Global Atlas of H_2 Potential

Sustainable locations in the world for the green hydrogen economy of tomorrow: technical. economic and social analyses for the development of a global sustainable hydrogen atlas

HYPAT Working Paper 03/2022

Global potential of renewable energy sources

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The information was compiled to the best of our knowledge in accordance with the principles of good scientific practice. The authors assume that the information in this report is correct, complete and up-to-date, but do not accept any liability for any errors, explicit or implicit.

Contents

List of acronyms

Acronym	Meaning
CSP	Concentrated Solar Power
ECMWF	European Centre for Medium-Range Weather Forecasts
RE	Renewable energies
FLH	Full Load Hours
GW	Gigawatt
IUCN	International Union for Conservation of Nature and Natural Resources
MENA	Middle East and North Africa
Mt	Megatonne
MWh	Megawatt hour
PV	Photovoltaic
TWh	Terawatt hour

1 Introduction

Recently, there has been growing global interest in green hydrogen as an instrument to decarbonize the energy, industry and transport sectors and the current non-energy applications of hydrogen (ammonia production, oil refining etc.), which accounted for 90 Mt of hydrogen demand in 2020 (IEA 2021). This is reflected, among other things, by the number of countries that have published national hydrogen strategies (e.g., Germany, Namibia, Australia, Japan, Canada, Chile etc.; Enerdata 2022), as well as by the large number of pilot projects worldwide. In Germany alone, there are currently 50 hydrogen projects in operation (IEA 2022).

One of the most important aspects when producing green hydrogen is the potential and specific costs of renewable energy sources (RE). Globally, the technologies of ground-mounted photovoltaic (PV) and onshore wind are already well developed. In the long term, however, technologies such as offshore wind and concentrated solar power (CSP) are also expected to play an important role in countries where such resources are available. Finally, technologies such as geothermal and hydropower can also be used to produce green hydrogen. Since electricity from renewable energies is one of the main cost components when producing green hydrogen, it is of particular interest in this context to identify the countries and regions with the lowest RE electricity generation costs (in Euro/MWh). The growing demand for hydrogen will drive up the demand for electricity from renewable energies even more, which again underscores the relevance of renewable energy sources.

This report presents the global potential for the above-mentioned renewable energy technologies and their specific costs, which were determined within the HYPAT project. These results are used in HYPAT as the basis for detailed modeling of selected countries and for calculating the global hydrogen potential. The presentation of this potential (chapter 3) is framed by a brief explanation of the methodology used (chapter 2) and a summary including conclusions (chapter 4).

2 Method

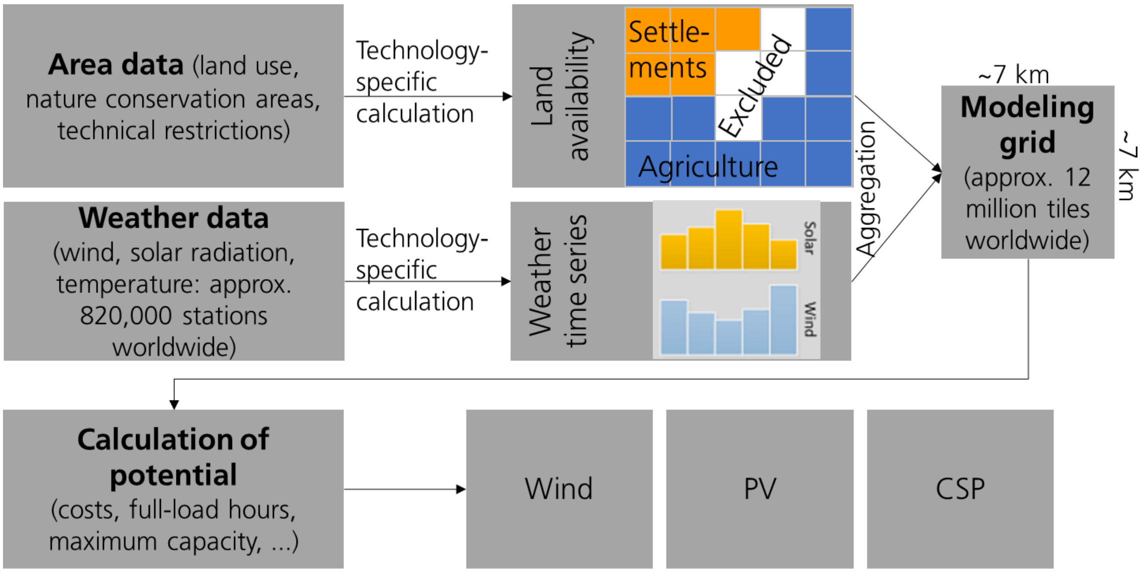
This short report presents the global potential of the above-mentioned technologies. This potential was determined using two different methods. The Enertile model, developed at Fraunhofer ISI, was used to calculate the potential for onshore wind, offshore wind, ground-mounted photovoltaic (PV) and concentrated solar power (CSP). The potential of geothermal and hydropower was assessed based on a literature review.

2.1 Modeling RE potential using Enertile

The Enertile model was used to calculate the global generation potential of onshore wind, offshore wind, PV, and CSP. This involved defining a new modeling grid in order to move beyond its usual European modeling horizon to a global one. Input data (weather and land use) with global coverage were integrated and mapping the technologies was also adapted so that the model provides better results for conditions outside of Europe. The model uses global weather data from the ECMWF's ERA5 reanalysis for the year 2010. The model divides the world's surface into approx. 12 million tiles, each measuring 6.5 x 6.5 km^2. The type of land use is then allocated to each tile based on the GlobCover2009 data set (ESA 2010). Then a utilization factor is defined for each type of land-use and each RE technology. These factors reflect the proportion of land per tile that can be used for expanding the respective RE technology. Details about these utilization factors can be found in Franke et al. (2022). The areas designated as protected area categories Ia, Ib and II according to the International Union for Conservation of Nature and Natural Resources (IUCN) were excluded when calculating the potential. An overview of this process is shown in Figure 1.

