



Update on the Solar Sector

November 2022

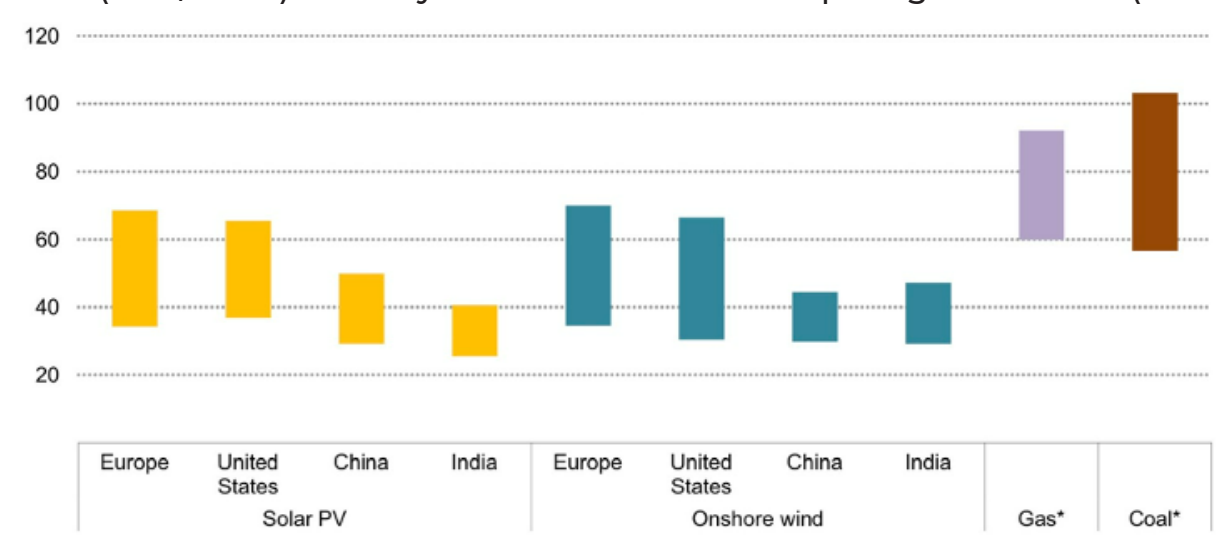
Solar power generation has become relatively more economic during 2022 as module prices have remained broadly flat while competing gas and coal fired generation costs have inflated sharply. Reflecting the improvement, solar installations in 2022 are likely to be around 260 GW, much higher than our initially expected level of 200 GW, with further growth of around 50 GW likely in 2023. The longer-term outlook has also improved with expectations that we could see somewhere around 500 GW pa of installations by the end of the decade. Despite this rapid expansion, the solar industry must grow even more to be aligned with our net zero scenario.

Update on relative economics of solar

The relative economic attractiveness of solar power generation has continued to improve in 2022. On the one hand, the structural story of cost deflation that we have witnessed for a number of years has stalled as a result of cyclical raw material, energy, and logistics cost inflation. But on the other hand, industry growth has brought improved economies of scale, plus the relative economics of solar versus hydrocarbons continues to improve thanks to inflation in competing fossil fuel generation. According to the IEA, the levelized cost of electricity generation (LCOE) for solar in 2022 sits comfortably below competing fossil fuel-based options, meaning that solar is typically the most economic option for new supply that can also help to alleviate energy security concerns.



LCOE (USD/MWh) of Utility Solar and Wind vs Competing Fossil Fuels (2022E)



Source: IEA estimates. Data sourced 06/30/2022.

* Refers to same regions within the figure: Europe, United States, China, & India.

Solar installations in 2022 and 2023

Solar's improved relative economics and the increased need for security of supply mean that installations in 2022 are likely to be around 260 GW, substantially higher than the 200 GW estimate that we made at the start of the year. With momentum strong, especially following the US Inflation Reduction Act (IRA) and the RePowerEU deals, we introduce an estimate for 2023 module demand of 310 GW, another record year for global installations, with growth of 50 GW versus 2022.

Regionally, the key moving parts in 2022 and 2023 are as follows:

- In the **United States** we initially expected installations in 2022 (20 GW) to be lower than 2021 (30 GW) as a result of i) the Withhold Release Order (WRO) placed on various solar product imports from China, ii) concerns around the level of residential solar support coming from a clean energy infrastructure bill and iii) the impact of new net metering

rules (NEM3.0) in California which reduce the attractiveness of solar economics for residential consumers. Actual installations in 2022 are now likely to be around 25 GW as NEM3.0 appears to be less of a threat (although it is still unresolved) and the WRO has not been as negative as initially feared. While the passing of the IRA in 2022 is a clear positive for solar, we do not expect the effect of the bill to be felt until 2023 and for it to be spread over a number of years, with installations reaching the 2021 peak of 30 GW again in 2023 and growing thereafter.

