The Global Source

THE SILVER INSTITUTE

Market Trend Report

SILVER'S IMPORTANT ROLE IN SOLAR POWER

CRU

JUNE 2020

Prepared by CRU Consulting

CRU Consulting, Chancery House, 53-64 Chancery Lane, London, WC2A 1QS, UK
Tel: +44 (0)20 7903 2000, Fax: +44 (0)20 7903 2172, Website: www.crugroup.com

Table of Contents

Index of Figures

1. Introduction

Silver is a malleable, white and lustrous precious metal which has the highest electrical and thermal conductivity of all metals. Consequently, its thermal and electrical conductivity properties make it an essential industrial metal. One of the most important industrial uses for silver, alongside electronics, is in photovoltaic (PV) cells, which are the building blocks of solar panels. Silver pastes are a critical part of PV cell manufacturing, where they form a conductive layer on both the front and rear sides of silicon solar cells.

Solar PV is hugely important to future silver demand. A recent report from the World Bank[1] forecasts that by 2050, consumption of silver in energy technologies could grow dramatically, reaching a level equivalent to more than 50% of current total silver demand; the largest proportion for any non-battery metal. More than 95% of this increase is due to an expansion of solar PV power generation.

CRU estimates that 100 million ounces (Moz) of silver, around 11% of total silver fabrication demand[2] was used in the production of PV cells in 2019. CRU believes that a combination of carbon emissions legislation, other government policies and a decrease in the cost per gigawatt (GW) of electricity generated using PV will cause the volume of solar panels installed to continue to increase over the next decade, albeit at a slightly slower rate than in recent years. This will help offset a declining trend in silver usage per PV cell due to thrifting, and while overall silver demand in the sector may dip from current levels, we believe consumption will ultimately be maintained at a substantial rate of around 70-80 Moz per year out to 2030.

This paper provides an overview of trends in solar power generation in different regions, silver usage in PV cells, and finally provides a forecast of silver demand from the PV industry.

2. Trends in solar power generation

World electricity generation reached 26,663 terawatt-hours (TWh) in 2019, growing at a compound annual growth rate (CAGR) of 2.9% from 2009. Terawatt-hours is a measure of electricity consumption and generation, equal to 1,000,000 megawatt-hours. For reference, the average US household consumes about 11 megawatt-hours per year, according to the US Energy Information Administration.

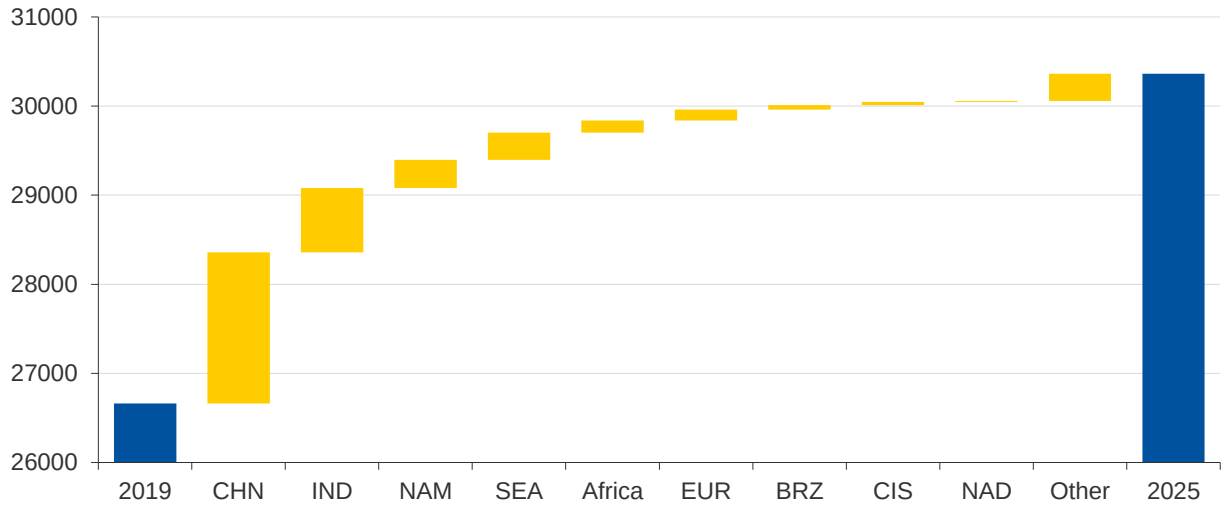
CRU forecasts global electricity generation growth to slow to 2.2% per year on average between 2019 to 2025, with total generation reaching 30,317 TWh in 2025. As the figure below shows, this