Two different scenarios were calculated. The first scenario was based on a uniform interest rate of 2 percent to determine the natural potential of each country. The second scenario considered a separate interest rate for each country. These individual interest rates are based on the equity risk premium that was compiled for a large number of countries as part of the HYPAT project and listed in Appendix A.1 (Wietschel et al. 2021). The regional average was used for those countries, for which no interest rate assumption was available. Details concerning the technical and economic assumptions for the two scenarios can be found in Franke et al. (2022).

Figure 1: Schematic diagram showing the procedure for calculating the potential of renewable energies using the Enertile model



2.2 Hydropower

Within the HYPAT project, the potential of hydroelectric power generation was identified, as were the generation capacities of already existing plants and of the plants currently under construction. These were ranked and assessed according to their respective theoretical, technical and economic potential for producing green hydrogen. These analyses were conducted based on internationally accessible data from the Hydropower & Dams World Atlas (2020), and supplemented by integrating IRENA (2021).

2.3 Geothermal

Based on specialist literature, the estimated electricity generation potential (MW) was compiled for the ten most important countries currently using geothermal energy sources to produce electricity. This was based on the list of installed and connected net generation capacities of geothermal power plants at the end of the calendar year 2020 (IRENA 2021a).

3 Results

3.1 Hydropower

The countries with the highest potential for hydropower are listed in Table 1. Due to the heterogeneity of the available data shown as either installed capacity in GW or as annual electricity production in TWh, an average of 4500h full-load hours was used as a basis to align the data given in GW. This assumption was based on evaluating graphs and tables of average and continent-based figures or lists of full-load hours between 2016 und 2020.

Table 1: Technically feasible hydropower potential for selected countries of the world in TWh/yr.

Country	Technically feasible potential in TWh/yr.
People's Republic of China	2,720
Russia	1,670
Brazil	1,250
Canada *	1,000
India	660
Democratic Republic of Congo*	450
Tajikistan	439
Peru	395
Norway	300
Nepal	300
Japan	284
Venezuela *	280
Ethiopia	260
Canada	240
Indonesia	225

* Assumption of an average of 4500 full-load hours (approx. 51 %) to convert GW into TWh.

The highest technically feasible potential is found in China, Russia and Brazil, all of which have a potential significantly above 1000 TWh. Canada has a potential of about 1000 TWh. The potential in the other countries is below 700 TWh.

3.2 Geothermal

The following table lists countries that currently have the highest installed geothermal power generation capacity (reference year 2020) as well as their estimated potential.

Calculating the potential (in TWh/yr.) was based on a uniform 8000 full-load hours per year.

Table 2: Feasible geothermal potential for selected countries of the world in TWh/yr.

Country	Capacity in 2020 (MW)[8]	Year	Potential (MW)	Potential (MWh/yr.)
USA[1, 2]	2587	2025	3874	30.99
		2050[2]	6000	48.00
		2050[3]	50000	400.00
Indonesia[4]	2131	2025	5104	40.83
		2030	7864	62.91
Philippines[5]	1928	2025	3233	25.86
		2030	3313	26.50
Turkey[1, 6]	1613	2025	722	5.77
		2050[2]	1839	14.72
		2050[3]	20000	160.00
New Zealand[1]	984	2025	1129	9.03
		>2025	1484	11.87
Mexico[7]	906	2025	1061	8.49
		2030	1670	13.36
Kenya[1, 8]	824	2025	932	7.46
		2030	5000	40.00
Italy[1]	797	2025	946	7.57
		>2025	1142	9.14
Iceland[1]	756	2025	752	6.02
		>2025	1322	10.58
Japan[1]	525	2025	612	4.90
		>2030	936	7.49

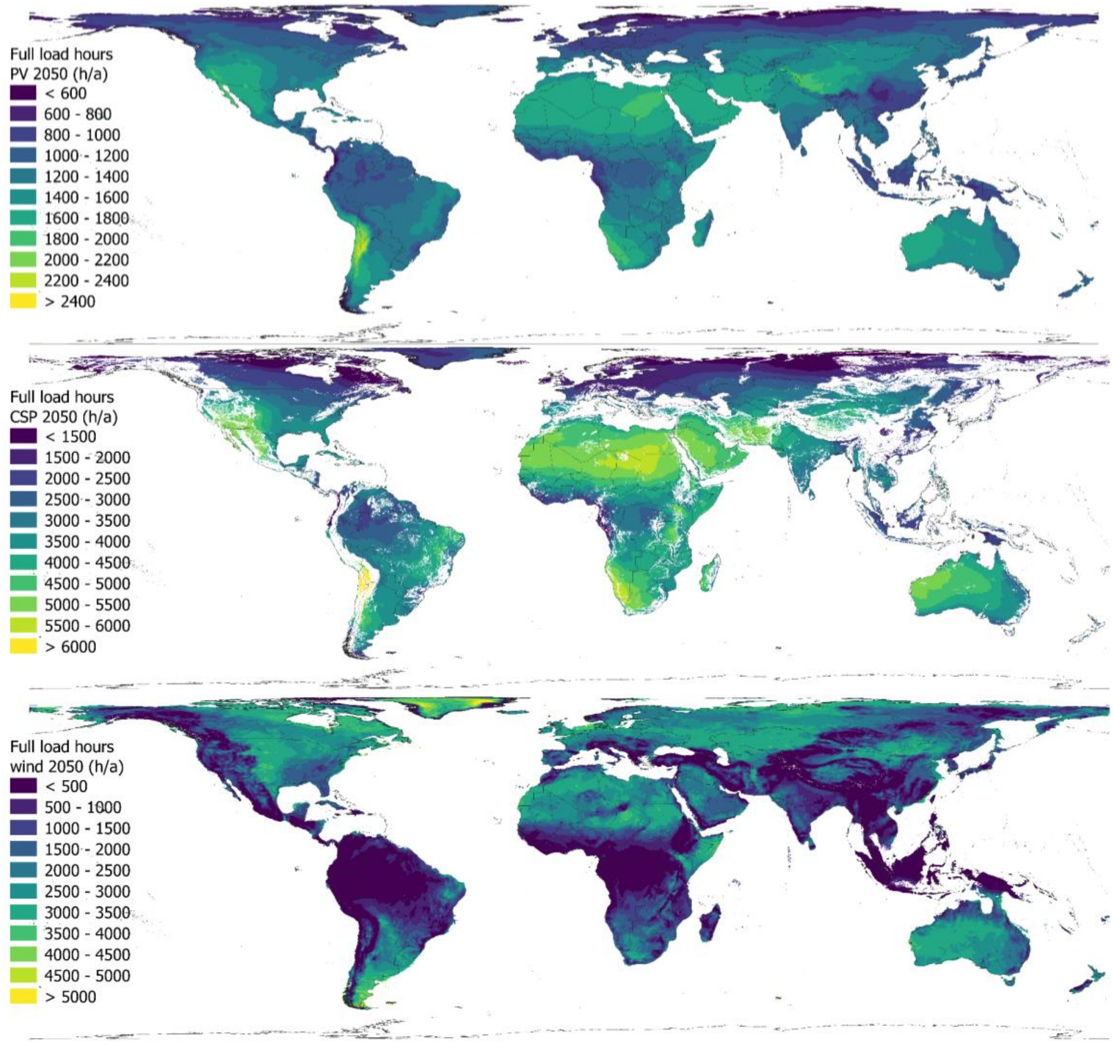
[1] IRENA 2017; [2] State-of-the-art: Hydrothermal geothermal;
[3] Technology improvement: Enhanced Geothermal Systems (EGS)
[4] Darma et al. 2021;[5] Fronda et al. 2021;[6] Mertoglu 2021;[7] Gutiérrez-Negrín 2020;
[8] Omenda 2020

