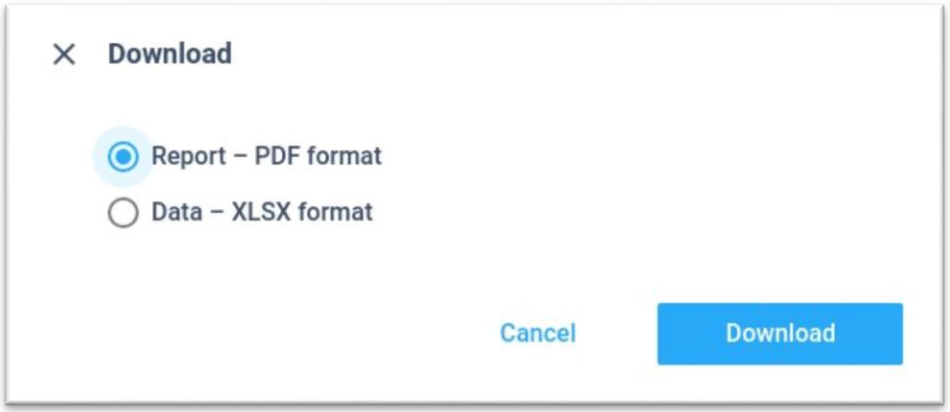
globalsolaratlas.info – prehľad





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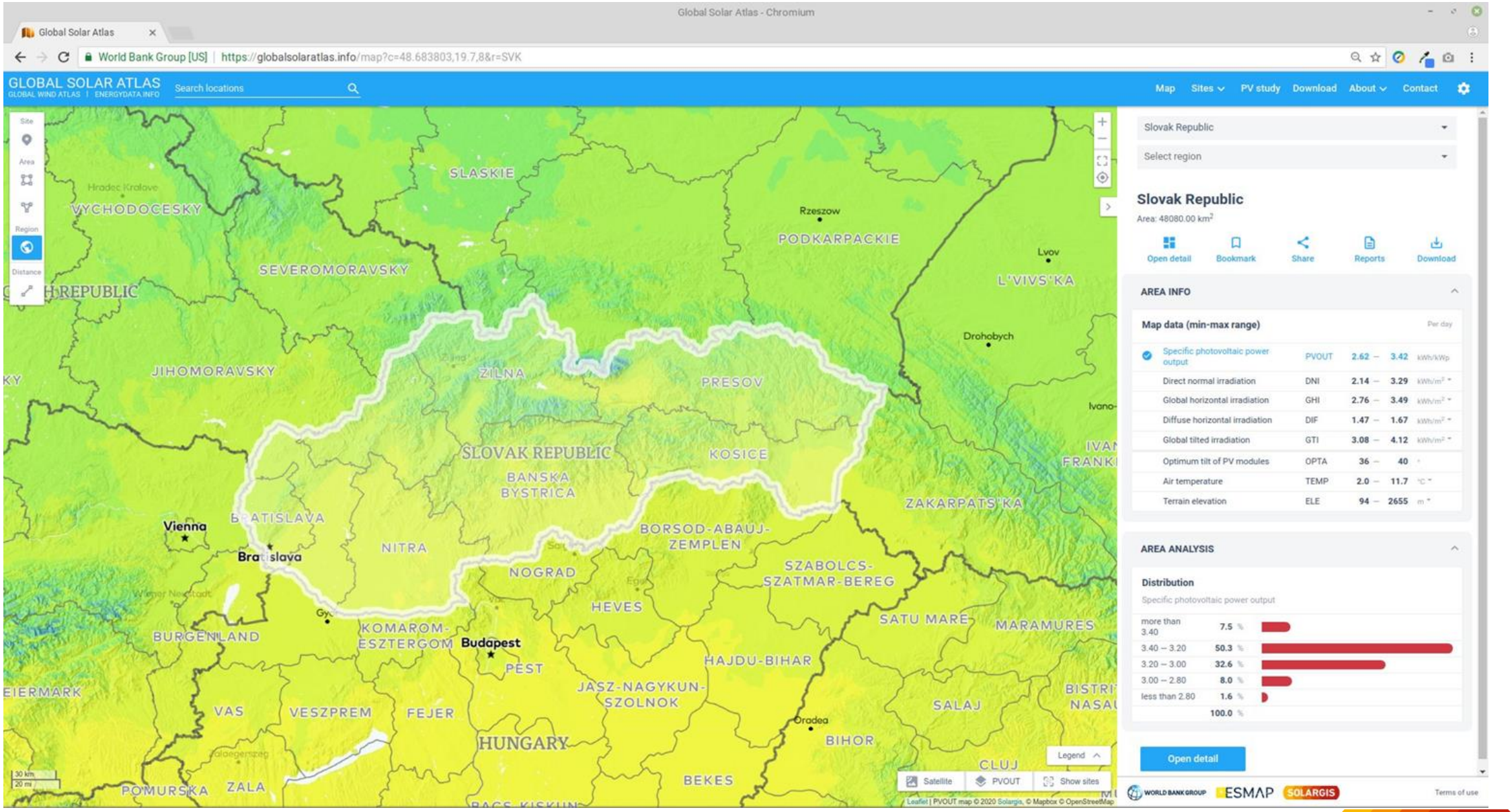
globalsolaratlas.info – Zonálna štatistika



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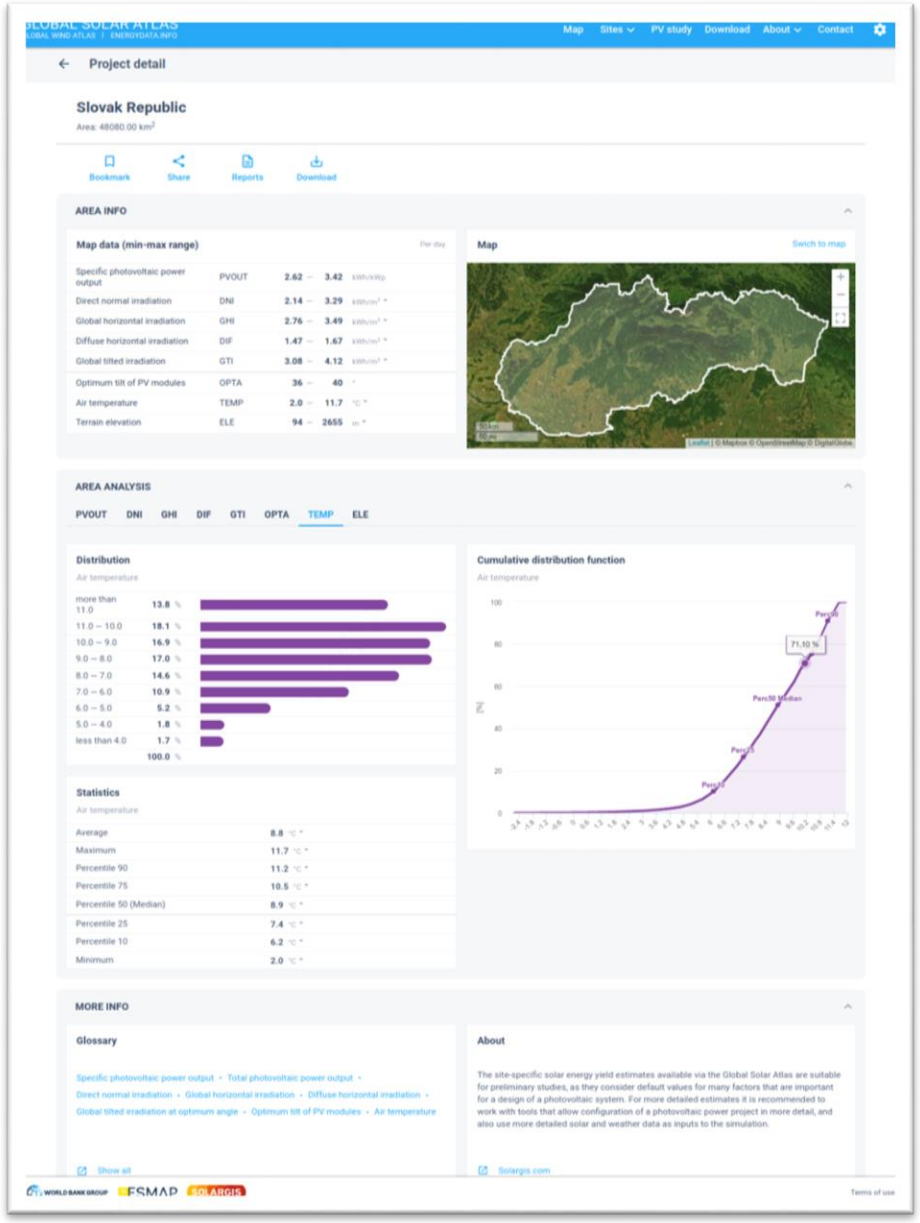
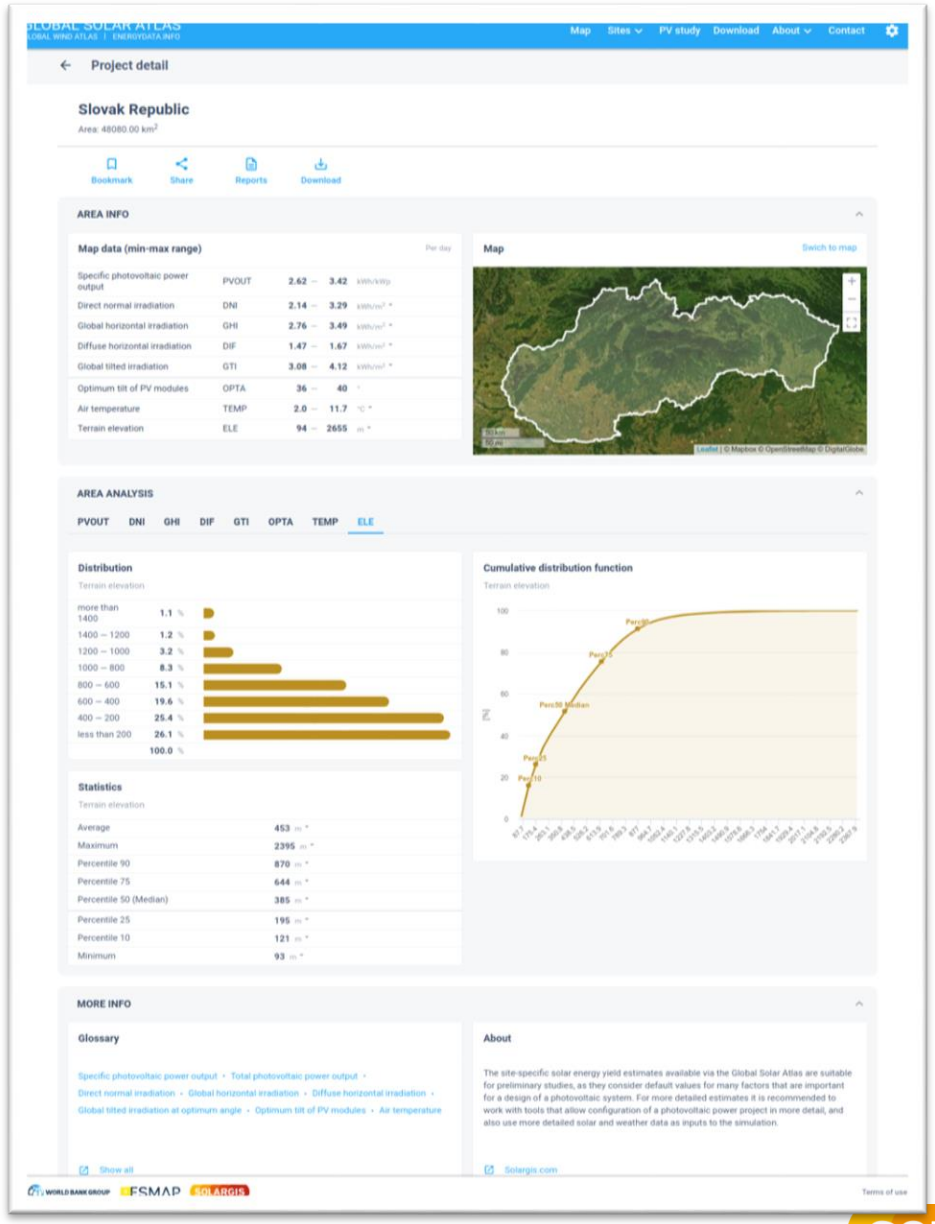
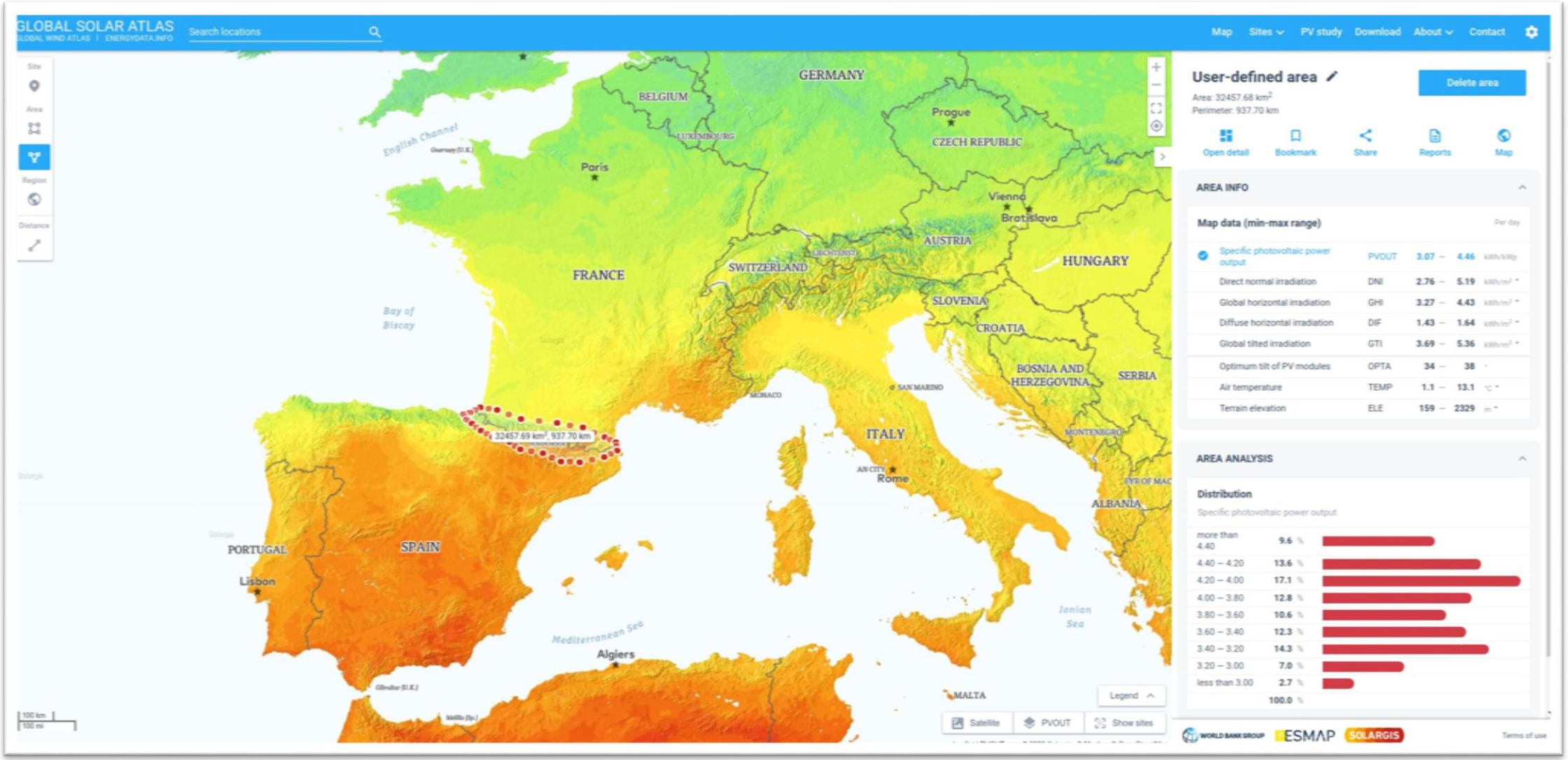
globalsolaratlas.info – Zonálna štatistika