- Demand in **Europe** is expected to be around 45 GW in 2022, up from 24 GW in 2021, as the region reacted to higher fossil fuel generated electricity prices (as a result of lower Russian natural gas imports) and the need for energy security. It is here that the relative economics of solar have improved the most and the RePowerEU deal has already started to incentivize new demand for solar installations. According to Bloomberg



New Energy Finance (BNEF), Europe imported \$2.5bn of Chinese photovoltaic (PV) products in July 2022, up \$1.5bn on the level from July 2021. Looking to 2023, we see further installation increases, with Europe reaching a new record of 62 GW spread well across an increasing number of countries, leading to substantially more growth in future years.

- In **China** module demand is also likely to beat our initial estimates, reaching 95 GW in 2022 (up 30 GW on 2021) as first half 2022 installations of 40 GW were more than double the levels seen in 1H 2021. Growth has come across utility, residential and commercial and we note plans for the development of significant offshore utility scale plants in 2023. As with Europe, higher power prices have been a key factor in driving stronger demand. In mid 2022, China published its 14th five-year plan for renewables which suggested that solar (and wind) installations in 2021-2025 should be double the levels seen in 2015-

2020. Accordingly, we expect China will see more growth in 2023, reaching around 115 GW, double the levels seen in 2020/2021, and representing around 37% global market share.

- The rest of the **non-OECD** (Organisation for Economic Co-operation and Development) has also seen greater than expected growth in demand, reaching around 60 GW in 2022 (up 23 GW on 2021 levels) with demand increases well spread across Latin America (especially Brazil), African and Middle Eastern countries. Indian installations look particularly impressive, but activity has been front-end loaded in response to a new import tax policy that places a 40% surcharge on imported panels from April 2022.

Considering all these factors, we believe that installations could exceed 300 GW in 2023, and are potentially biased higher, with the non-OECD (at 195 GW) still dominating with a 63% market share.

Global Solar Module Installations, 2010 - 2023E (GW)

| | 2010 | 2011 | 2012 | 2013 | 2014 | 2015 | 2016 | 2017 | 2018 | 2019 | 2020 | 2021 | 2022E | 2023E |
|--|-----------|-----------|-----------|-----------|-----------|-----------|-----------|-----------|------------|------------|------------|------------|------------|------------|
| OECD solar installations (annual) | | | | | | | | | | | | | | |
| North America | 1 | 2 | 4 | 6 | 7 | 8 | 14 | 11 | 10 | 11 | 19 | 30 | 23 | 30 |
| Germany | 7 | 7 | 8 | 3 | 2 | 1 | 2 | 2 | 4 | 4 | 5 | 5 | 8 | 11 |
| Spain | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 5 | 3 | 4 | 7 | 9 |
| Rest of Europe | 3 | 4 | 5 | 5 | 5 | 6 | 4 | 3 | 4 | 6 | 8 | 15 | 30 | 42 |
| Australia | 0 | 1 | 1 | 1 | 1 | 1 | 1 | 2 | 4 | 4 | 4 | 5 | 6 | 8 |
| South Korea | 0 | 0 | 0 | 1 | 1 | 1 | 1 | 1 | 2 | 3 | 4 | 4 | 5 | 6 |
| Japan | 1 | 1 | 2 | 7 | 10 | 11 | 8 | 8 | 7 | 7 | 9 | 7 | 9 | 9 |
| Total OECD | 17 | 23 | 24 | 24 | 25 | 29 | 29 | 26 | 31 | 40 | 51 | 70 | 88 | 115 |
| <i>Change in OECD annual installations</i> | <i>10</i> | <i>7</i> | <i>0</i> | <i>0</i> | <i>2</i> | <i>4</i> | <i>0</i> | <i>-3</i> | <i>5</i> | <i>9</i> | <i>11</i> | <i>19</i> | <i>18</i> | <i>27</i> |
| Non-OECD solar installations (annual) | | | | | | | | | | | | | | |
| China | 0 | 3 | 3 | 14 | 13 | 19 | 30 | 53 | 44 | 33 | 52 | 65 | 95 | 115 |
| India | 0 | 0 | 1 | 1 | 1 | 2 | 5 | 10 | 11 | 12 | 4 | 12 | 17 | 18 |
| Rest of non-OECD | 1 | 3 | 3 | 4 | 6 | 6 | 11 | 9 | 22 | 34 | 37 | 37 | 60 | 62 |
| Total Non-OECD | 2 | 5 | 8 | 18 | 21 | 27 | 46 | 72 | 77 | 78 | 93 | 114 | 172 | 195 |
| <i>Change in non-OECD annual installations</i> | <i>1</i> | <i>3</i> | <i>2</i> | <i>11</i> | <i>2</i> | <i>6</i> | <i>19</i> | <i>26</i> | <i>5</i> | <i>1</i> | <i>15</i> | <i>21</i> | <i>58</i> | <i>23</i> |
| Total solar installations (annual) | 19 | 29 | 31 | 42 | 46 | 56 | 75 | 98 | 108 | 118 | 144 | 184 | 260 | 310 |
| <i>Change in world annual installations</i> | <i>11</i> | <i>10</i> | <i>2</i> | <i>11</i> | <i>4</i> | <i>10</i> | <i>19</i> | <i>23</i> | <i>10</i> | <i>10</i> | <i>26</i> | <i>40</i> | <i>76</i> | <i>50</i> |