3.3 Solar and wind power (modeling using Enertile)

3.3.1 Full-load hours

Full-load hours (FLH) indicate the number of hours that a specific technology runs at its rated capacity over the course of one year. In the case of RE technologies, they offer a way of measuring the potential energy yield.

Figure 2: Full-load hours for PV (top), CSP (middle) as well as onshore and offshore wind (bottom) in 2050[1]



[1] The white areas, which are mainly visible for CSP, represent terrain that cannot be used because the slope gradient is too steep. For offshore wind, only marine areas up to a water depth of 50m are considered; other areas are also shown shaded white.

Figure 2 shows the full-load hours in 2050. The regions with the highest FLH for the solar technologies of PV (top) and CSP (middle) are in northern Chile and Argentina. The difference between the FLH values for PV (> 2400 h) and for CSP (> 6000 h) is mainly due to the widespread oversizing of the solar collectors for CSP compared to the generator power (assumption: factor of 2.2) in combination with thermal energy storage (assumption: 8 hours of storage capacity). Other regions with especially high FLH for PV and CSP are the arid regions and deserts in North Africa, the Middle East, the highlands of Tibet, southwestern Africa, Australia, as well as the western USA and Mexico.

For wind energy, the highest FLH (> 5000 h) are in the extreme south of South America and in Greenland, although the latter is probably not suitable for energy generation due to its ice cover. Other regions with especially high FLH for wind energy include the North Sea and adjacent coastal regions, the Midwest of the U.S., northern Canada, the desert and steppe regions of northern and eastern Africa, Central Asia and Mongolia as well as Australia, each with values of more than 3500 hours.

3.3.2 Specific electricity generation costs

The specific costs were calculated based on technical and economic assumptions for the years 2030 and 2050, and for both scenarios (uniform and country-specific interest rates).

Figure 3 shows the specific costs based on a uniform interest rate in 2030. Generally, regions with the highest FLH are also those with the lowest electricity generation costs (cp. Figure 2). This correlation does not apply without restriction only in the case of offshore wind, since the costs here increase with increasing marine depth and distance to the coast, which counteract the effect of higher FLH at sea. Using an identical color scale across all RE technologies allows a comparison of their costs with each other. Globally, PV has the lowest electricity generation costs, beginning with 15-20 €/MWh in northern Chile, while large parts of the world have PV electricity costs of 20-30 €/MWh. The costs of wind power at the most favorable locations have a similar range of 20-30 €/MWh, but the regional variations for wind are much higher than for PV. CSP power, in contrast, is only available from 30-40 €/MWh (in Chile and Namibia).

Figure 4 shows the specific costs with country-specific interest rates in 2030. Compared to Figure 3, it is obvious that higher interest rates strongly influence the costs. This is illustrated by the example of PV for Argentina and Chile. In Chile, PV costs are under 20 €/MWh, whereas these increase to 30-40 €/MWh for Argentina despite comparable full-load hours, because of the higher interest rate there. Another example is the region of North Africa, which shows relatively uniform specific costs for PV in Figure 3 and larger cost variations due to differing interest rates in Figure 4. This effect is also apparent for onshore wind, for which Chile has the lowest costs of less than 30 €/MWh. Chile also has the lowest costs for CSP of less than 40 €/MWh.