globalsolaratlas.info – Zonálna štatistika – *Custom area*



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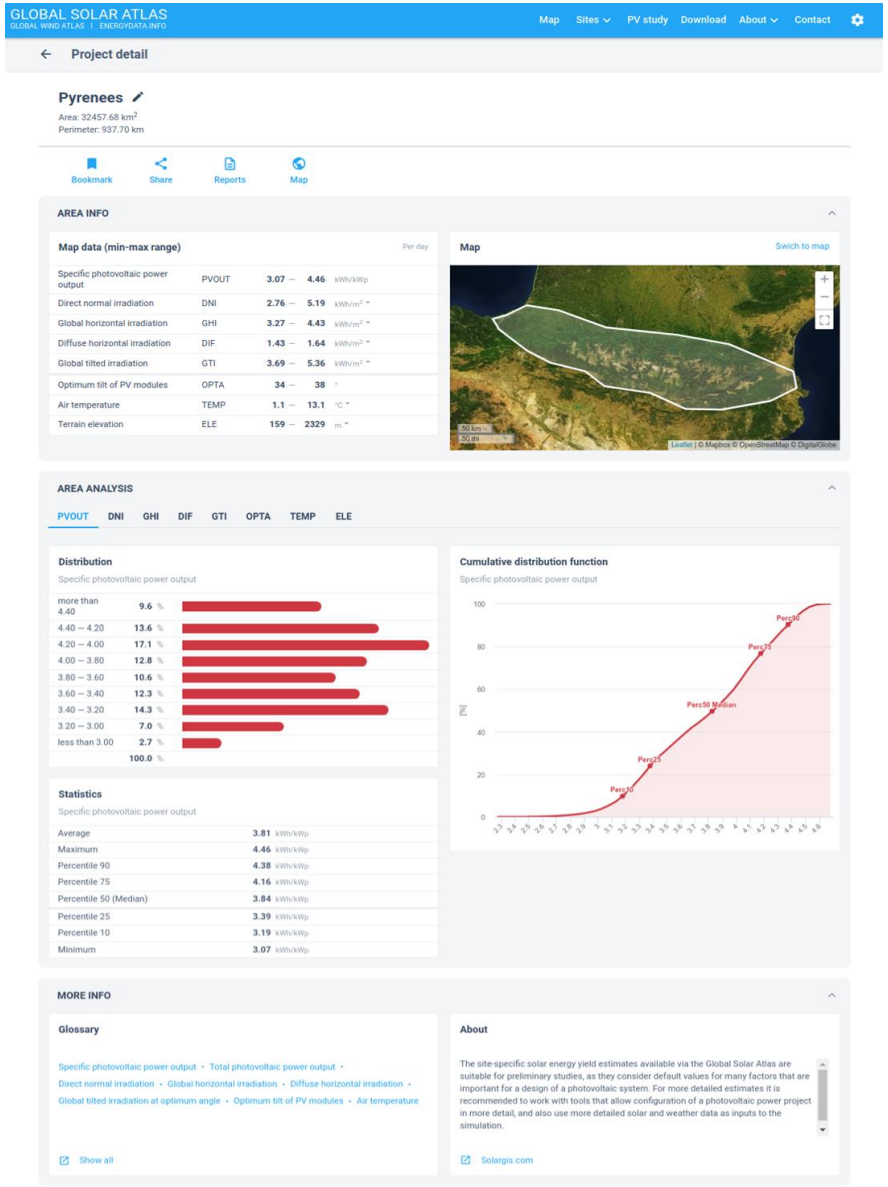
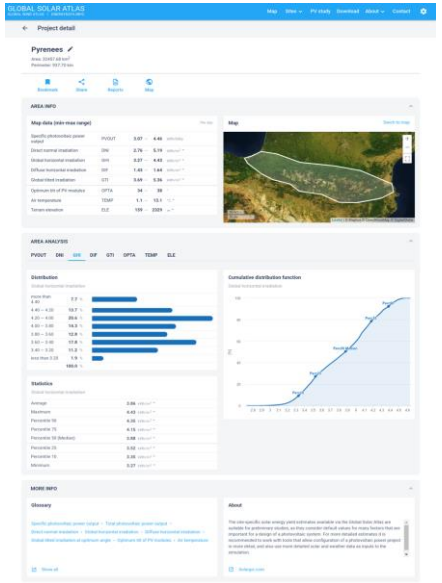
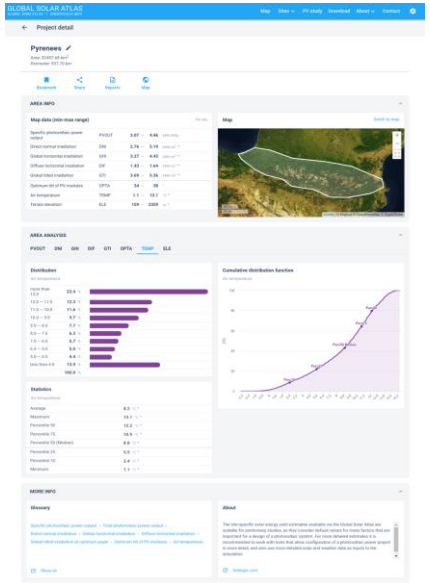
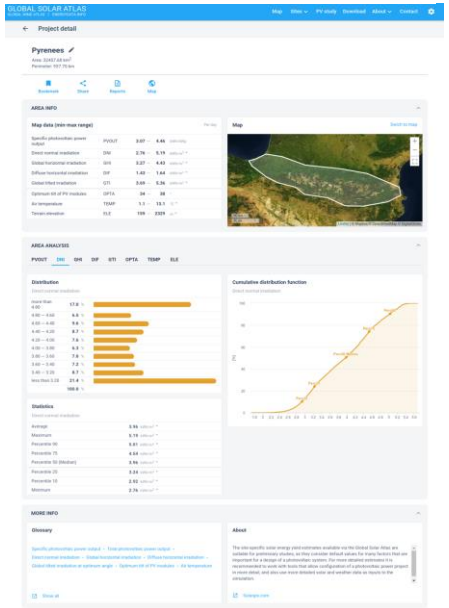
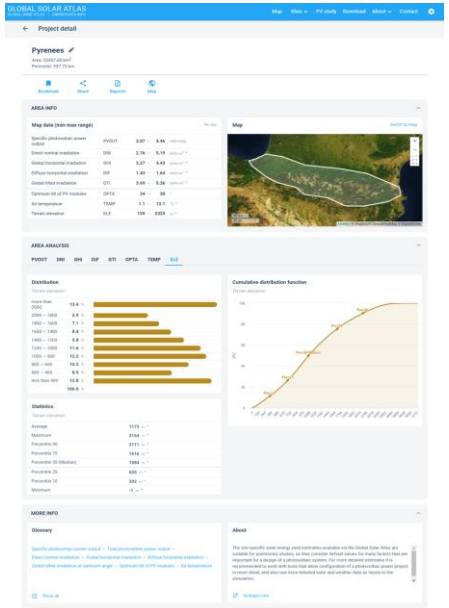
globalsolaratlas.info – Zonálna štatistika – *Custom area*











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globalsolaratlas.info – Zonálna štatistika – *Custom area*

