

GLOBAL SOLAR ENERGY TRENDS

“Yep, the sun is intermittent.
But you only need a few minutes of sun to fill a large tank of water.”

© M. Ragheb
5/11/2024

INTRODUCTION

By 2023 electrical solar energy accounted for three-quarters of the renewable capacity additions worldwide. In 2023, global renewable capacity increased by 50 percent to nearly 510 gigawatts, GWs, the fastest growth rate in three decades, of which three-quarters came from solar photovoltaic energy, according to the International Energy Agency IEA.

Solar panels continue producing power on cloudy days and even under rainy conditions, albeit at a lower rate as the ultraviolet part of solar radiation penetrates the cloud cover to the Earth’s surface. The main impediment to solar energy production is particulate matter air pollution that can reach a level above 300 ppm in polluted industrial environments. Most of this growth occurred in Asia, the European Union EU, and the USA, continuing a trend observed over the past decade.

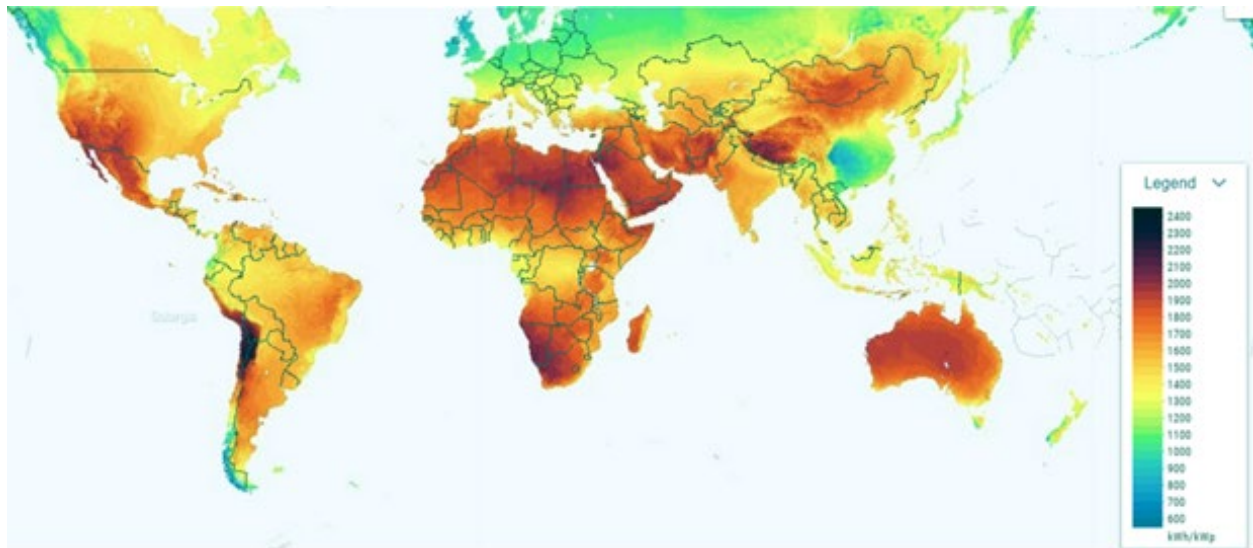


Figure 1. Worldwide solar energy photovoltaic potential map includes Western North America, North and South Africa, Middle East, South America and Australia.. Countries closer to the equator are a better match with solar than those farther from it. away.

<https://fingfx.thomsonreuters.com/gfx/ce/egvbyggdlpq/WolrdSolarGISMap.png>

Areas closer to the equator as shown in Fig,1 are most favorable for solar energy production. Most of Europe is not good for it. Thirty percent of the USA and China are suitable. Both in their South-West corridor regions. Most of Australia is also suitable.

SOLAR ENERGY GLOBAL STATUS

The newly installed solar Photo-Voltaic (PV) capacity in China, the EU, and the USA between 2010 and 2022 are displayed in Fig. 2 and Table 1, by Bruno Venditti in terms of Gigawatts (GWs) of power.