Figure 3: **Specific electricity generation costs for PV (top), CSP (middle) as well as onshore and offshore wind (bottom) with uniform interest rate in 2030**

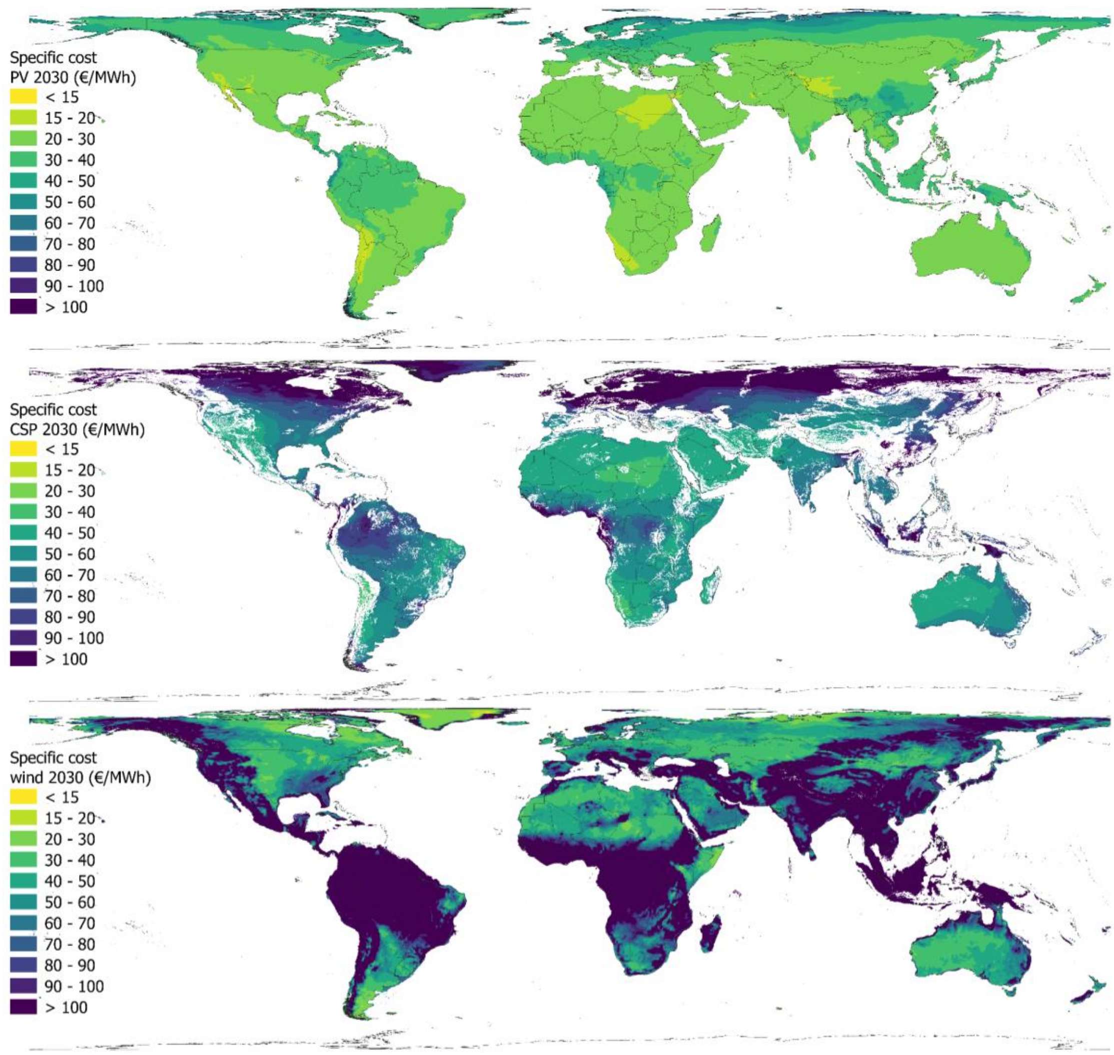


Figure 4: Specific electricity generation costs for PV (top), CSP (middle) as well as onshore and offshore wind (bottom) with country-specific interest rates in 2030