[1] Minerals for Climate Action: The Mineral Intensity of the Clean Energy Transition

[2] Note: excluding use in coins and medals, but including jewelry and silverware

slowdown will primarily occur in developed areas, such as Europe, North America and Northeast Asia, as energy-efficient technologies become more widespread. Meanwhile, China will continue its fast-paced growth, joined by India, Southeast Asia and sub-Saharan Africa, as improvements in quality of life and rapid economic growth lead a burgeoning middle class in these areas to require more electricity.

Figure 1 Forecast increase in electricity generation by region, TWh



Data: CRU. CHN-China, IND-India, NAM-North America, SEA-Southeast Asia, EUR-Europe, BRZ-Brazil, CIS-Russia+CIS, NAD-North Asia Developed

Fossil fuels continue to dominate electricity generation in most regions, with coal, oil and gas accounting for around 62% of global electricity generation in 2019. However, as the issue of climate change continues to grow in significance in the wake of the Paris Agreement, governments are increasingly looking to implement policies encouraging low-carbon sources of power generation. Thanks to these policies, and the steady reduction in the cost of generating power from renewable sources, CRU forecasts the share of electricity generated from fossil fuels will decline to 57% by 2025.

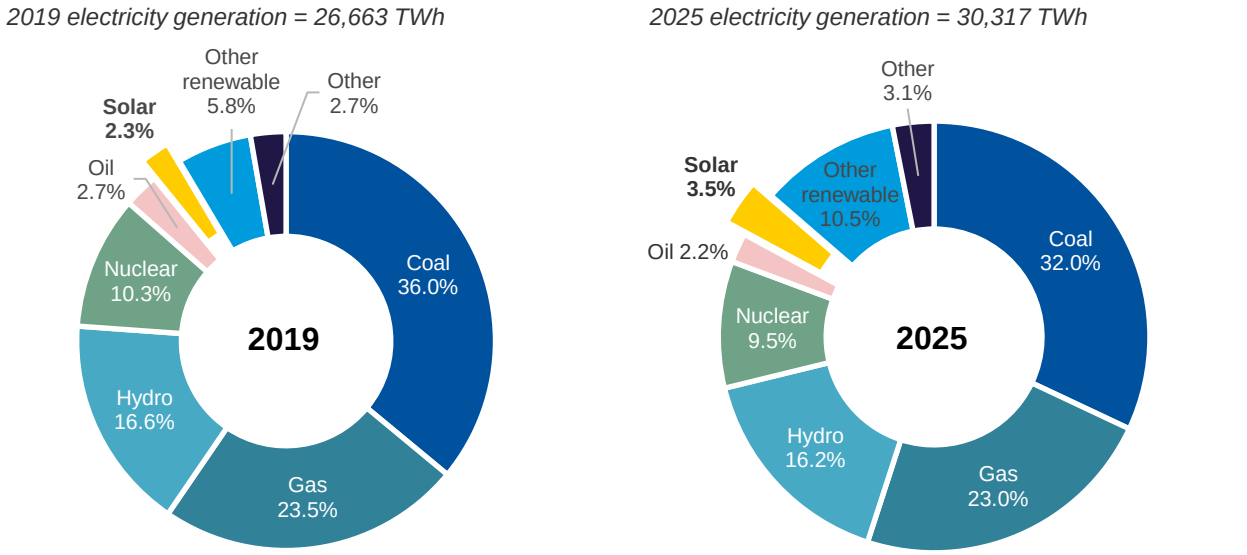
Accordingly, electricity generation from renewable sources is predicted to grow rapidly over the same period. CRU forecasts that electricity generated from renewable sources will more than double from 2,159 TWh in 2019 to 4,243 TWh in 2025, accounting for 8.1% of total global generation in 2019 and 14.0% in 2025.