Source: BP, BNEF, PN InfoLink, IEA, and Guinness Atkinson Asset Management estimates



Solar supply chain in 2022 and 2023

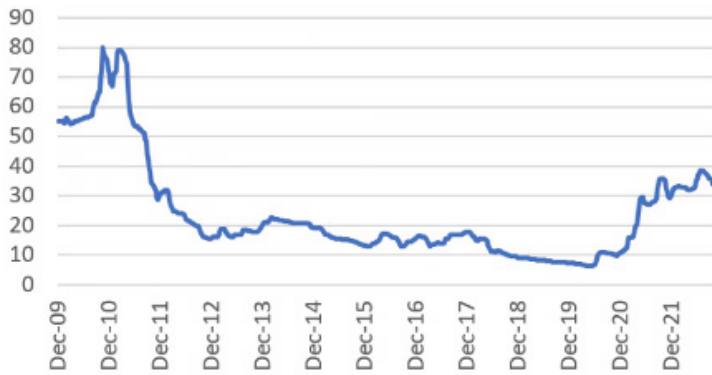
All parts of the solar module manufacturing chain, except polysilicon, appear to have been in oversupply again in 2022 and are likely remain so in 2023. We treat nameplate capacity estimates here with some caution because technological advances and cost improvements can bring rapid capacity obsolescence meaning that actual supply may well be lower than nameplate capacity. Nonetheless, significant new manufacturing capacity is planned across the entire value chain which will likely bring lower module prices and will likely help to support global solar module demand.

- Poly-silicon is a key raw material for a solar wafer and the poly market continued to be the tightest part of the solar market in 2022, evidenced by poly-silicon prices rising through the year to reach nearly \$40/kg in August. Poly prices have been high enough over the past two years to incentivize new supply and we can now see signs that the new supply is on the cusp of arrival. Bloomberg New Energy Finance (BNEF) estimates that the capacity of the poly silicon industry rose to 900 metric tonnes per annum (Mtpa) in 2022 (sufficient to support over 300 GW of solar module manufacturing) but that new capacity additions of nearly 2,500 Mtpa are being planned by either existing players or new entrants. While several plants will not be built and many will take longer than expected to reach full production capacity, the scale of capacity growth leads us to believe that poly prices and associated margins for poly producers will fall in 2023 and beyond, allowing margin expansion elsewhere in the value chain as well as lower solar module prices.

- Wafer and solar cell manufacturing capacity, according to PV InfoLink, will reach 583 GW in Q4 2022 and to grow a further 15% in 2023. In 2022, wafer and cell companies have generally been able to pass through cost inflation and to defend reasonable margins but, similar to polysilicon, this may come under pressure in 2023 as new capacity is added. Unlike polysilicon however, the wafer business is highly concentrated with nearly 80% of 2022 wafer capacity is in the hands of the five largest producers. This may be a factor to help support prices in 2023. A consideration slightly longer term will be the rate at which demand moves from p-type wafers to n-type wafers (with greater efficiency and lower degradation) and how this might cause some existing wafer and cell manufacturing capacity to become obsolete, effectively leaving this part of the market tighter than initially apparent.
- Solar module prices have moderated so far in 2022, down to around US\$0.25/W currently, and are likely to average in 2022 the levels seen in 2021. With elevated polysilicon and power prices, it is the module manufacturers that have suffered the greatest margin compression so far in 2022. Module manufacturing nameplate capacity in 2022 is estimated to be around 470 GW, of which around 310 GW is newer "Tier 1" capacity with lower costs resulting from the scale of manufacturing and new technologies. In 2023, this likely expands to 660 GW and potentially to as high as 820 GW by the end of the year.