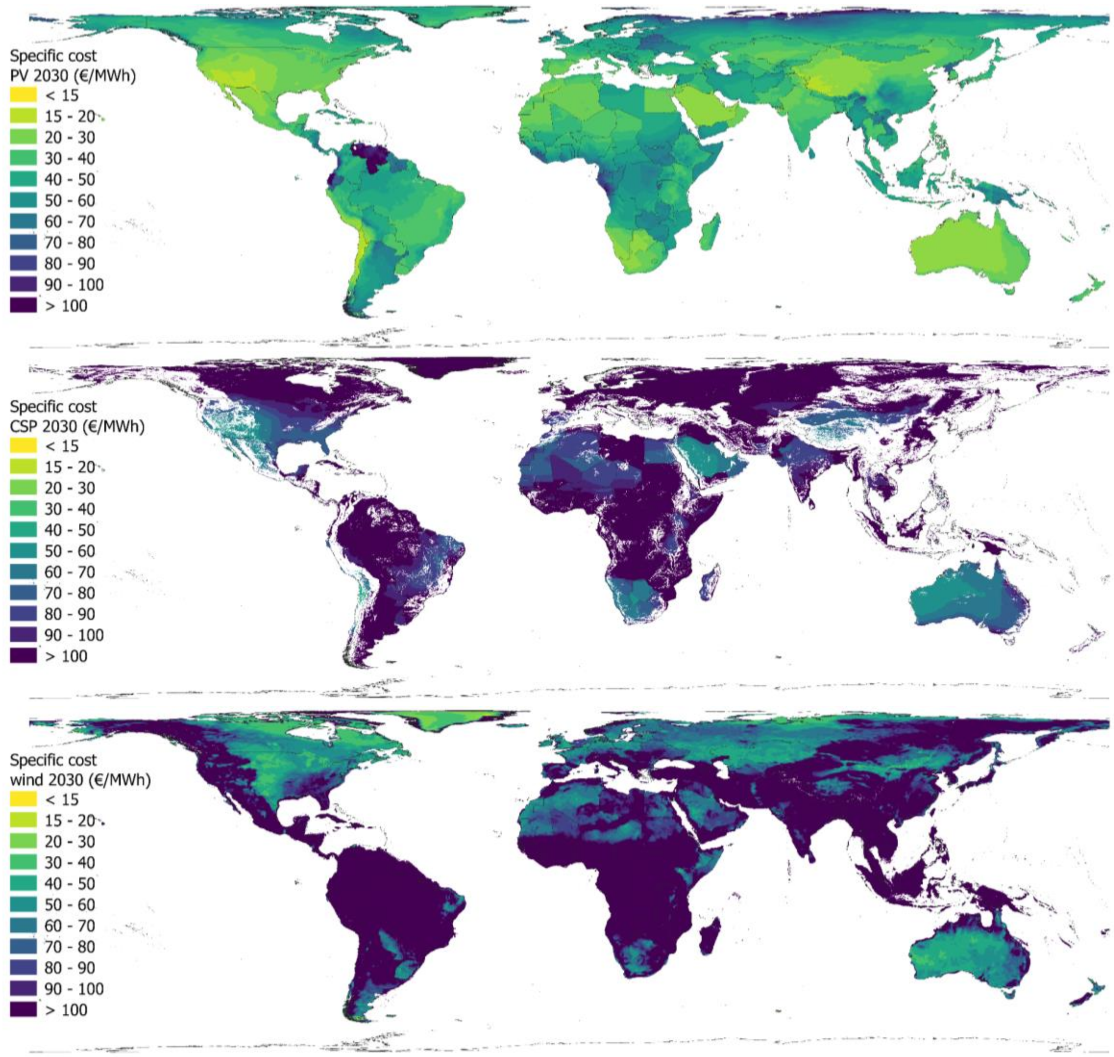


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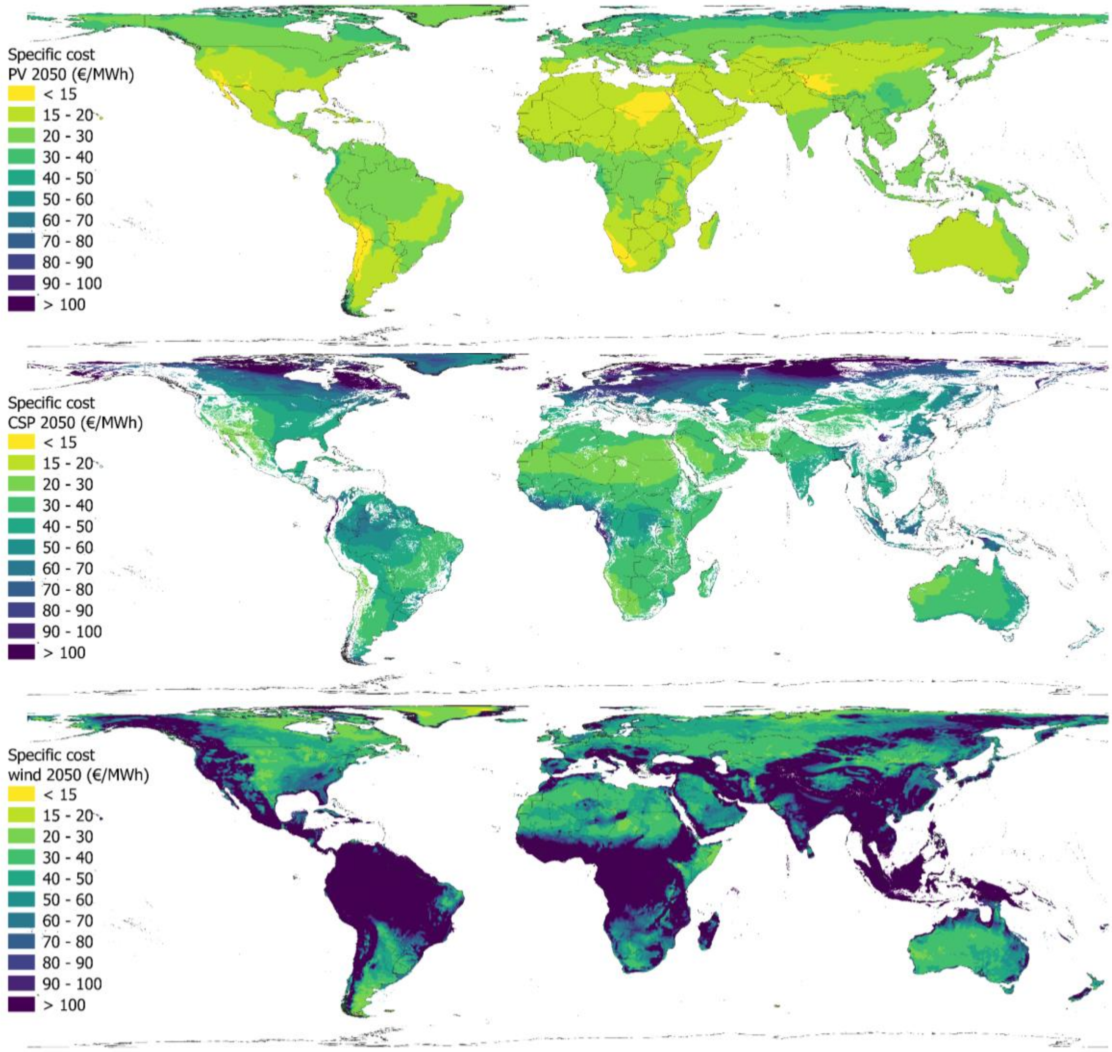
Figure 5 shows the specific costs based on a uniform interest rate in 2050. Compared to 2030, there is an obvious cost reduction for all technologies. The electricity generation costs in 2050 are less than 15 €/MWh for PV in the most favorable regions, and are in the range of 15-20 €/MWh for large parts of the world. The cost reductions are less pronounced for wind power. Here, the lowest specific costs of less than 30 €/MWh are in Chile, Somalia and Australia. For CSP, Chile, Bolivia and Argentina have the lowest costs, but many countries in the MENA region also have costs of less than 30 €/MWh.