Within renewables, the solar photovoltaic (PV) industry will be a key driver of new capacity. The cost of electricity generation from PV has declined at a rapid rate over the past decade, and is in many instances close to or below the cost of power generated by burning fossil fuels.

Solar power generation is expected to increase to 1,053 TWh in 2025, almost doubling from 615 TWh in 2019. This is equivalent to a compound annual growth rate (CAGR) of 9.4%, and results

in the sector's share of global electricity generation increasing from 2.3% to 3.5%, as shown in the figures above. Given the nature of solar energy, the development of solar power is dependent upon geographic and climate factors, which limit its applicability in certain regions. As a result, we forecast greater relative growth in other renewables on a global scale, with wind power set to expand by the largest amount.

Figure 2 Global electricity generation by type

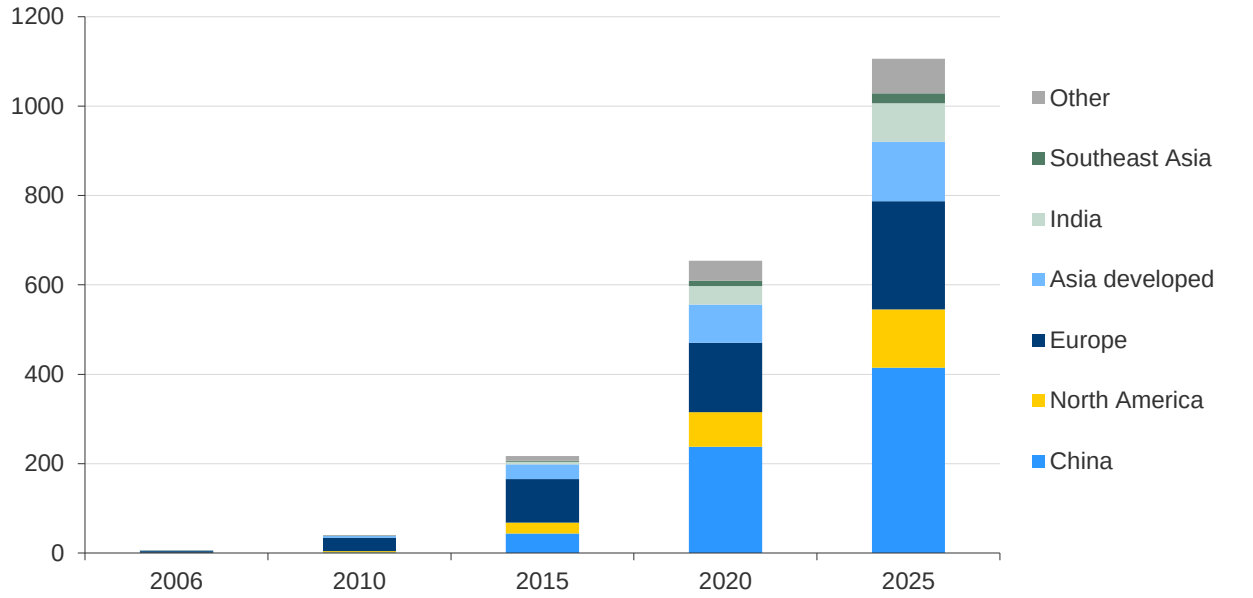


Data: CRU. *Note that totals may not equal 100% due to rounding.*

With solar power generation forecast to increase by 438 TWh from 2019 to 2025, CRU estimates that the additional installation of 416 gigawatts (GW) of PV capacity will be required globally, from a total capacity of 580 GW in 2019 to 996 GW in 2025. The largest part of the additional solar capacity moving forward is expected to be installed in China, accounting for about 40% of future capacity increase out to 2025. Elsewhere, CRU expects Europe (17% of the forecast capacity increase), North America (12%), developed Asian countries (10% collectively), and India (10%) will be the other key regions driving solar capacity development.