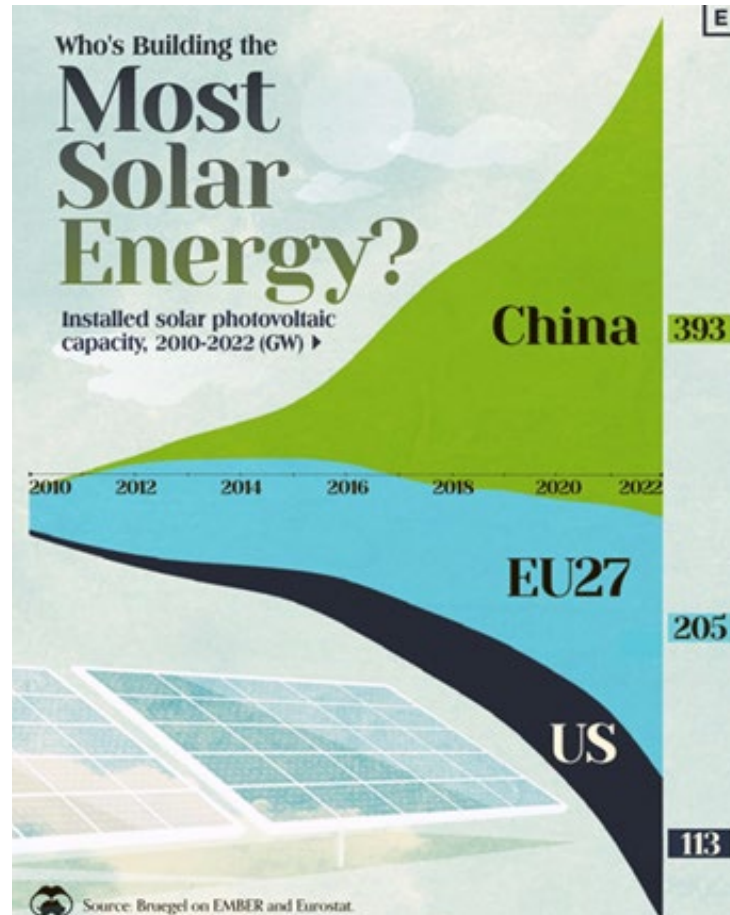


Figure 2. As of 2022, China’s total solar installed capacity stands at 393 GW, nearly double that of the EU’s 205 GW and surpassing the USA’s total of 113 GW by more than threefold.

Since 2017, China has shown a Compound Annual Growth Rate (CAGR) of approximately 25 percent in installed Photo-Voltaic PV capacity, while the USA has seen a CAGR of 21 percent, and the EU’s 16 percent.

China also leads in the production of solar power components, producing 80 percent of the world’s solar panel supply chain. In 2022, China’s solar industry employed 2.76 million workers, with manufacturing roles representing approximately 1.8 million and the remaining 918,000 jobs in construction, installation, and O&M Operations and Maintenance.

Moreover, China is the largest rechargeable battery maker in the world so they can make energy while the sun shines and supplement it with energy storage for later use.

West, North, and northwest parts of China have large swath of desert yet are short in infrastructures which is ideal for solar power. In terms of “dispatchability”, China developed some of the best High Voltage Direct Current HVDC long range transmission systems in the world for its

Three Gorges hydroelectric dam and is complementing nuclear power generation to its base load hydroelectric and thermal energy generation.

A perceived challenge is that increasing penetration of solar electrical generation is associated with technical problems dealing with the materials choices (think hail storms), power transmission, instability and intermittence associated with it. To address these issues, China educates out more Science, Technology, Engineering, and Mathematics STEM graduates per year than all the Western nations combined.

The EU industry employed 648,000 individuals, while the USA reached 264,000 jobs. According to the International Energy Agency IEA, China accounts for almost 60 percent of new renewable capacity expected to become operational globally by 2028.

Despite the phasing out of national subsidies in 2020 and 2021, deployment of solar PV in China is accelerating. The country is expected to reach its national 2030 target for wind and solar PV installations in 2024, six years ahead of schedule.

Table 1. Solar installed capacity in the USA, European Union EU and China.