Figure 5: **Specific electricity generation costs for PV (top), CSP (middle) as well as onshore and offshore wind (bottom) with uniform interest rate in 2050**



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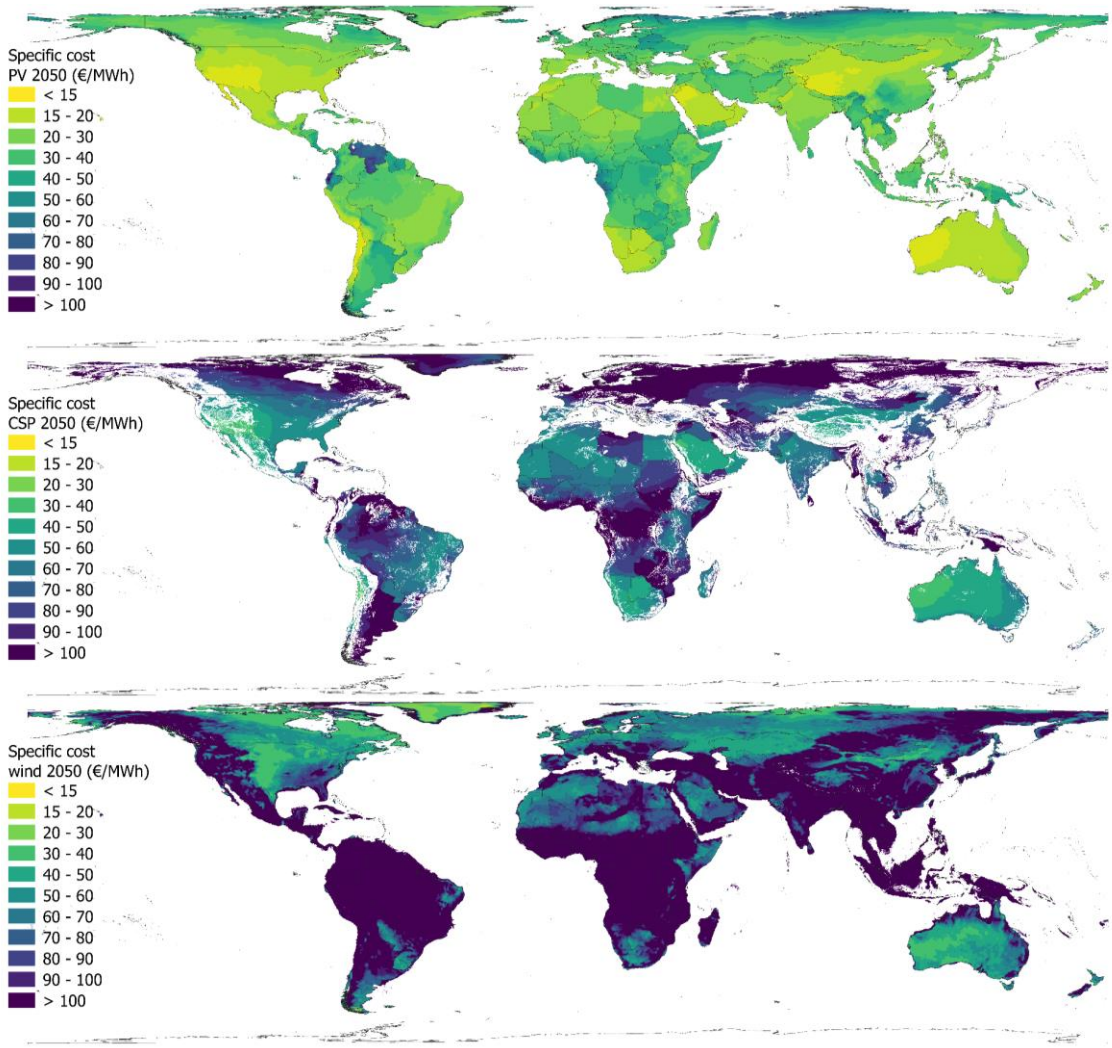
Similar to Figure 3, Figure 6 illustrates the effect of country-specific interest rates in the form of higher costs for various countries, even if the renewable energy source is similar in all countries. The lowest specific PV costs of less than 20 €/MWh are in Saudi Arabia, Chile and Australia. Canada and Australia have specific costs of less than 40 €/MWh for wind power. Chile and Australia have the lowest specific costs for CSP of less than 40 €/MWh.

Figure 6: Specific electricity generation costs for PV (top), CSP (middle) as well as onshore and offshore wind (bottom) with country-specific interest rates in 2050



4 Summary and conclusions

In order to lower anthropogenic greenhouse gas emissions, it is crucial to continue to expand renewable energy capacities for both the direct use of electricity and the production of green hydrogen and green synthesis products. Therefore, it is of particular interest to determine the global potential of renewable energies and to identify regions that are particularly suitable for renewable energies as a basis for the production of hydrogen. This was examined within the HYPAT project with the aid of the Enertile model (for the technologies PV, CSP, onshore and offshore wind) and a literature review (for geothermal energy and hydropower).

The potential for geothermal energy and hydropower is concentrated on specific world regions to a greater extent. The costs of these technologies are generally higher than the lowest costs for PV and onshore wind, but the higher number of full-load hours available for geothermal energy and hydrogen power could contribute to reducing the costs for hydrogen, as these would enable higher capacity utilization of the electrolyzers. However, because these energy sources are able to provide baseload power, they would also be needed to meet the demand for electricity and to stabilize electricity systems with high shares of fluctuating renewable energies (PV, wind) and would therefore probably only be available to a limited extent for hydrogen production.

The highest full-load hours for both PV and CSP are in the same regions (Chile, MENA, Australia). However, the restrictions on installing CSP (slope gradient) limit its use in mountainous regions (shaded white in the maps). Offshore wind usually has higher full-load hours than onshore wind, but also higher specific costs. In the face of limited acceptance of expanding onshore wind and increased efforts to reduce the dependency on energy imports, offshore wind could still play an important role in Europe and other regions.