There is a comparative lack of development of solar power in other parts of the world, often despite favorable climates such as in parts of Africa and South America; this reflects that for many developing countries, coal remains the quickest and often cheapest way to meet the sizeable baseload demand required by a rapidly growing consumer base. Renewables may be used in these regions where they can provide a clear advantage, for example rooftop solar power generation for off-grid residential properties.

Figure 3 Historical and forecast solar capacity by region, 2006-2025, GW



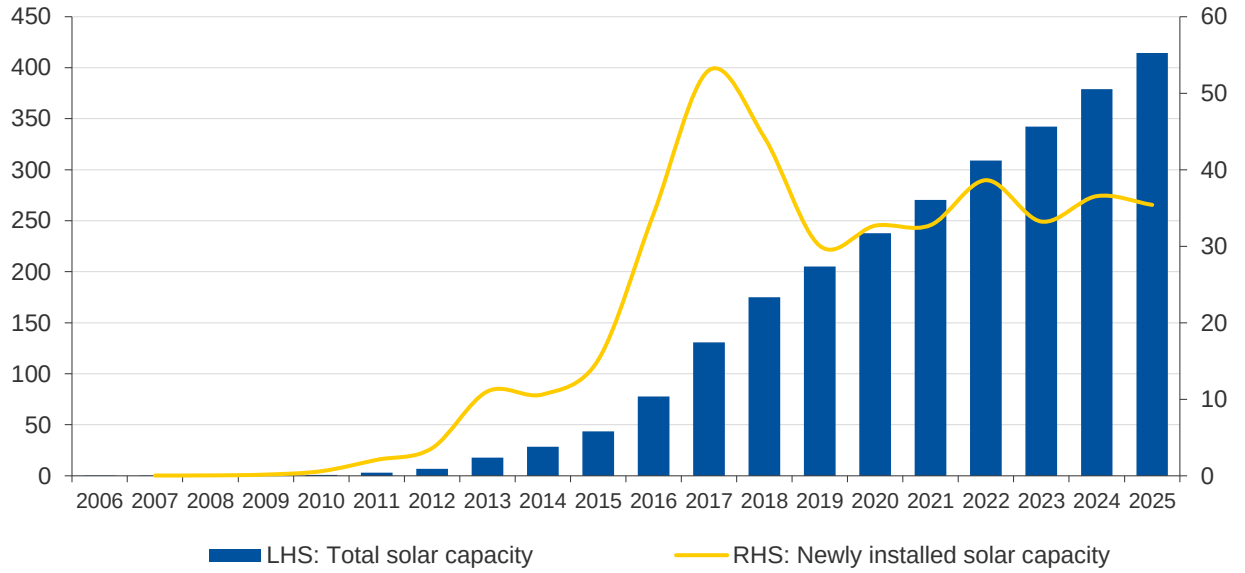
Data: CRU

2.1. China

Compared to developed regions like Europe and North America, China was a latecomer to the PV industry. In 2006, China had just 0.16 GW of PV capacity, far less than the 3.27 GW in Europe and 0.74 GW in North America. However, the Chinese PV industry quickly gained momentum, becoming the largest annual contributor to global newly installed capacity by 2013, and then in 2017 surpassing Europe as the region with the largest total capacity. Though the amount of new capacity installed per year in China started to decrease beginning in 2018, China is expected to remain the largest market for photovoltaics and the world leader for new installations. CRU forecasts that China will double its PV capacity over the next five years, growing from 205 GW in 2019 to 414 GW in 2025.

A large part of the rapid rise has been in response to the energy demand associated with China's continued development. In 2019, China's GDP grew by 6.1%, continuing a steady deceleration over the past few years. Due to the influence of COVID-19, CRU forecasts it will decrease to just 2.0% in 2020, but then bounce back to 7.6% in 2021. Out to 2024, China's GDP growth is forecast to be 5.3%. Against this backdrop of fluctuating economic growth, CRU anticipates a continuous substantial growth in demand for electricity, which is forecast to reach more than 9,000 TWh in China in 2024.