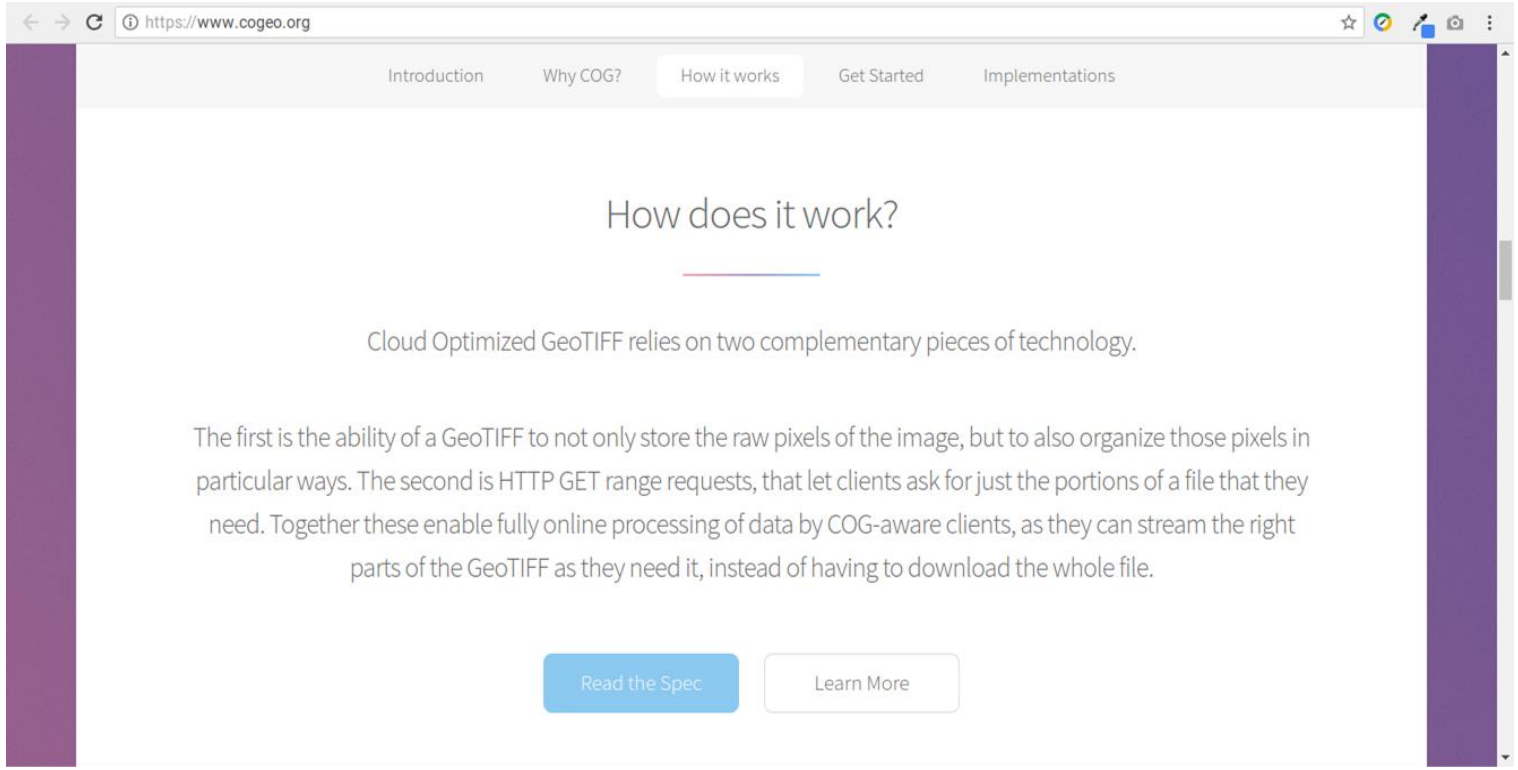
COG: Cloud Optimized GeoTIFF

= malá revolúcia pre prácu s veľkými rastrovými dátami

Vývoj OSGeo Foundation/GDAL, začiatok ~2016

Projekt + doku: https://github.com/cogeotiff/ (3 contributors)

https://www.cogeo.org/



→ GISKOLA

August 2020, Bratislava
Peter Piesecky,
Milo Ofukany, a kol.

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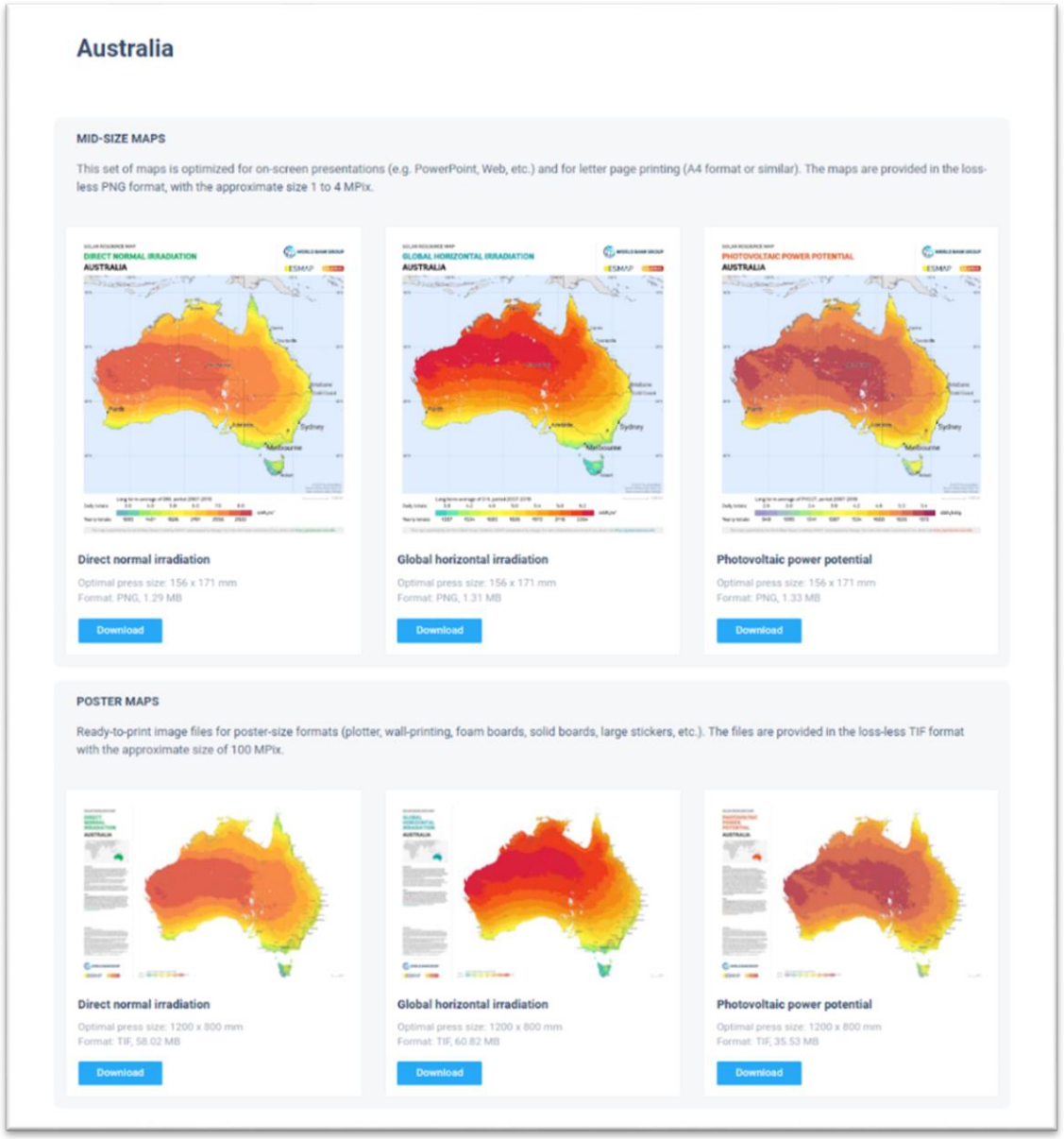

Mapy pre 180+ krajín/regiónov

Formát A0 (poster) a A4,
Renderované v ***QGIS***

Preklady pre vybrané krajiny (~60)
FR, ES, PT, RU, CN, KO, TR

Využitie:
Prezentácie, reporty, strategické stretnutia
učebnice, wikipedia, atď.

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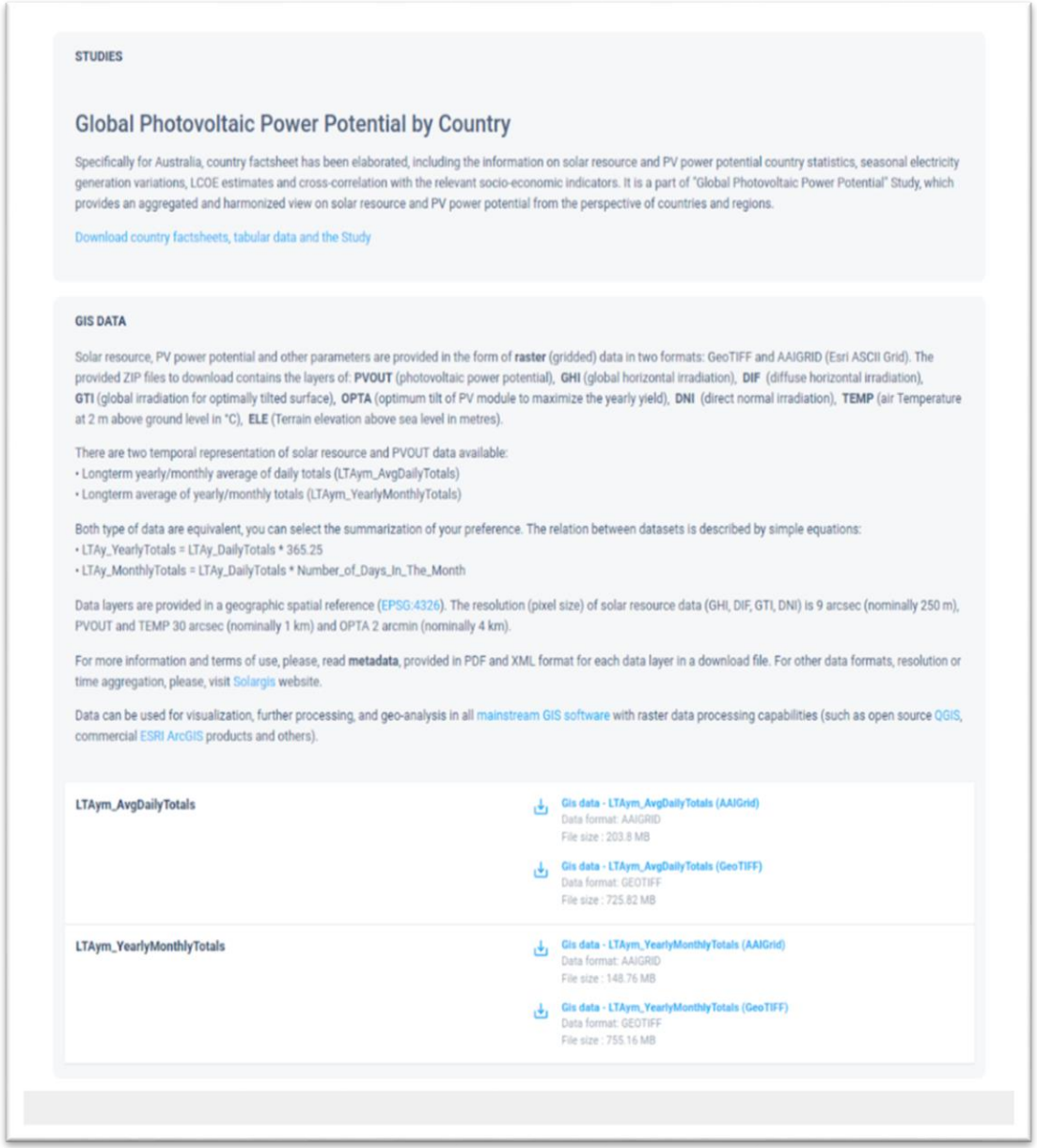


GIS data pre 180+ krajín/regiónov

Rastrový formát:

GeoTIFF

ESRI ASCII GRID

Google Scholar 2019:

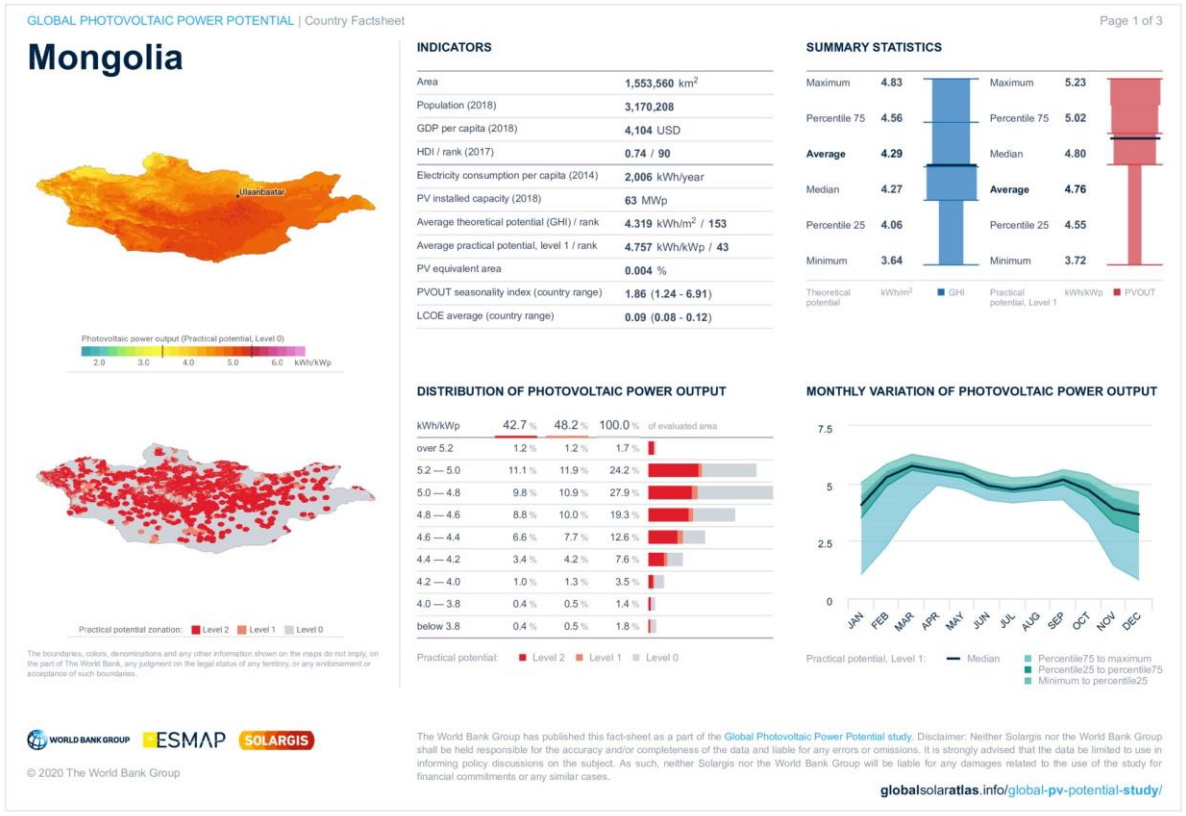
~ 200 štúdií

Štúdie, *Fact-sheets* →

SOLARGIS

globalsolaratlas.info - DOWNLOAD sekcia

Štúdie, *Fact-sheets* →



GLOBAL PHOTOVOLTAIC POWER POTENTIAL | Country Factsheet

Page 1 of 3

Mongolia

INDICATORS

Area	1,553,560 km²
Population (2018)	3,170,208
GDP per capita (2018)	4,104 USD
HDI / rank (2017)	0.74 / 90
Electricity consumption per capita (2014)	2,006 kWh/year
PV installed capacity (2018)	63 MWp
Average theoretical potential (GHI) / rank	4.319 kWh/m² / 153
Average practical potential, level 1 / rank	4.757 kWh/kWp / 43
PV equivalent area	0.004 %
PVOUT seasonality index (country range)	1.86 (1.24 - 6.91)
LCOE average (country range)	0.09 (0.08 - 0.12)

SUMMARY STATISTICS

Maximum	4.83	Maximum	5.23
Percentile 75	4.56	Percentile 75	5.02
Average	4.29	Median	4.80
Median	4.27	Average	4.76
Percentile 25	4.06	Percentile 25	4.55
Minimum	3.64	Minimum	3.72

Theoretical potential kWh/m² ■ GHI Practical potential, Level 1 kWh/kWp ■ PVOUT

DISTRIBUTION OF PHOTOVOLTAIC POWER OUTPUT

kWh/kWp	42.7 %	48.2 %	100.0 % of evaluated area
over 5.2	1.2 %	1.2 %	1.7 %
5.2 — 5.0	11.1 %	11.9 %	24.2 %
5.0 — 4.8	9.8 %	10.9 %	27.9 %
4.8 — 4.6	8.8 %	10.0 %	19.3 %
4.6 — 4.4	6.6 %	7.7 %	12.6 %
4.4 — 4.2	3.4 %	4.2 %	7.6 %
4.2 — 4.0	1.0 %	1.3 %	3.5 %
4.0 — 3.8	0.4 %	0.5 %	1.4 %
below 3.8	0.4 %	0.5 %	1.8 %

Practical potential: ■ Level 2 ■ Level 1 ■ Level 0

MONTHLY VARIATION OF PHOTOVOLTAIC POWER OUTPUT

Practical potential, Level 1: — Median ■ Percentile75 to maximum ■ Percentile25 to percentile75 ■ Minimum to percentile25

WORLD BANK GROUP ESMAP SOLARGIS

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globalsolaratlas.info/global-pv-potential-study/

GLOBAL PHOTOVOLTAIC POWER POTENTIAL | Country Factsheet

Page 2 of 3

Mongolia

Average theoretical potential (GHI, kWh/m²) 4.319

Seasonality index 1.86

Human development index (2018) 0.74

PV installed capacity (MWp, 2018) 63

PV installed capacity per capita (Wp, 2018) 20

Access to electricity (% of rural population, 2016) 44.2

Electricity consumption (kWh/capita/year, 2014) 2,006

Reliability of supply and transparency of tarrif 3.0

Approximate electricity tarriffs (USD cents, 2019) 5.9

PVOUT [kWh/kWp]

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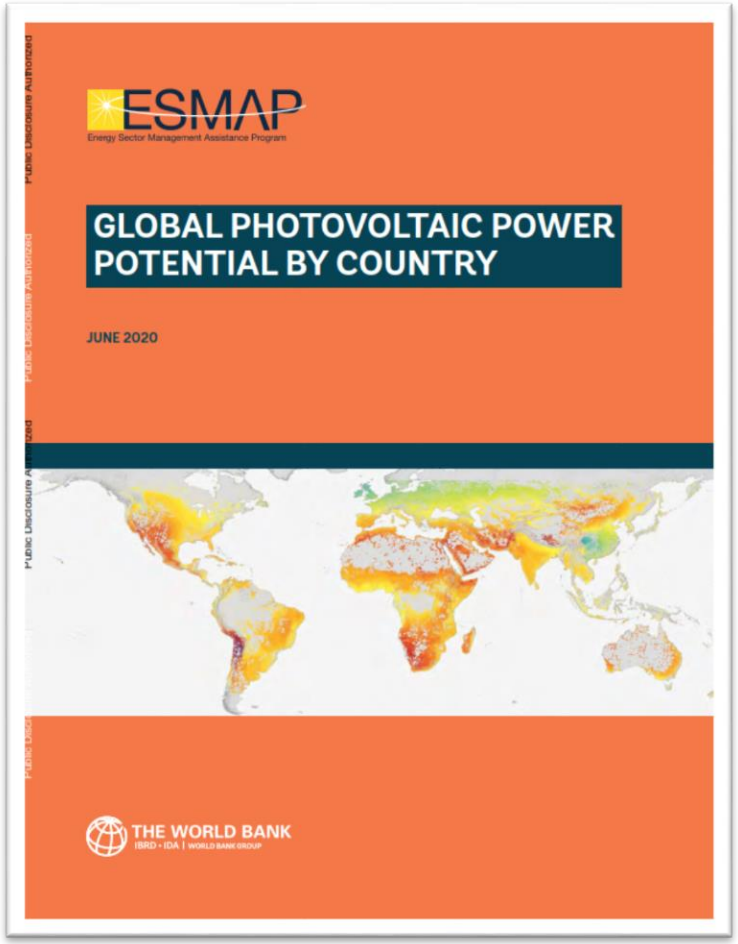
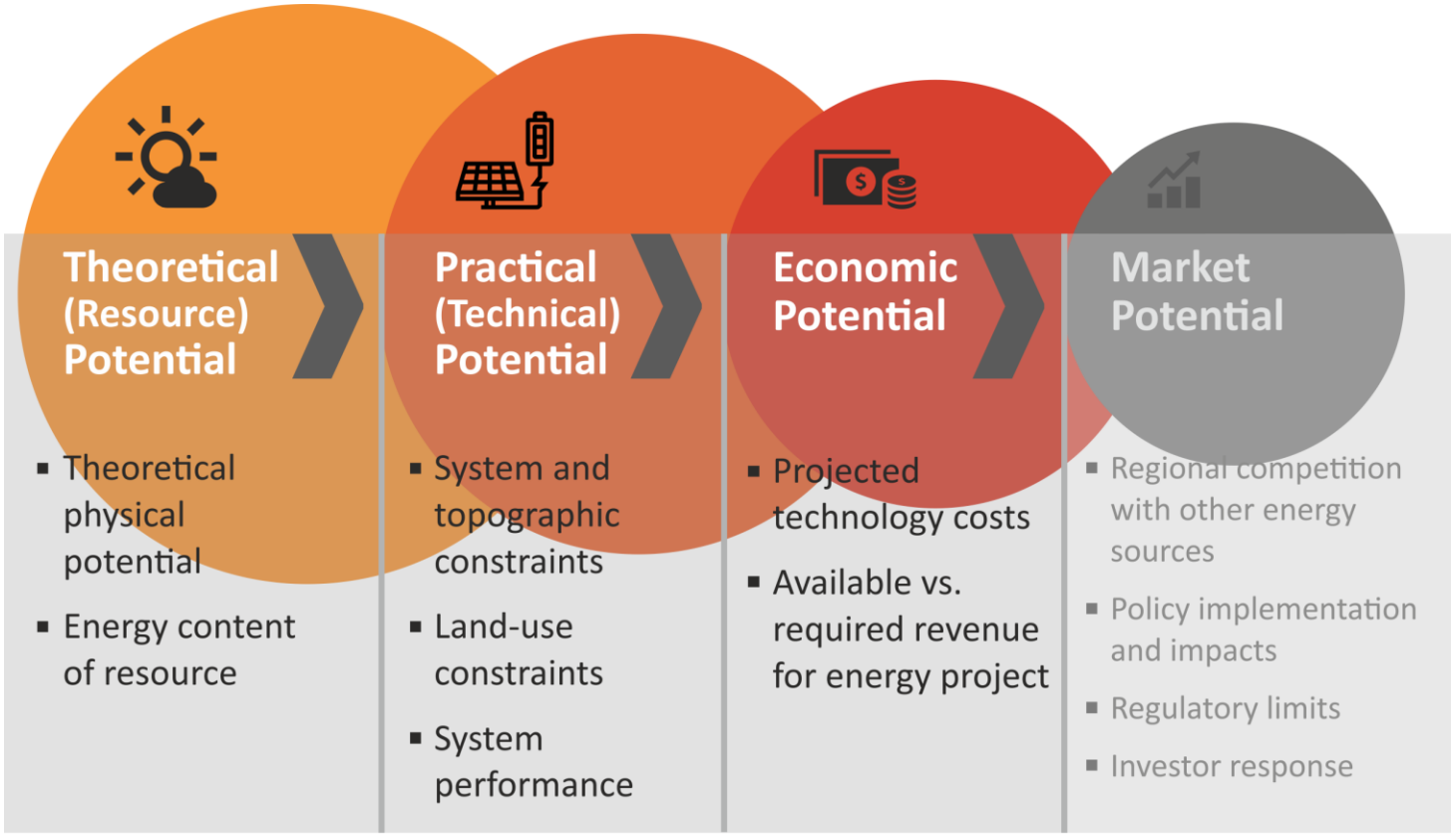
globalsolaratlas.info/global-pv-potential-study/

SOLARGIS

Global Photovoltaic Power Potential By Country

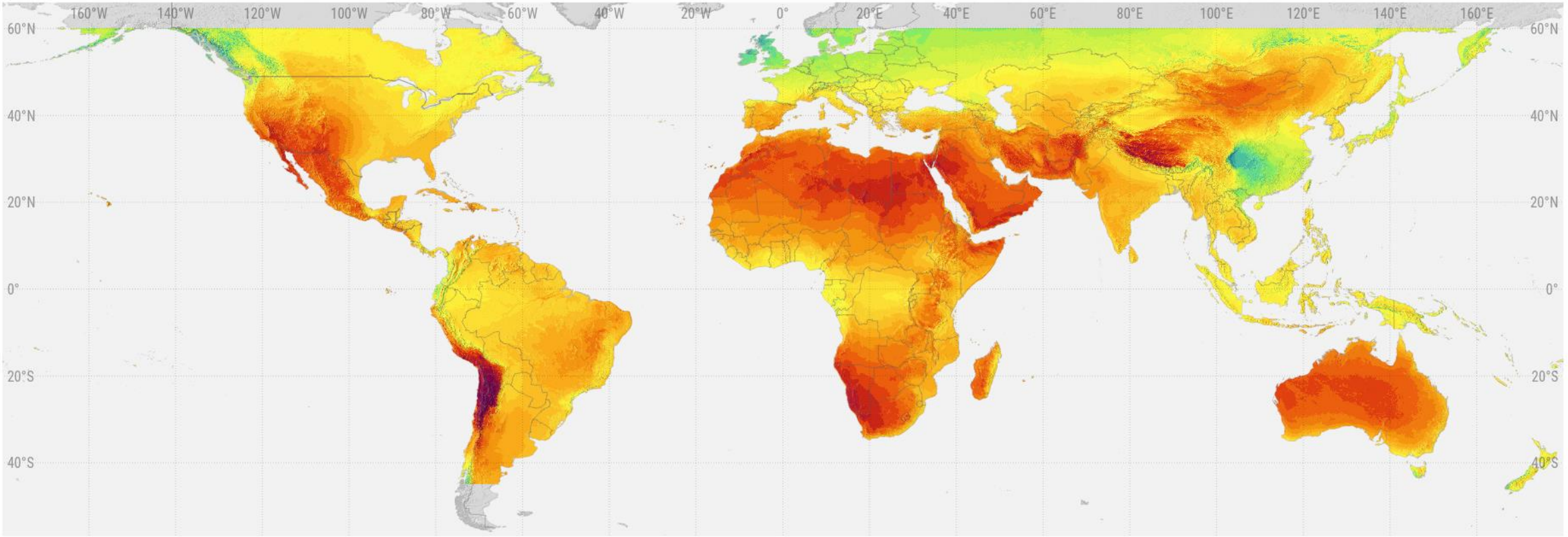
ESMAP, 2020. Washington, DC: World Bank.