Installed solar capacity (GW)	China	EU27	U.S.
2022	393.0	205.5	113.0
2021	307.0	162.7	95.4
2020	254.0	136.9	76.4
2019	205.0	120.1	61.6
2018	175.3	104.0	52.0
2017	130.8	96.2	43.8
2016	77.8	91.5	35.4
2015	43.6	87.7	24.2
2014	28.4	83.6	18.1
2013	17.8	79.7	13.3
2012	6.7	71.1	8.6
2011	3.1	53.3	5.6
2010	1.0	30.6	3.4

Most Chinese non-oil/gas/coal comes from Hydroelectric, which is the favored energy generation alternative worldwide. However, wind and solar, and to a lesser extent nuclear energy are prominently introduced into the mix.

Table 2. Total Power Production of electrical energy in China, 2019-2020.

https://en.wikipedia.org/wiki/Electricity_sector_in_China

Source	Terawatt.hr TWh 2020	Terawatt.hr TWh 2019	Percent change
--------	----------------------	----------------------	----------------

Total Power production	7,326.9	7,263.0	4.0
Hydroelectric	1,302.1	1,355.2	4.1
Thermal	5,046.5	5,174.3	2.5
Nuclear	348.7	366.2	5.0
Wind	405.3	466.5	15.1
Solar	224.0	261.1	16.6



Figure 3. Concentrated Thermal Solar Parabolic Trough Power Plant.



Figure 4. Commercial Roof Top Photovoltaic solar power Production.



Figure 5. Domestic backyard photovoltaic solar panels.



Figure 6. Domestic Roof Top photovoltaic solar panels.

RESOURCE NEEDS FOR SOLAR POWER GENERATION

SILVER

“A booming solar-power industry is driving a surge in the demand for silver, which is needed in large quantities to make photovoltaic panels.

Silver is integral to the production of solar photovoltaic—or solar PV—panels because of its high electrical conductivity, thermal efficiency and optical

reflectivity, and mining companies are aiming to boost output as prices for the precious metal have climbed to decade highs.[1]”

Global investment in solar Photo-Voltaic PV manufacturing more than doubled in 2023 to around \$80 billion, accounting for around 40 percent of global investment in clean-technology manufacturing, according to a report from the International Energy Agency IEA. China doubled its investment in solar PV manufacturing between 2022 and 2023.

Demand for silver from the makers of solar PV panels, particularly those in China, is forecast to increase by almost 170 percent by 2030, to roughly 273 million ounces—or about one-fifth of total silver demand—based on current trend projections, according to investment manager Sprott, which specializes in precious metals,

“Industrial demand is soaring, driven by photovoltaic and other electrification end uses, while supply is flat to declining,” said Mitchell J. Krebs, chief executive of Chicago-based Coeur Mining.

Spot prices for solar PV fell almost 50 percent in 2023, according to the IEA as a result of Chinese supply flooding the market. In 2023, China commissioned as much solar photovoltaic as did the entire world in 2022, according to the IEA. It is expected to maintain an 80 to 95 percent market share of the supply chains and to double its manufacturing capacity again by the end of 2024, significantly swelling the supply.

Coeur Mining, a Chicago-based miner is hoping to capitalize on the increasing demand for silver. It recently completed a large expansion of a mine in Nevada, set to become the largest source of domestically produced silver in the USA.

Hochschild Mining, based in London, is expanding its silver operations. In 2024, it hopes to secure permits for a silver project in southern Peru, scheduled to start production in 2027, adding 50 million of predominantly silver ounces to its annual output.

The boom in demand has contributed to increased silver prices to \$28.84 an ounce, the highest closing price in more than a decade.

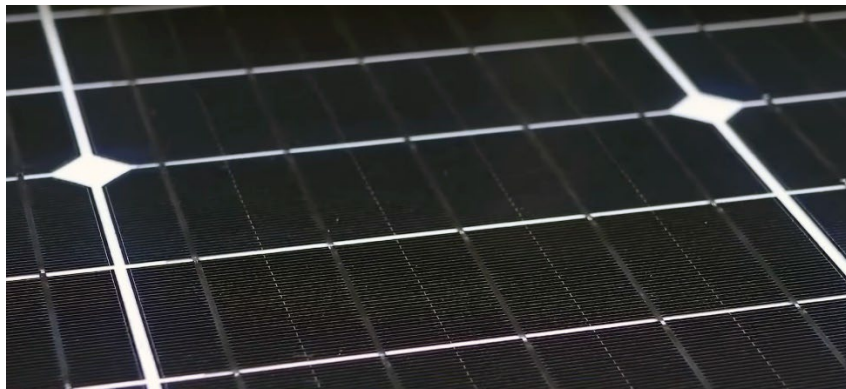


Figure 7. Ferroelectric crystal conventional PN junction solid state fuel cell.