Figure 4 Newly installed and total solar capacity in China, 2006-2025, GW



Data: CRU

The amount of solar electricity generation capacity installed in China in 2019 was 30 GW, a significant reduction compared to the 53 GW and 44 GW added in 2017 and 2018 respectively. This significant drop in installation volumes was partially driven by a new regulatory landscape. China's National Energy Administration (NEA) is in the middle of a plan to transition the country's electricity market from a predominately subsidy-driven market prior to 2019, through a two-year transition featuring a range of policy instruments, some of which incorporate subsidies, and some that do not, and then a subsidy-free era starting from 2021, lining up with the start of the 14th Five Year Plan.

One key policy change for the solar sector as part of this new regulatory framework has been reduced feed-in tariff (FIT) rates. The FIT is a fixed amount paid to solar power generators for each unit of electricity produced, based typically on the cost of generation. The FIT reduction is an attempt to achieve grid parity, wherein the cost of solar energy in a certain area would be equal to or less than conventional energy forms like fossil fuels, without requiring a subsidy. The immediate impact of this change is reduced profitability for solar projects compared to 2018, and provides a key reason as to why solar installation volumes dipped in 2019.

Significant uncertainty exists about the specifics of possible policies that may be introduced to support the renewables sector from 2021 onwards, in the absence of direct subsidisation. It is possible that stronger support than anticipated could lead to a stronger outlook for new PV installations than CRU's base case forecast.

2.2. North America

11 GW of new PV capacity was added in North America in 2019, bringing the regional total to 68 GW. The US in particular has seen a strong increase in PV capacity over the past decade, with various federal policies supporting the research and development of solar technology. One key policy that has significantly helped to drive growth in the solar sector in the US is the Solar Investment Tax Credit. This was introduced in 2005 and allowed for 30% of the cost of purchasing and installing residential or commercial solar panels to be deducted from federal taxes. Its value was initially capped at US$2000, but this cap was removed in 2008 and the credit became a strong incentive for the installation of new solar capacity; from 2008 to 2019 annual additions to North American solar power capacity grew by an average of 47% per year. In 2019 solar accounted for around one third of total newly installed energy capacity in North America.

A key concern for future solar capacity growth in the US is the current plan to phase out the tax credit. It has been reduced from 30% to 26% for 2020, will fall further to 22% in 2021, and then from 2022 a 10% credit will be available for commercial solar energy systems only, with no credit for residential installations. Without this credit, a strong incentive driving the installation of solar capacity will be removed. In mitigation, the cost of PV-generated electricity has become far more competitive relative to other forms of power generation over the last ten years, reducing the importance of the credit in ensuring the economic installation of new PV capacity.

Indeed, the $1bn development of the 690MW ‘Gemini’ project in Nevada, which will be the largest in the USA and the eighth largest in the world when it comes on stream (due in late 2023), has recently become the largest of three major PV projects to be greenlit by the current administration – despite its perceived negative attitude towards renewables relative and the drawdown in subsidies. The others are the 500MW Palen project in California and the 80MW Sweetwater project in Wyoming; the proposed 450MW Quartzite project in California is also in advanced stages of permitting.

North American PV capacity development in 2020 is likely to also be adversely impacted by COVID-19 mitigation actions, as several different PV projects in the states of California, New York and Florida have been suspended. Household purchases of PV installations have been disrupted by stay at home orders and the closure of non-essential businesses, and it is likely that a longer-lasting impact will be brought about as a result of the significant hit to consumer confidence and general macroeconomic weakness, also reducing demand for PV for the remainder of 2020.

CRU believes that this disruption to PV installation growth will only be temporary. As the cost of electricity generated by PV continues to fall, we will see capacity grow as more projects follow on from those described above. Such projects will be supported on a smaller but wider scale by policies such as California’s requirement introduced in May 2018 that all new housing

developments incorporate solar power beginning in 2020. This will be further enhanced by developments in battery technologies, helping to reduce the cost and improve the performance of offline storage of electricity from intermittent sources, such as solar.