https://documents.worldbank.org/en/publication/documents-reports/documentdetail/466331592817725242/global-photovoltaic-power-potential-by-country

globalsolaratlas.info – Štúdia: Global Photovoltaic Power Potential By Country



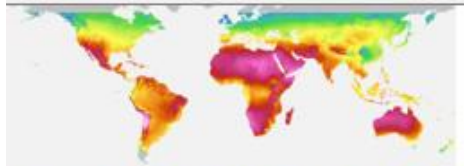
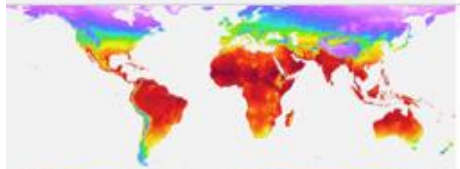
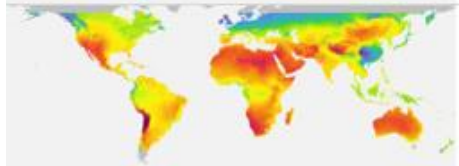
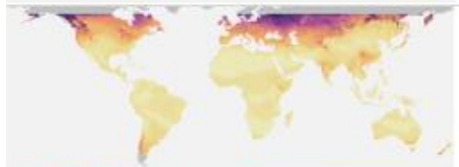
Long-term average of PVOUT

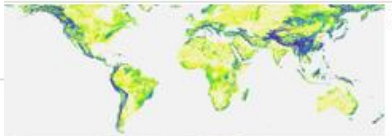
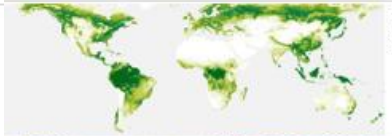
Daily totals:	1.8	2.2	2.6	3.0	3.4	3.8	4.2	4.6	5.0	5.4	5.8	6.2
												kWh/kWp
Yearly totals:	657	803	949	1095	1241	1387	1534	1680	1826	1972	2118	2264

SOLARGIS

globalsolaratlas.info – Štúdia: Global Photovoltaic Power Potential By Country

MCDA – Multiple criteria decision analysis

Preview	Name	Source	Spatial resolution[1]
	Global horizontal irradiance (GHI)	Solargis	30 arcsec (approx. 1 km)
	Air temperature at 2 meters (TEMP)	ECMWF, NASA and Solargis	30 arcsec (approx. 1 km)
	Photovoltaic power potential (PVOUT)	Solargis	30 arcsec (approx. 1 km)
	PVOUT seasonality index ($PVOUT_{SEASON}$)	Solargis	30 arcsec (approx. 1 km)
	Levelized cost of electricity (LCOE)	Solargis, based on inputs from IRENA [17]	30 arcsec (approx. 1 km)
	Administrative boundaries	Cartography Unit, GSDPM, World Bank Group, 2016.	Vector polygon layer

	Terrain elevation	Merged data sources, post-processed by Solargis. SRTMv4.1 (Jarvis, et al, 2008), viewfinderpanoramas.org by Jonathan de Ferranti, ASTER GDEM v2 (ASTER Science Team, 2009)	3 arcsec (approx. 90 m)
	Terrain slope	Derived from terrain elevation by Solargis	3 arcsec (approx. 90 m)
	Built-up area density	GHS BUILT-UP, EC JRC (Pesaresi, et al, 2015)	1 km
	Population clusters	GHS S-MOD, EC JRC (Pesaresi, et al, 2016)	1 km
	Tree cover density	MOD44B Version 6 Vegetation Continuous Fields (Dimiceli, et al, 2015)	250 m
	Land cover	Land Cover CCI, v2.0.7 © ESA Climate Change Initiative - Land Cover led by UCLouvain (2017)	10 arcsec (approx. 330 m)
	Water bodies	Global Surface Water, Source: Source: EC JRC/Google (Pekel, et al, 2016)	1 arcsec (approx. 30 m)
	Protected areas	World Database on Protected Areas (UNEP-WCMC, 2016)	Vector polygon layer

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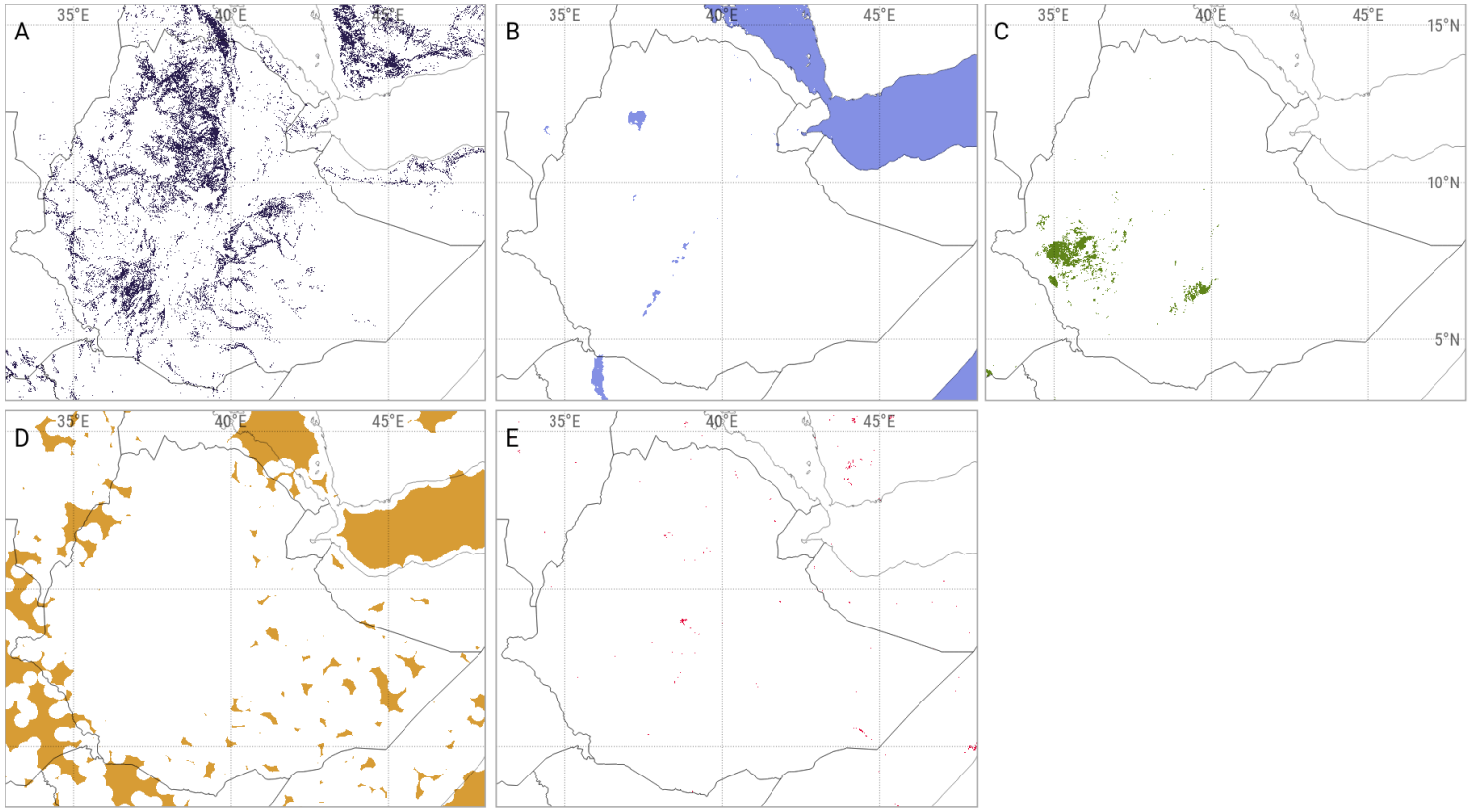
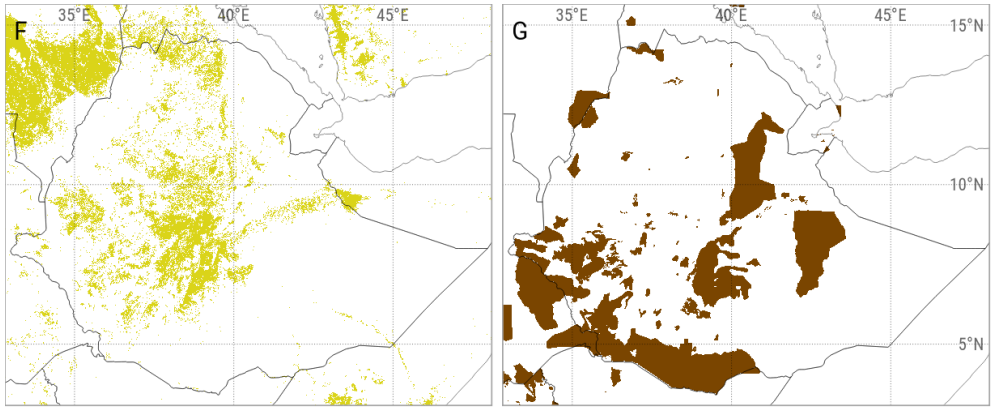
LEVEL 1