Polysilicon (\$/kg)



Modules (\$/Watt)



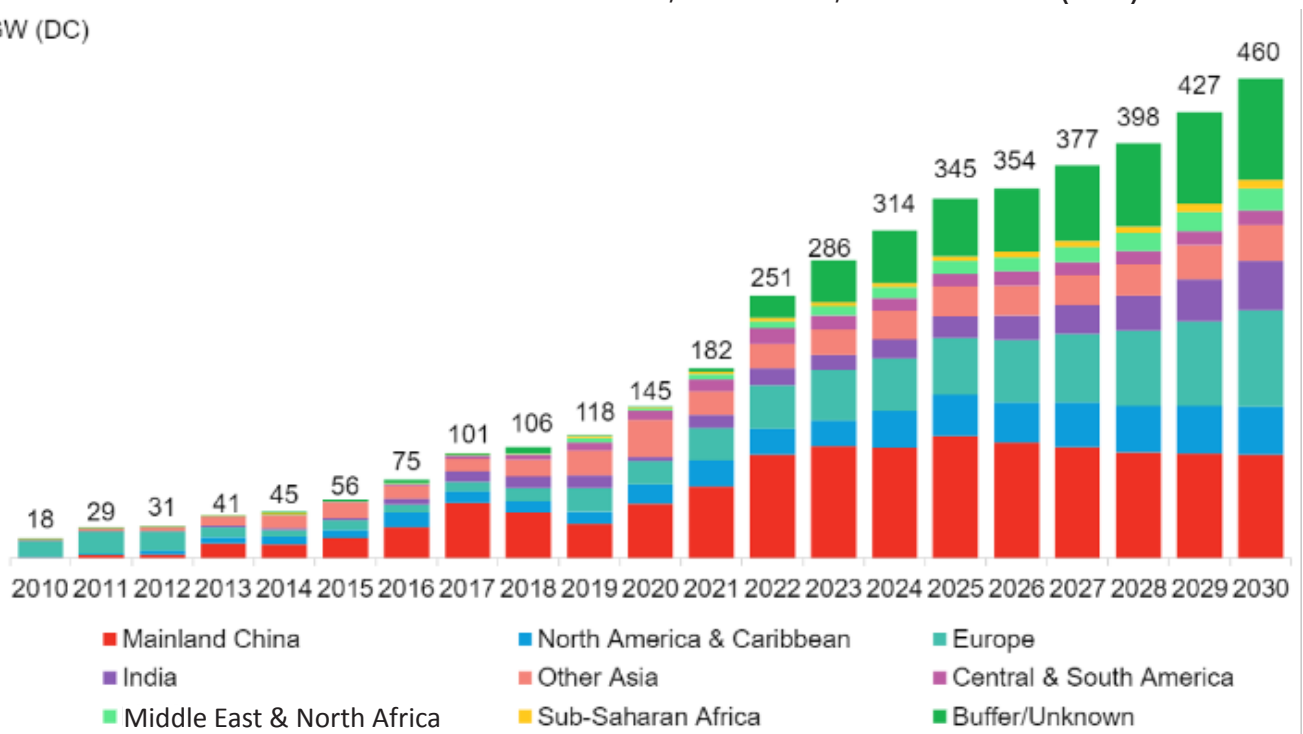
Source: Bloomberg

Long-term solar outlook

The long-term outlook for solar has improved since the start of the year. In August, BNEF updated its long-term projections, increasing its 2030 module installation forecast to 460 GW from the prior year's forecast of 334 GW, an increase of 37%. The impact of the increase is that a total of 3.4 TW of solar is forecast to be installed globally this decade (up 0.8 TW, or 30%, on the previous forecast) with total capacity in 2030 being 4.2 TW (versus prior estimate of 3.4 TW).

Global Solar Module Installations, mid-case, 2010 - 2023E (GW)

GW (DC)



Source: BNEF

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SmartETFs

With the 2022 United Nations Climate Change Conference (COP27) in November, it is worth considering the solar industry's growth profile in the context of a net zero or 1.5 degree warming target. In BNEF's net zero scenario, total installed solar capacity would need to be around 5.3 TW by 2030 (25% higher than their base case forecast of 4.2 TW). For comparison, the SmartETFs net zero scenario indicates that total installed capacity would need to be 5.4 TW in 2030 (a compound growth rate of 18%pa from 2021) and that reaching this level of installed capacity would require annual installations to be around 650 GW pa. While solar is a key and well-placed component of any net zero energy transition scenario, the industry still must deliver more growth in order to be fully aligned.

We believe that the outlook for the solar industry on both a near term and long-term basis remains very robust. Near term cost and supply issues are being worked through and we see good reason to believe that the price of poly silicon, and consequently the price of solar modules, will fall as new manufacturing capacity comes online. We believe that underlying economics will win through, and that solar will gain increasing market share of global electricity generation (supported by storage technologies) with it becoming more dominant than coal fired power generation in around ten years' time.

Disclosure

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