Another area of upside for additional solar PV power generation is in new applications opened up by the continued reduction in costs and improvements in related technologies. For example, solar PV is now a competitive option for power generation at industrial sites, particularly in remote locations with favorable conditions. One very public example of this type of solar usage is at the Tesla Gigafactory in Nevada, but using PV for power can reduce the carbon intensity of many industrial plants around the world – such as at mine sites in South Africa, Chile and Western Australia. A subject-to-approval project by Xcel Energy in Colorado would make Evraz's Rocky Mountain Steel mill the first to run on solar power[3]. The offsetting of carbon generated during industrial processes is only likely to grow in importance as more regions look at increasing the cost of carbon emissions, and solar is one technology that is likely to benefit from this trend.

2.3. Europe

2019 was a strong year for European Union (EU) countries with respect to newly installed PV capacity. The region added 20 GW of new capacity in 2019, more than double the amount added per year between 2013 and 2018 (8.8 GW). Total installed PV capacity in the EU reached 145 GW in 2019, making it the second largest region after China, and well ahead of North America (68 GW) and developed Asian countries[4] (collectively 76 GW).

The EU has a target of meeting at least 20% of its total energy needs with renewables by 2020, and 27% by 2030. Although CRU believes it will be a close call as to whether the 2020 target is achieved (our forecast as of early April is for renewables to account for 19% of EU power generation in TWh in 2020), CRU's estimations show that the region is on track to meet the 2030 target, based on known capacity expansions over the next five years.

The European Union's goal of being a global leader with respect to climate change and carbon emissions, including an overarching ambition of being the first carbon-neutral continent, has helped to promote renewables, including solar power, as an essential industry for development. However, the development of solar may be limited in some European nations. For example, in northern Europe, hydropower already forms a substantial part of total power generation, and where renewable capacity is being added, wind power is often prioritized given the nature of the climate, wind, and sunlight in the area.

Nonetheless, we expect PV capacity to continue to benefit from the EU's ambitious climate goals. CRU forecasts solar capacity in Europe will reach 242 GW by 2025, growing at a CAGR of 8.8%

[3] Big steel goes big solar in the US - pv magazine
[4] Japan, South Korea, Taiwan, Hong Kong, Singapore

from 2019 to 2025. While other regions may be growing at a faster rate, we expect that only China will add more PV capacity in absolute terms over this time period.

As in the USA, Covid-19 mitigation efforts are likely to impact construction of European PV installations in 2020. In the USA, it appears that Covid-19 related economic stimulus measures are unlikely to contain any specific policies benefiting green policies in general and the solar sector specifically, at least at the federal level. However, in Europe the availability of significant amounts of public funds to boost economies post-pandemic is seen by some as an opportunity to preferentially inject capital into the green sector. NGOs, corporates and national governments[5] as well as the European Commission want to avoid missing an opportunity to maintain the dramatic drop in CO2 emissions that has been a side-effect of widespread lockdowns in response to the pandemic. At this stage, little confirmed details around such proposed policies are public, much less passed into law, so the extent to which PV might benefit specifically is unknown. Nonetheless, the dramatic scale of the mooted investments means that even if only a small portion is spent on funding PV capacity at the residential or grid level through direct or indirect incentives, the impact could be substantial.

2.4. India

In 2010, India set itself a target of installing 20 GW of solar capacity by 2022, a level that was exceeded four years ahead of schedule in 2018. In 2015, a substantially more ambitious new goal of 100 GW installed capacity by 2022 was set.

In 2019, India added 7.7 GW new PV capacity, reaching a total of 35 GW capacity. The amount added was a decline compared to 2018 and 2017, which were each record years for PV capacity additions. Over the forecast to 2025, CRU expects Indian additions to PV capacity to remain in the range of 8-10 GW per year. This will bring total capacity up to 86 GW by 2025, more than double the current level, but significantly short of the 100 GW target.