LEVEL 2



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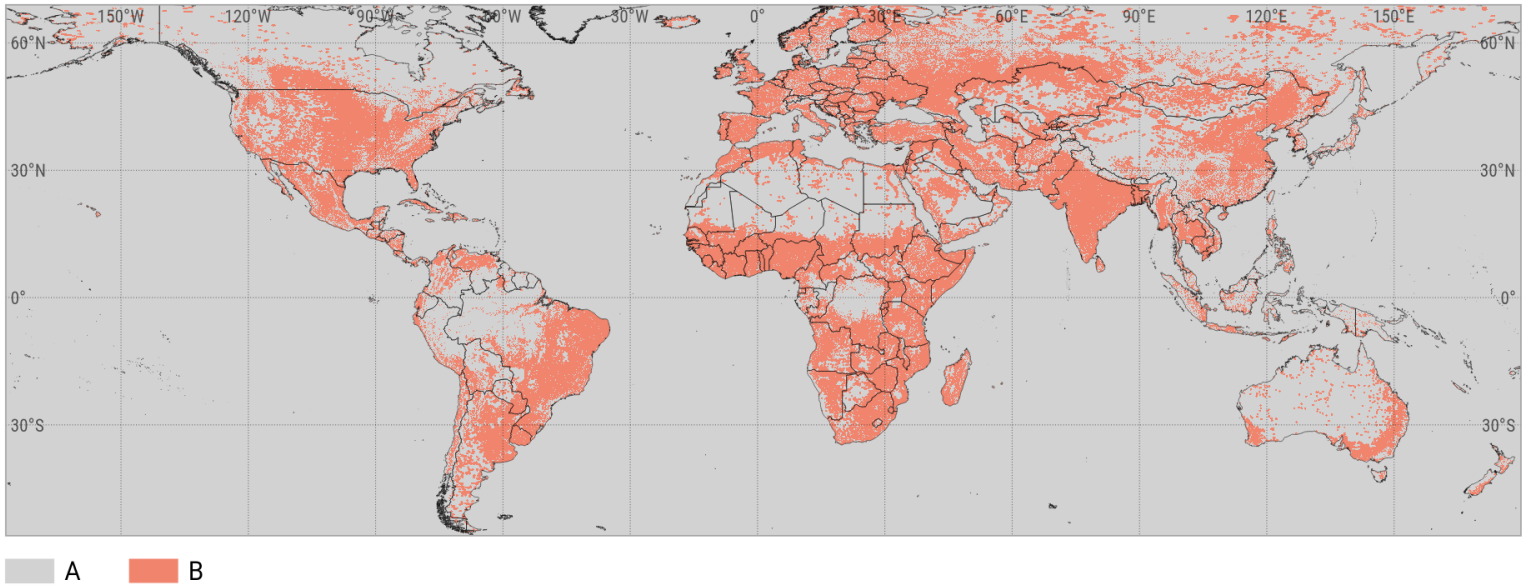
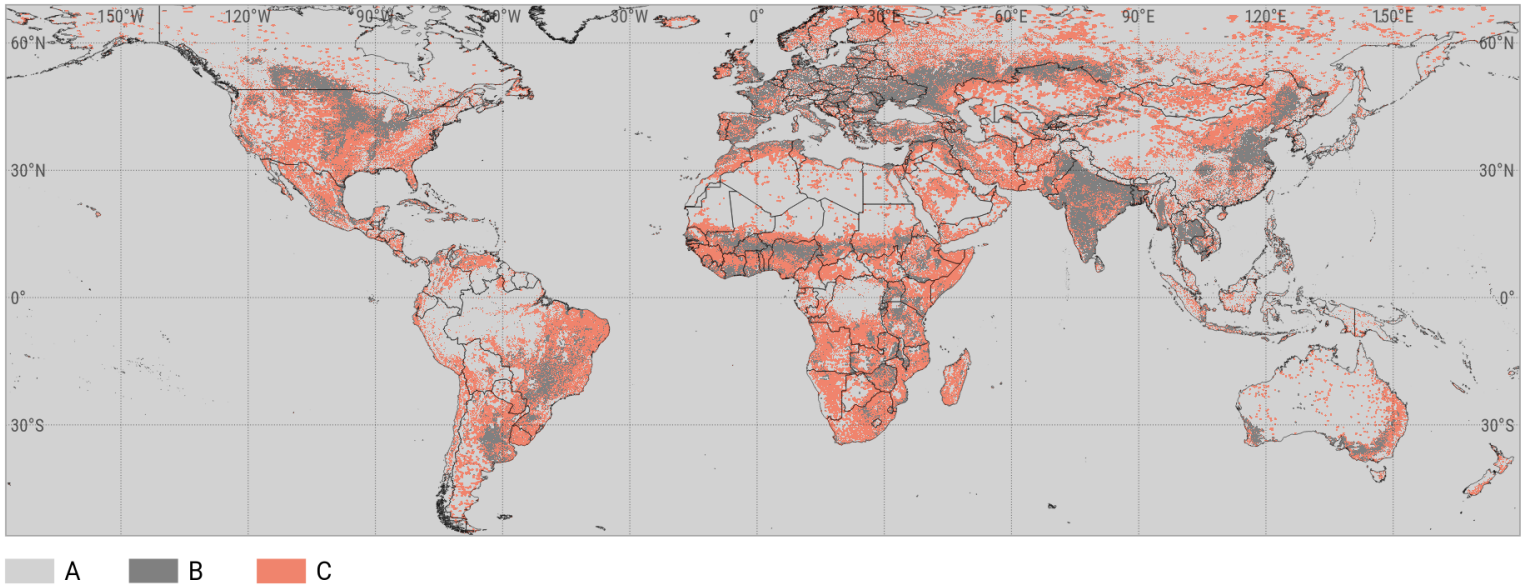
LEVEL 1



LEVEL 2



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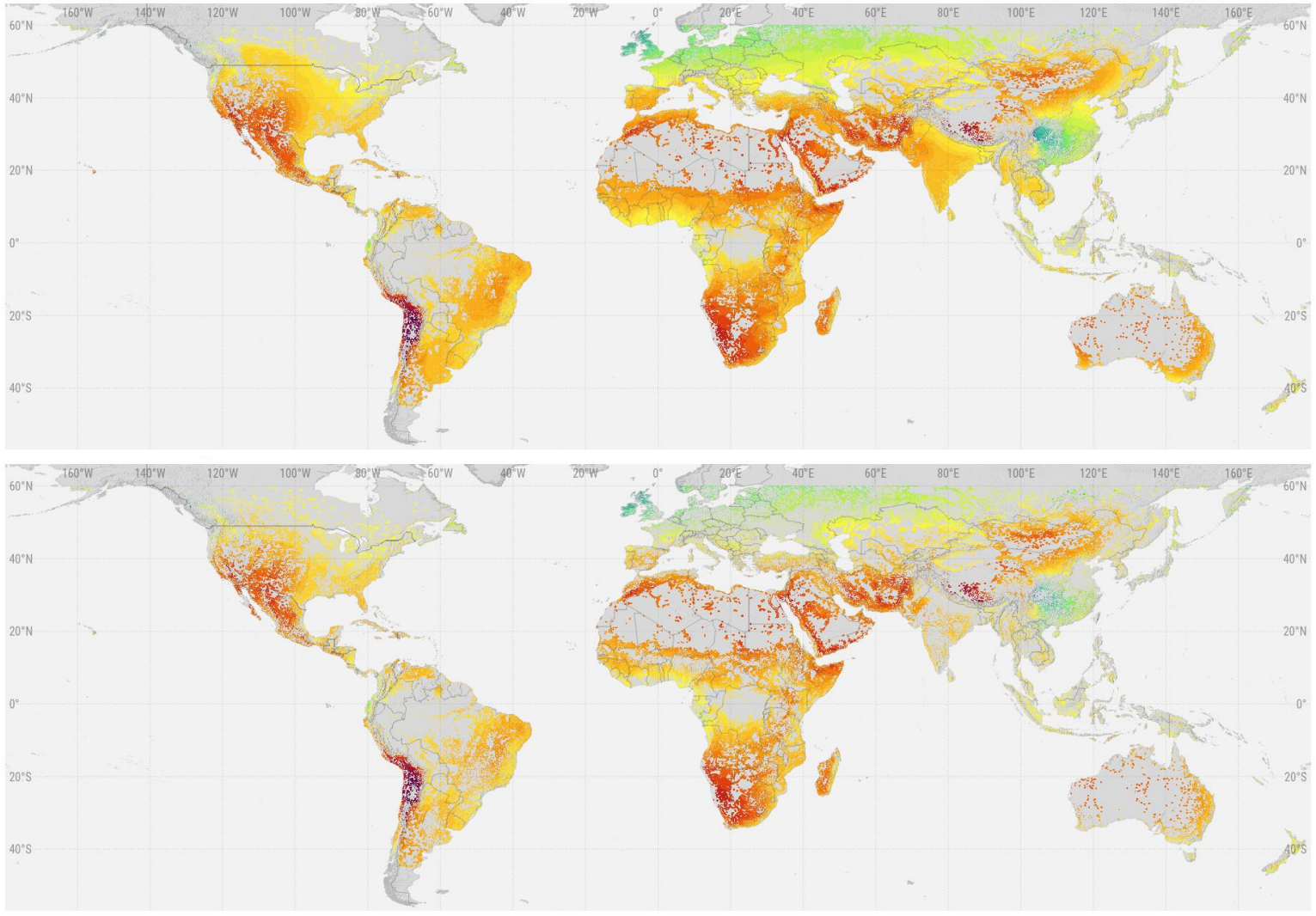
LEVEL 1

LEVEL 2



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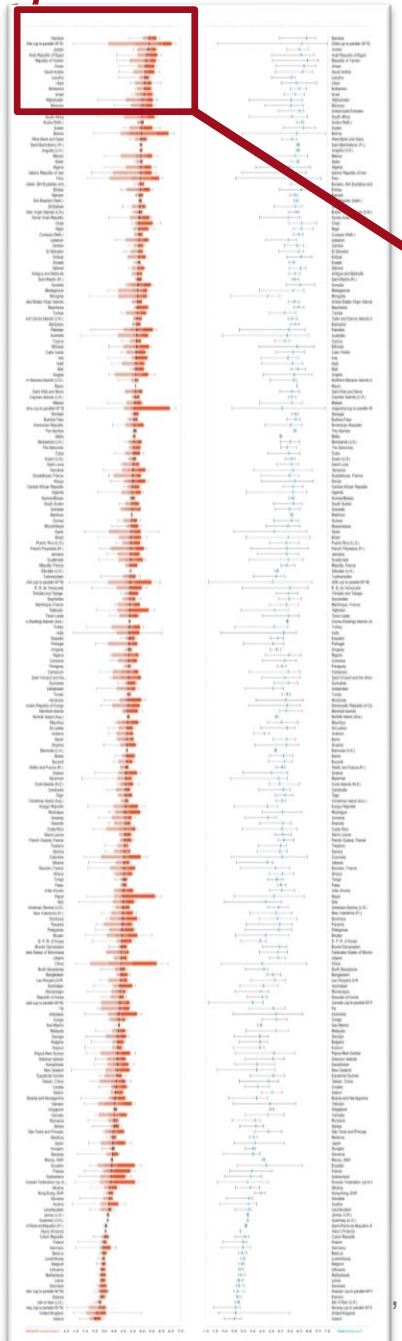
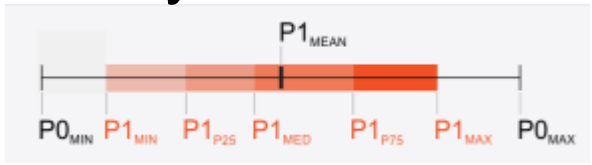
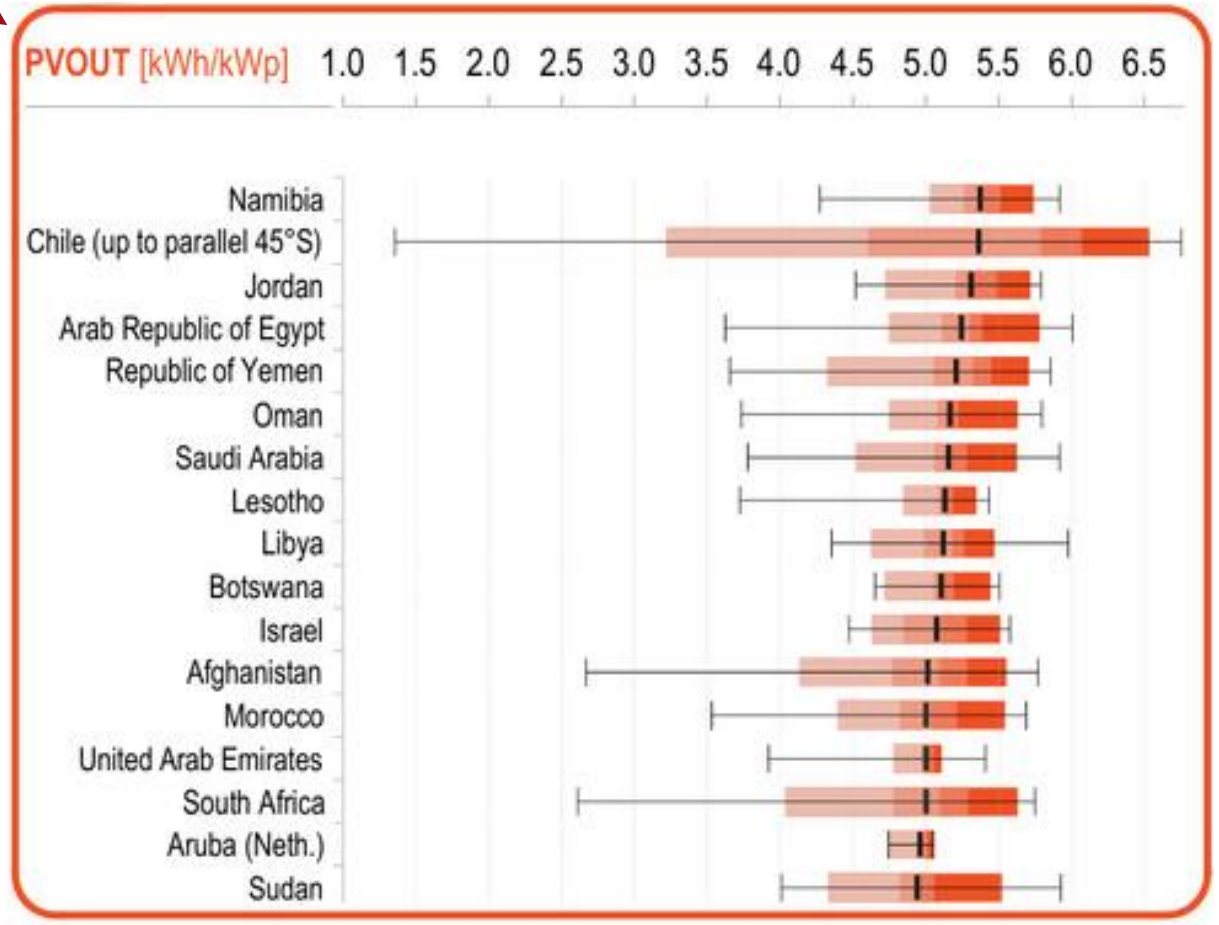
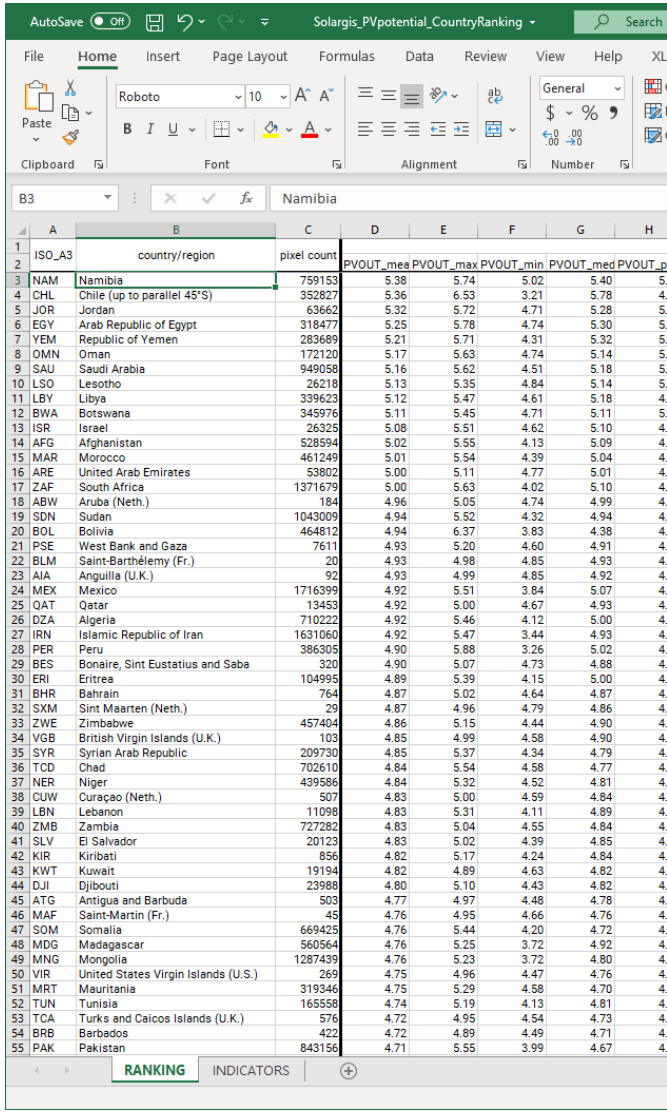
Výsledky zonálnej štatistiky