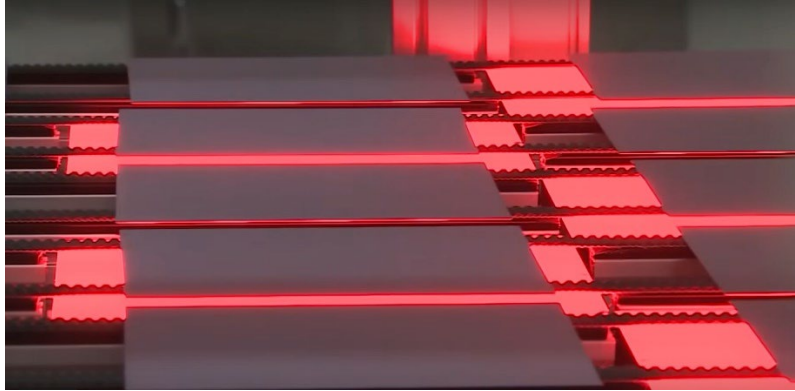


Figure 8. Barium titanate crystal film solar cells.



Figure 9. Water washing the surface of Barium titanate crystal film solar cells.

COPPER

Demand for refined copper will grow 53% by 2040, but mine supply will climb only 16%. S&P Global said electric vehicles require twice as much copper as an internal combustion engine vehicle. Copper demand will double to 50,000,000 metric tons annually by 2035, more than all the copper consumed worldwide between 1900 and 2021.

Eurasian Resources Group's (ERG) chief executive officer Benedikt Sobotka said the world's appetite for copper is set to soar and might even exceed supply over the next decade unless new mines are built. The demand increase is due to the ambitious energy transition goals set by governments.

The World Economic Forum's Annual Meeting of New Champions suggests that copper miners must increase supplies. New mines are more challenging and located in expensive jurisdictions. Deposits are getting more expensive and harder to find, funding is limited, and economies have to prepare for the importance of the mining industry to lead the energy transition.

DISCUSSION

Overcoming the intermittent nature of solar and wind energy poses an engineering challenge in developing of associated energy storage systems both for central base-load utilities and distributed individual applications.

It is estimated that 88 percent of the global population needs green energy. The market share of 88 percent of humanity happens to be where future growth will occur.

It is sobering to consider the experience of a solar energy user comment:

“For all the solar naysayers.

Goop just completed a solar project. For a well pump. The pump is now off-grid. That means free water. From now on, replacing batteries in five or six years notwithstanding. Yep, the sun is intermittent. But you only need a few minutes of sun to fill a large tank of water.

In the big freeze out a couple years back the power was out for a week in sub-freezing temps (Texas, USA). Goops solar backup kept the lights and TV on, the fireplace kept the house livable.

Yes, solar is intermittent. But it damn sure beats the hell out of ...

Nothing.”

In some USA locations, almost every house has installed solar panels. Five kw of capacity is the largest system one can have installed in residential applications. Most installations do not have battery backup and they do not work if the power goes out on the grid.

Solar power is meant to be the cheapest form of energy distribution to millions of disadvantaged individuals, as well as the world population at large.

REFERENCES

1. Christian Moess Laursen, “The Global Solar Power Boom Is Driving a Surge in Silver Demand. Miners are expanding their operations and ramping up production as prices for the precious metal climb to decade highs,” Wall Street Journal WSJ, Sustainable Business, May 7, 2024. <https://www.wsj.com/articles/the-global-solar-power-boom-is-driving-a-surge-in-silver-demand-4ac20435>
2. <https://fingfx.thomsonreuters.com/gfx/ce/egvbyggdlpq/WolrdSolarGISMap.png>