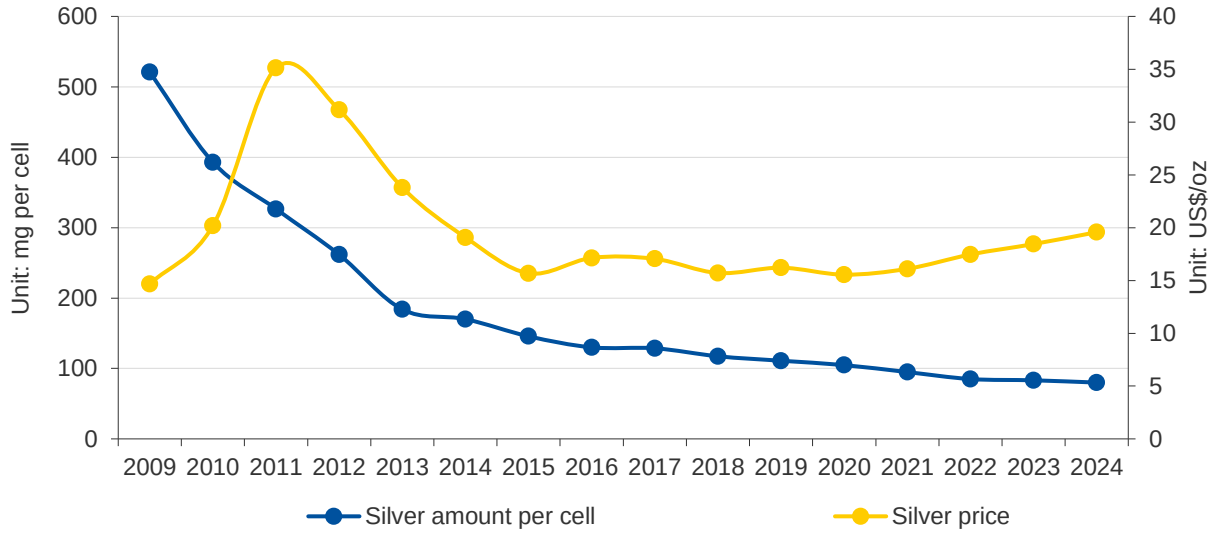
India generally has favorable atmospheric conditions for solar power generation, and strong governmental backing providing policy support to the sector. Small scale rooftop solar power is well suited for lighting and water pumping in areas of the country that are off-grid, and various large scale projects for developments of new PV capacity are under development. Indeed, two of the ten largest solar installations in the world are based in India.

[5] Germany's top politicians, companies throw weight behind green stimulus
European leaders push 'Green Recovery' plan for post-Covid economy
Germany Touts Green Stimulus in Post Covid-19 Policy Push
Germany's Merkel wants green recovery from coronavirus crisis

3. Silver use in solar panels

Silver thrifting in PVs has loomed over suppliers since the beginning of the industry. The push to reduce the amount of silver used per PV cell has caused demand for silver within the solar industry to rise at a slower pace than overall PV demand. This trend is set to persist as manufacturers continue to reduce the silver content of their panels as a cost saving measure. However, thrifting has its limits. Consequently, the rate of silver reduction has substantially decelerated since 2016; having fallen from 521 mg per cell in 2009 to 130 mg per cell in 2016, with a CAGR of -12.9%. After 2016, the decline rate further slowed, at a CAGR of -5.1% from 2016 to 2019, to 111 mg per cell in 2019. CRU forecasts silver content to drop slightly further over the forecast period, leveling out at around 80 mg per cell.

Figure 5 Silver usage per cell and nominal silver price, 2009-2024



Data: CRU

A key driver for this thrifting is the price of silver; when it more than doubled between 2009 and 2011, the amount of silver in the average PV cell halved from 521 mg to 327 mg. The rate of thrifting then halved between 2012 and 2017 as the price of silver fell from US$31 to US$17 per ounce. CRU forecasts show the price of silver is unlikely to rebound in the near-term to the record-high levels reached in 2011, and will increase modestly from US$16 to US$20 per ounce from 2020 to 2024, playing a role in the decelerating rate at which thrifting is expected to continue.