Solargis_PVpotential_CountryRanking

B3: Namibia

ISO_A3	country/region	pixel count	PVOUT_mea	PVOUT_max	PVOUT_min	PVOUT_med	PVOUT_p
NAM	Namibia	759153	5.38	5.74	5.02	5.40	5.
CHL	Chile (up to parallel 45°S)	352827	5.36	6.53	3.21	5.78	4.
JOR	Jordan	63662	5.32	5.72	4.71	5.28	5.
EGY	Arab Republic of Egypt	318477	5.25	5.78	4.74	5.30	5.
YEM	Republic of Yemen	283689	5.21	5.71	4.31	5.32	5.
OMN	Oman	172120	5.17	5.63	4.74	5.14	5.
SAU	Saudi Arabia	949058	5.16	5.62	4.51	5.18	5.
LSO	Lesotho	26218	5.13	5.35	4.84	5.14	5.
LBY	Libya	339623	5.12	5.47	4.61	5.18	4.
BWA	Botswana	345976	5.11	5.45	4.71	5.11	5.
ISR	Israel	26325	5.08	5.51	4.62	5.10	4.
AFG	Afghanistan	528594	5.02	5.55	4.13	5.09	4.
MAR	Morocco	461249	5.01	5.54	4.39	5.04	4.
ARE	United Arab Emirates	53802	5.00	5.11	4.77	5.01	4.
ZAF	South Africa	1371679	5.00	5.63	4.02	5.10	4.
ABW	Aruba (Neth.)	184	4.96	5.05	4.74	4.99	4.
SDN	Sudan	1043009	4.94	5.52	4.32	4.94	4.
BOL	Bolivia	464812	4.94	6.37	3.83	4.38	4.
PSE	West Bank and Gaza	7611	4.93	5.20	4.60	4.91	4.
BLM	Saint-Barthélemy (Fr.)	20	4.93	4.98	4.85	4.93	4.
AIA	Anguilla (U.K.)	92	4.93	4.99	4.85	4.92	4.
MEX	Mexico	1716399	4.92	5.51	3.84	5.07	4.
QAT	Qatar	13453	4.92	5.00	4.67	4.93	4.
DZA	Algeria	710222	4.92	5.46	4.12	5.00	4.
IRN	Islamic Republic of Iran	1631060	4.92	5.47	3.44	4.93	4.
PER	Peru	386305	4.90	5.88	3.26	5.02	4.
BES	Bonaire, Sint Eustatius and Saba	320	4.90	5.07	4.73	4.88	4.
ERI	Eritrea	104995	4.89	5.39	4.15	5.00	4.
BHR	Bahrain	764	4.87	5.02	4.64	4.87	4.
SXM	Sint Maarten (Neth.)	29	4.87	4.96	4.79	4.86	4.
ZWE	Zimbabwe	457404	4.86	5.15	4.44	4.90	4.
VGB	British Virgin Islands (U.K.)	103	4.85	4.99	4.58	4.90	4.
SYR	Syrian Arab Republic	209730	4.85	5.37	4.34	4.79	4.
TCD	Chad	702610	4.84	5.54	4.58	4.77	4.
NER	Niger	439586	4.84	5.32	4.52	4.81	4.
CUW	Curaçao (Neth.)	507	4.83	5.00	4.59	4.84	4.
LBN	Lebanon	11098	4.83	5.31	4.11	4.89	4.
ZMB	Zambia	727282	4.83	5.04	4.55	4.84	4.
SLV	El Salvador	20123	4.83	5.02	4.39	4.85	4.
KIR	Kiribati	856	4.82	5.17	4.24	4.84	4.
KWT	Kuwait	19194	4.82	4.89	4.63	4.82	4.
DJI	Djibouti	23988	4.80	5.10	4.43	4.82	4.
ATG	Antigua and Barbuda	503	4.77	4.97	4.48	4.78	4.
MAF	Saint-Martin (Fr.)	45	4.76	4.95	4.66	4.76	4.
SOM	Somalia	669425	4.76	5.44	4.20	4.72	4.
MDG	Madagascar	560564	4.76	5.25	3.72	4.92	4.
MNG	Mongolia	1287439	4.76	5.23	3.72	4.80	4.
VIR	United States Virgin Islands (U.S.)	269	4.75	4.96	4.47	4.76	4.
MRT	Mauritania	319346	4.75	5.29	4.58	4.70	4.
TUN	Tunisia	165558	4.74	5.19	4.13	4.81	4.
TCA	Turks and Caicos Islands (U.K.)	576	4.72	4.95	4.54	4.73	4.
BRB	Barbados	422	4.72	4.89	4.49	4.71	4.
PAK	Pakistan	843156	4.71	5.55	3.99	4.67	4.

RANKING | INDICATORS

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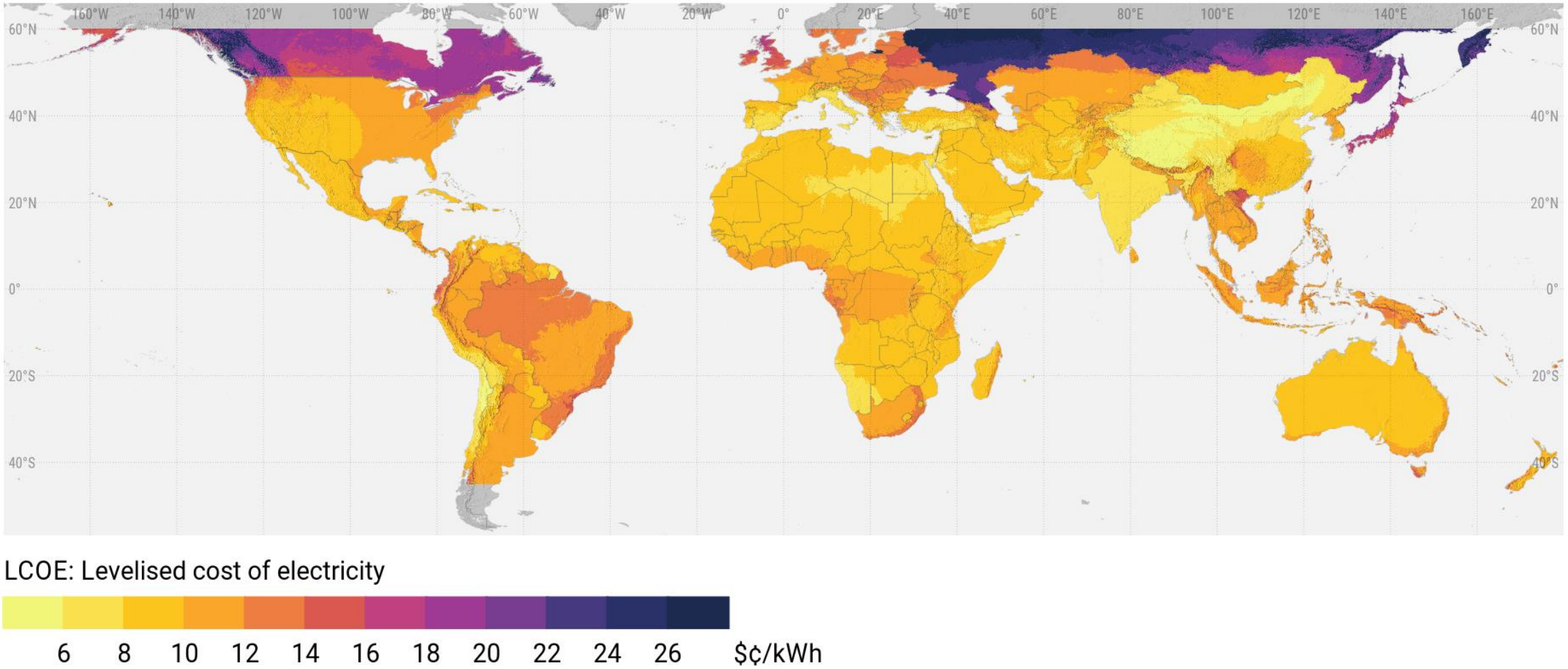
LCOE – *Levelised cost of electricity* z veľkých fotovoltických elekrární



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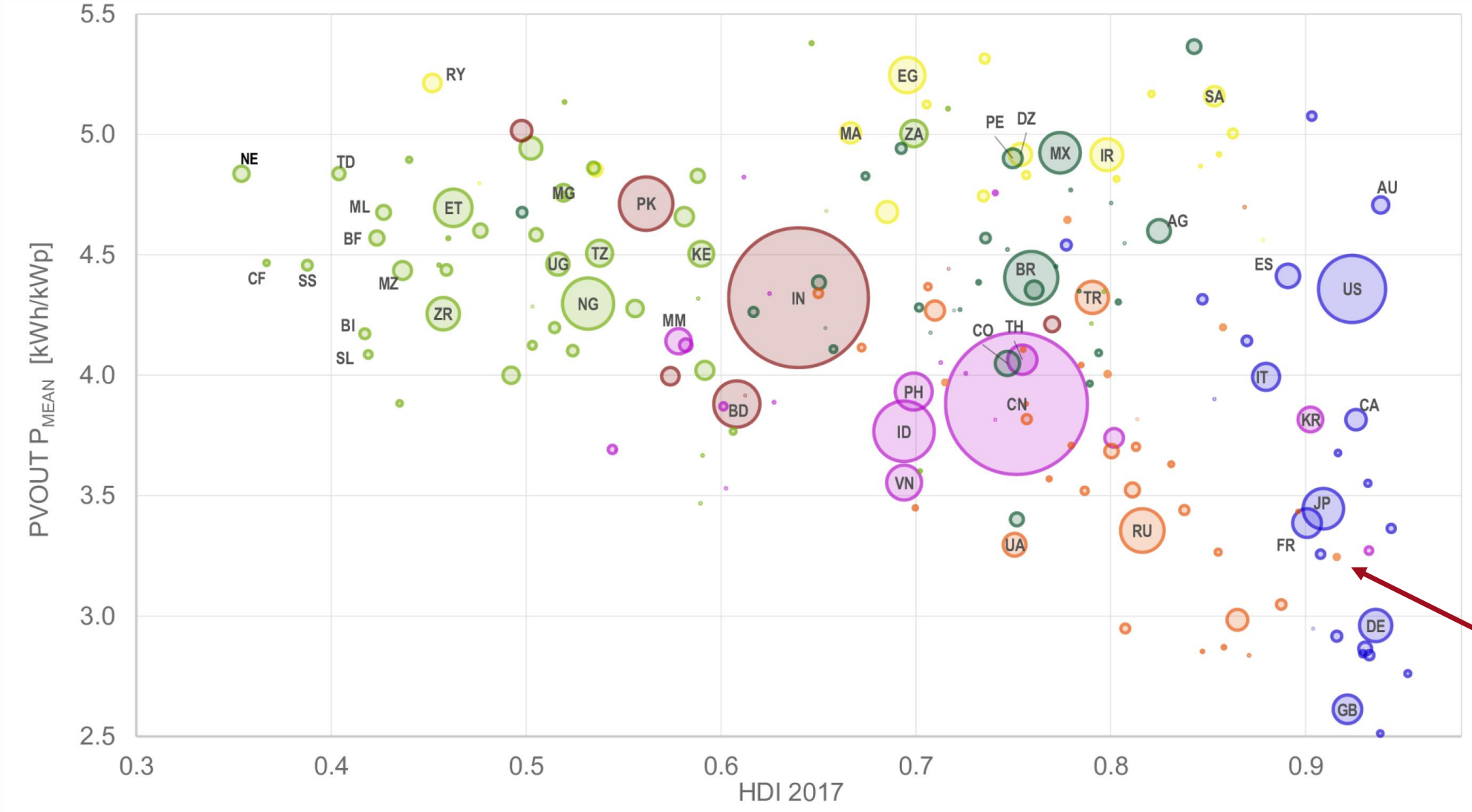
Human development index VS Fotovoltický potenciál



kruh = štát/región
farba = Ekonomický región (kontinent)
veľkosť = veľkosť populácie