The costs of PV are low in large parts of the world in both the considered time horizons of 2030 and 2050. In contrast, the lowest specific costs for wind power are in specific regions in North America, Europe, Australia and MENA. The highest costs among the assessed technologies are for CSP. However, the impacts of energy storage capacities are not considered here, as these can contribute to stabilizing the energy system of a country/region or enabling higher utilization of the electrolyzers for hydrogen production. This will be considered in an in-depth analysis of selected countries as part of the further work within the HYPAT project.

The choice of interest rate plays an important role in the calculations, as a higher interest rate (based on higher risks) implies higher costs for a country's electricity and hydrogen production. This situation is represented by Chile and Argentina, as both have similar natural resources, but the lower interest rate in Chile results in lower specific costs there. However, the risks and thus also the costs of financing could be lowered, for example, by the support of states with more favorable financing conditions or by international institutions.

Finally, it can be concluded that renewable energy technologies in large parts of the world have good to very good potential, and that they will become increasingly competitive as their costs decrease (especially photovoltaic). The relatively widespread distribution of these resources opens up the possibility of producing green hydrogen at many different locations, which can reduce the dependency on single suppliers of the countries importing hydrogen (Wietschel et al. 2022).

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6 List of figures

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A.1 Appendix

Table 3: Interest rates applied in Enertile calculations

ISO 3	Country/Territory	Interest rate	ISO 3	Country/Territory	Interest rate
ABW	Aruba	6.3%	DEU	Germany	4.7%
AFG	Afghanistan	16.4%	DJI	Djibouti	9.2%
AGO	Angola	12.0%	DMA	Dominica	8.0%
AIA	Anguilla	8.0%	DNK	Denmark	4.7%
ALB	Albania	9.1%	DOM	Dominican Republic	8.2%
AND	Andorra	12.0%	DZA	Algeria	9.2%
ARE	United Arab Emirates	5.2%	ECU	Ecuador	14.4%
ARG	Argentina	16.3%	EGY	Egypt	10.1%
ARM	Armenia	8.2%	ERI	Eritrea	16.4%
ASM	American Samoa	6.2%	ESH	Western Sahara	10.2%
ATF	French Southern and Antarctic Lands	5.9%	ESP	Spain	6.3%
ATG	Antigua and Barbuda	8.0%	EST	Estonia	5.4%
AUS	Australia	4.7%	ETH	Ethiopia	10.1%
AUT	Austria	5.1%	FIN	Finland	5.1%
AZE	Azerbaijan	7.6%	FJI	Fiji	8.2%
BDI	Burundi	16.4%	FLK	Falkland Islands	9.6%
BEL	Belgium	5.3%	FRA	France	5.2%
BEN	Benin	10.1%	FRO	Faroes	5.9%
BES	Bonaire. Sint Eustatius and Saba	8.0%	FSM	Micronesia	6.2%
BFA	Burkina Faso	10.1%	GAB	Gabon	12.0%
BGD	Bangladesh	8.2%	GBR	United Kingdom	5.3%
BGR	Bulgaria	6.3%	GEO	Georgia	7.6%
BHR	Bahrain	10.1%	GGY	Guernsey	4.7%
BHS	Bahamas	7.6%	GHA	Ghana	11.0%
BIH	Bosnia and Herzegovina	11.0%	GIB	Gibraltar	5.9%
BLM	Saint Barthélemy	8.0%	GIN	Guinea	9.2%
BLR	Belarus	11.0%	GLP	Guadeloupe	5.9%
BLZ	Belize	14.4%	GMB	Gambia	10.2%
BMU	Bermuda	5.5%	GNB	Guinea-Bissau	10.2%
BOL	Bolivia	10.1%	GNQ	Equatorial Guinea	10.2%
BRA	Brazil	7.6%	GRC	Greece	8.2%
BRB	Barbados	12.0%	GRD	Grenada	8.0%
BRN	Brunei	7.5%	GRL	Greenland	5.9%
BTN	Bhutan	7.5%	GTM	Guatemala	7.1%
BVT	Bouvet Island	5.9%	GUF	French Guiana	5.9%
BWA	Botswana	5.5%	GUM	Guam	8.0%
CAF	Central African Republic	12.1%	GUY	Guyana	12.1%
CAN	Canada	4.7%	HKG	Hong Kong	5.3%
CCK	Cocos (Keeling) Islands	6.2%	HMD	Heard Island and McDonald Islands	6.2%
CHE	Switzerland	4.7%	HND	Honduras	9.1%
CHL	Chile	5.4%	HRV	Croatia	7.1%
CHN	China	5.4%	HTI	Haiti	12.1%
CIV	Côte D'Ivoire	8.2%	HUN	Hungary	6.9%
CMR	Cameroon	10.1%	IDN	Indonesia	6.6%
COD	Democratic Republic of The Congo	12.0%	IMN	Isle of Man	5.3%
COG	Congo	13.4%	IND	India	6.9%
COK	Cook Islands	9.1%	IOT	British Indian Ocean Territory	5.9%
COL	Colombia	6.6%	IRL	Ireland	5.5%
COM	Comoros	10.2%	IRN	Iran	16.4%
CPT	Clipperton Island	6.2%	IRQ	Iraq	12.0%
CPV	Cape Verde	10.1%	ISL	Iceland	5.5%
CRI	Costa Rica	10.1%	ISR	Israel	5.4%
CUB	Cuba	13.4%	ITA	Italy	6.9%
CUW	Curaçao	5.9%	JAM	Jamaica	10.1%
CXR	Christmas Island	6.2%	JEY	Jersey	4.7%
CYM	Cayman Islands	5.3%	JOR	Jordan	9.1%
CYP	Cyprus	7.6%	JPN	Japan	5.4%
CZE	Czechia	5.3%	KAZ	Kazakhstan	6.9%