Nonetheless, the fact that manufacturers continue to reduce their silver loadings is symptomatic of a highly competitive market in which prices are consistently being driven down. Thrifting continues to be spurred on by new manufacturing processes and other technological improvements. However, silver's electroconductive capabilities are not readily overcome, and

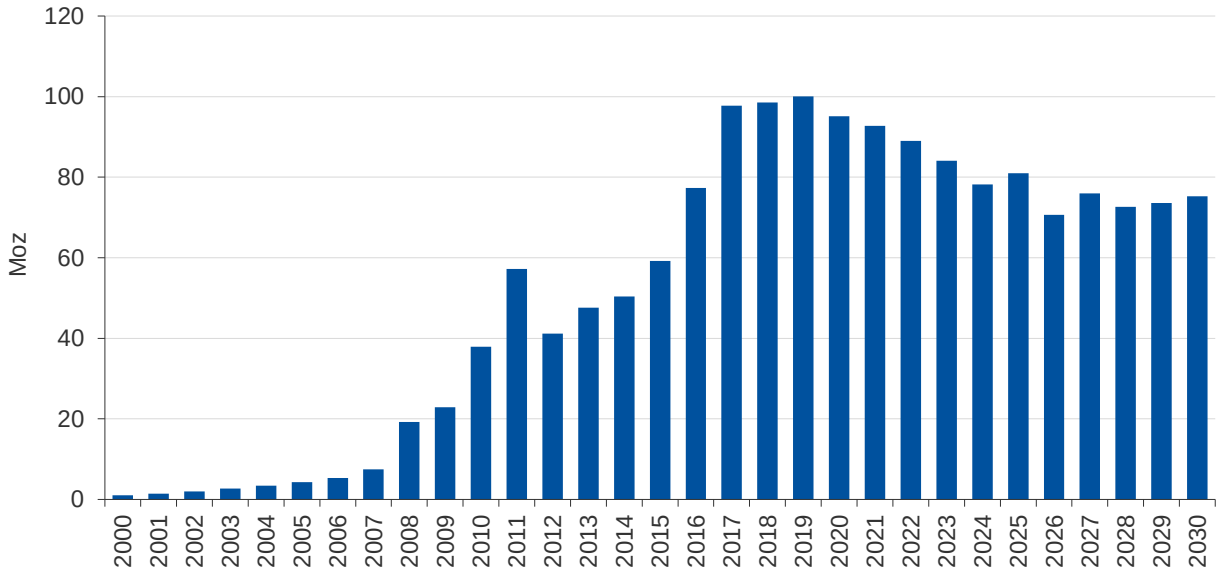
solar PV manufacturers can only reduce silver loadings so much before performance and efficiency losses begin to outweigh whatever benefits are achieved from lower raw material costs.

As in other applications, there is also a modest risk that silver may be substituted with less expensive materials, such as copper. However, substitute materials have had difficulty competing. Silver has the lowest electrical resistance among all metals at standard temperatures, meaning its substitutes cannot match it in terms of energy output per panel; the savings made in substitution may therefore be offset by the increased number of panels needed to match capacity. Moreover, due to technical hurdles, such as the reduced adhesiveness of front pastes containing high amounts of copper or aluminium, non-silver PVs tend to be less reliable and have shorter lifespans, meaning they remain some way off in terms of commercial development. CRU believes that copper or aluminum are therefore unlikely to gain significant market share between now and 2030 as the broader market heads toward more compact and efficient solar panel equipment.

4. Silver demand forecast

CRU estimates that annual demand for silver from the PV sector may have peaked in 2019, at 100 Moz. We forecast a slow decline in silver demand from 2020 to 2023 as PV capacity added per year dips, while attempts at silver thrifting in PV panels continues at a diminished rate.

Figure 6 Demand for silver in PV cells, 2000-2030, million oz



Data: CRU

Looking to the longer term, CRU expects silver demand to fluctuate between 70 to 80 Moz per year between 2024 and 2030, as the rate of silver thrifting slows further, and PV capacity additions

slightly increase. While this amount is a small decline from the 2019 peak, it would be higher than any consumption level prior to 2016, and demonstrates that the PV sector will remain an important and consistent source of industrial demand for silver.

Author:

Alex Laugharne

Principal Consultant, New York

+1 724 720 1016

alex.laugharne@crugroup.com