Slovensko

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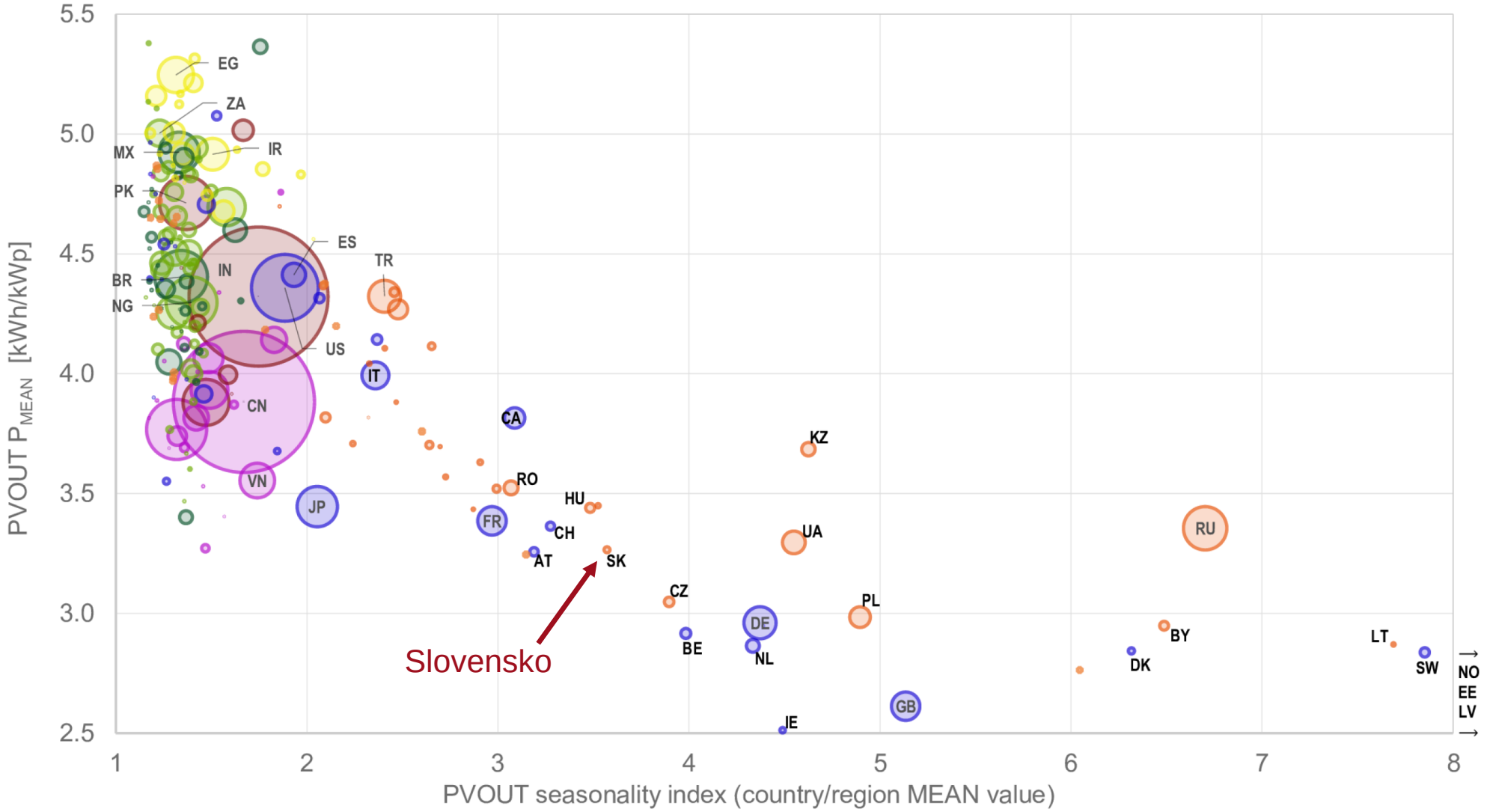
Sezonalita VS Fotovoltický potenciál



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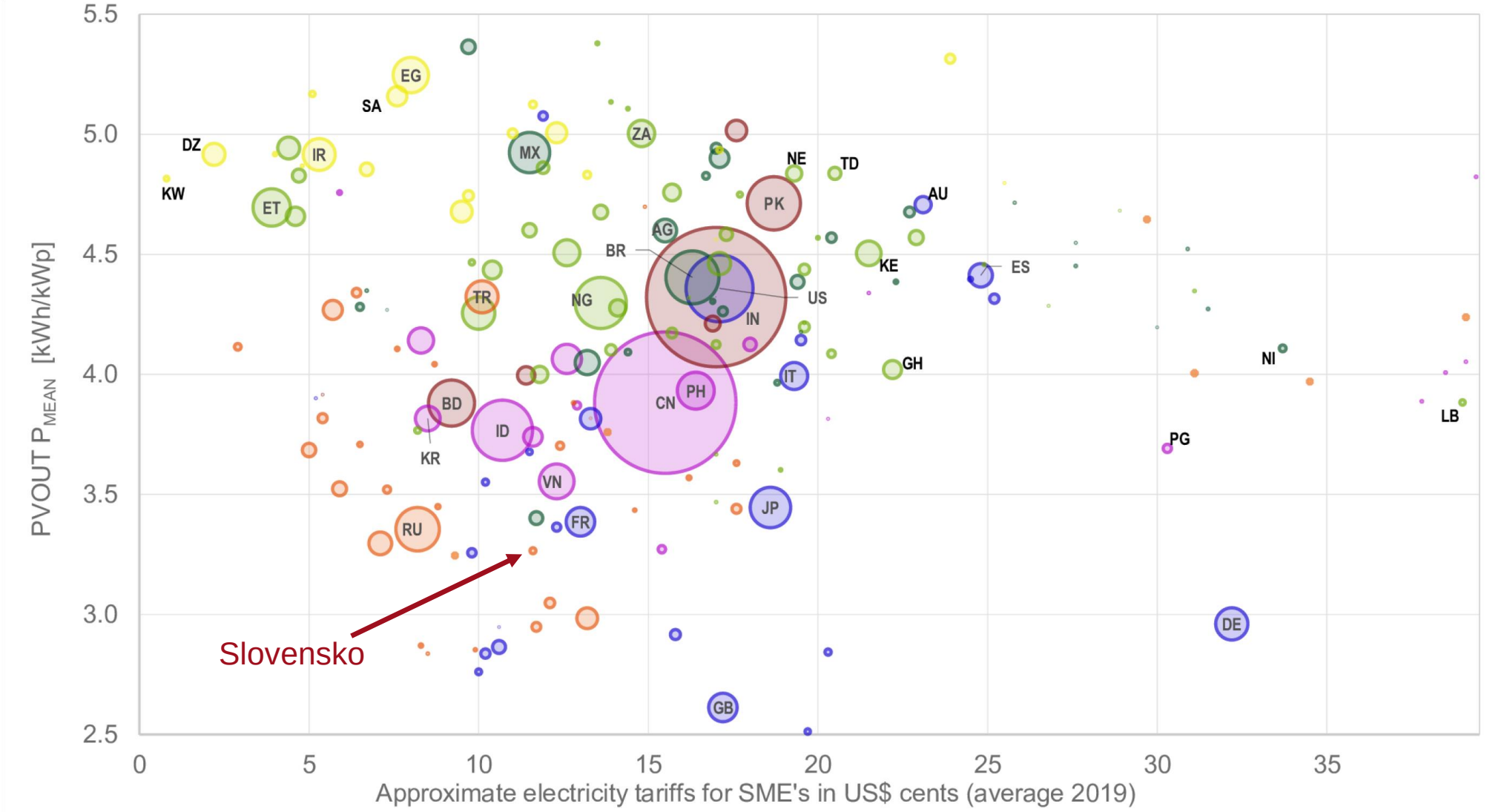
Priemerná cena elektriny na odbernom mieste pre *SME* VS Fotovoltický potenciál



kruh = štát/región
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Záver

Geodáta

Kľúč pre pochopenie mechanizmov klimatickej zmeny

Svetová energetika je v transformácii, pre efektivitu a ekonomiku technológií OZE sú potrebné kvalitné geodáta

Kartografia

Mapy sú fenomén, *esperanto* ľudí decíznej sféry

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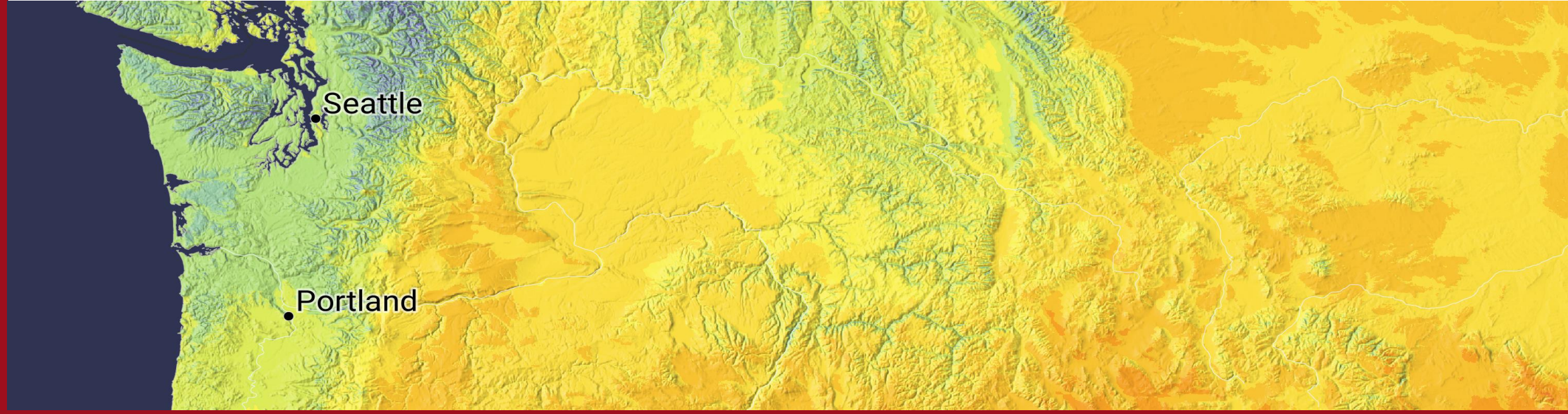

GLOBAL SOLAR ATLAS

Geo-dáta a online nástroje pre podporu rozvoja solárnej energetiky

Marcel Šúri, Juraj Beták, Tomáš Cebecauer, Michal Moravčík, Šimon Štassel, Konštantín Rosina, Artur Skoczek, Peter Orosi

Solargis s.r.o., Mýtna 48, 811 07 Bratislava, contact@solargis.com

GeoKarto 2020, 10-11 Sep, Košice

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