ISO 3	Country/Territory	Interest rate		ISO 3	Country/Territory	Interest rate
KEN	Kenya	10.1%		PRI	Puerto Rico	8.0%
KGZ	Kyrgyzstan	10.1%		PRK	North Korea	16.4%
KHM	Cambodia	10.1%		PRT	Portugal	6.9%
KIR	Kiribati	6.2%		PRY	Paraguay	7.1%
KNA	Saint Kitts and Nevis	8.0%		PSE	Palestine	12.1%
KOR	South Korea	5.2%		PYF	French Polynesia	5.9%
KWT	Kuwait	5.4%		QAT	Qatar	5.3%
LAO	Laos	13.4%		REU	Reunion	5.9%
LBN	Lebanon	23.9%		ROU	Romania	6.9%
LBR	Liberia	12.1%		RUS	Russian Federation	6.9%
LBY	Libya	16.4%		RWA	Rwanda	10.1%
LCA	Saint Lucia	8.0%		SAU	Saudi Arabia	5.4%
LIE	Liechtenstein	4.7%		SDN	Sudan	16.4%
LKA	Sri Lanka	12.0%		SEN	Senegal	8.2%
LSO	Lesotho	10.2%		SGP	Singapore	4.7%
LTU	Lithuania	5.9%		SGS	South Georgia and The South Sandwich Islands	5.9%
LUX	Luxembourg	4.7%		SHN	Saint Helena. Ascension and Tristan Da Cunha	5.9%
LVA	Latvia	5.9%		SJM	Svalbard and Jan Mayen	5.9%
MAC	Macau	7.5%		SLB	Solomon Islands	11.0%
MAR	Morocco	7.1%		SLE	Sierra Leone	12.1%
MCO	Monaco	5.9%		SLV	El Salvador	11.0%
MDA	Republic of Moldova	11.0%		SMR	San Marino	5.9%
MDG	Madagascar	9.2%		SOM	Somalia	16.4%
MDV	Maldives	11.0%		SPM	Saint Pierre and Miquelon	5.9%
MEX	Mexico	6.3%		SRB	Serbia	8.2%
MHL	Marshall Islands	6.2%		SSD	South Sudan	16.4%
MKD	North Macedonia	8.2%		STP	São Tomé and Príncipe	10.2%
MLI	Mali	12.0%		SUR	Suriname	14.4%
MLT	Malta	5.5%		SVK	Slovakia	5.5%
MMR	Myanmar/Burma	12.1%		SVN	Slovenia	5.9%
MNE	Montenegro	9.1%		SWE	Sweden	4.7%
MNG	Mongolia	11.0%		SWZ	Eswatini	10.2%
MNP	Northern Mariana Islands	6.2%		SXM	Sint-Maarten	8.0%
MOZ	Mozambique	13.4%		SYC	Seychelles	10.2%
MRT	Mauritania	9.2%		SYR	Syria	16.4%
MSR	Montserrat	6.9%		TCA	Turks and Caicos Islands	6.3%
MTQ	Martinique	5.9%		TCD	Chad	12.1%
MUS	Mauritius	6.3%		TGO	Togo	11.0%
MWI	Malawi	12.1%		THA	Thailand	6.3%
MYS	Malaysia	5.9%		TJK	Tajikistan	11.0%
MYT	Mayotte	5.9%		TKL	Tokelau	6.2%
NAM	Namibia	8.2%		TKM	Turkmenistan	12.1%
NCL	New Caledonia	5.9%		TLS	Timor-Leste	12.1%
NER	Niger	11.0%		TON	Tonga	6.2%
NFK	Norfolk Island	6.2%		TTO	Trinidad and Tobago	7.1%
NGA	Nigeria	10.1%		TUN	Tunisia	10.1%
NIC	Nicaragua	11.0%		TUR	Turkey	10.1%
NIU	Niue	6.2%		TUV	Tuvalu	6.2%
NLD	Netherlands	4.7%		TWN	Chinese Taipei (Taiwan)	5.3%
NOR	Norway	4.7%		TZA	United Republic of Tanzania	10.1%
NPL	Nepal	9.2%		UGA	Uganda	10.1%
NRU	Nauru	6.2%		UKR	Ukraine	11.0%
NZL	New Zealand	4.7%		UMI	United States Minor Outlying Islands	4.7%
OMN	Oman	8.2%		URY	Uruguay	6.6%
PAK	Pakistan	11.0%		USA	United States	4.7%
PAN	Panama	6.3%		UZB	Uzbekistan	9.1%
PCN	Pitcairn Islands	6.2%		VAT	Vatican City	5.9%
PER	Peru	5.9%		VCT	Saint Vincent and The Grenadines	8.0%
PHL	Philippines	6.6%		VEN	Venezuela	23.9%
PLW	Palau	7.5%		VGB	British Virgin Islands	5.9%
PNG	Papua New Guinea	10.1%		VIR	US Virgin Islands	4.7%
POL	Poland	5.5%		VNM	Vietnam	8.2%

ISO 3	Country/Territory	Interest rate		ISO 3	Country/Territory	Interest rate
VUT	Vanuatu	6.2%		XL	Navassa Island (Disputed Territory)	4.7%
WLF	Wallis and Futuna	8.0%		XM	Scarborough Reef (Disputed Territory)	7.5%
WSM	Samoa	6.2%		XN	Senkaku Islands (Disputed Territory)	7.5%
XA	Paracel Islands (Disputed Territory)	7.5%		XO	Bassas Da India (Disputed Territory)	5.9%
XB	Spratly Islands (Disputed Territory)	7.5%		XU	Abyei (Disputed Territory)	10.2%
XC	Aksai Chin (Disputed Territory)	7.5%		XV	Bir Tawil (Disputed Territory)	10.2%
XD	Arunachal Pradesh (Disputed Territory)	7.5%		YEM	Yemen	16.4%
XF	Hala'Ib Triangle (Disputed Territory)	10.2%		ZAF	South Africa	7.6%
XG	Ilemi Triangle (Disputed Territory)	10.2%		ZMB	Zambia	16.3%
XH	Jammu Kashmir (Disputed Territory)	7.5%		ZWE	Zimbabwe	16.4%
XI	Kuril Islands (Disputed Territory)	7.5%				