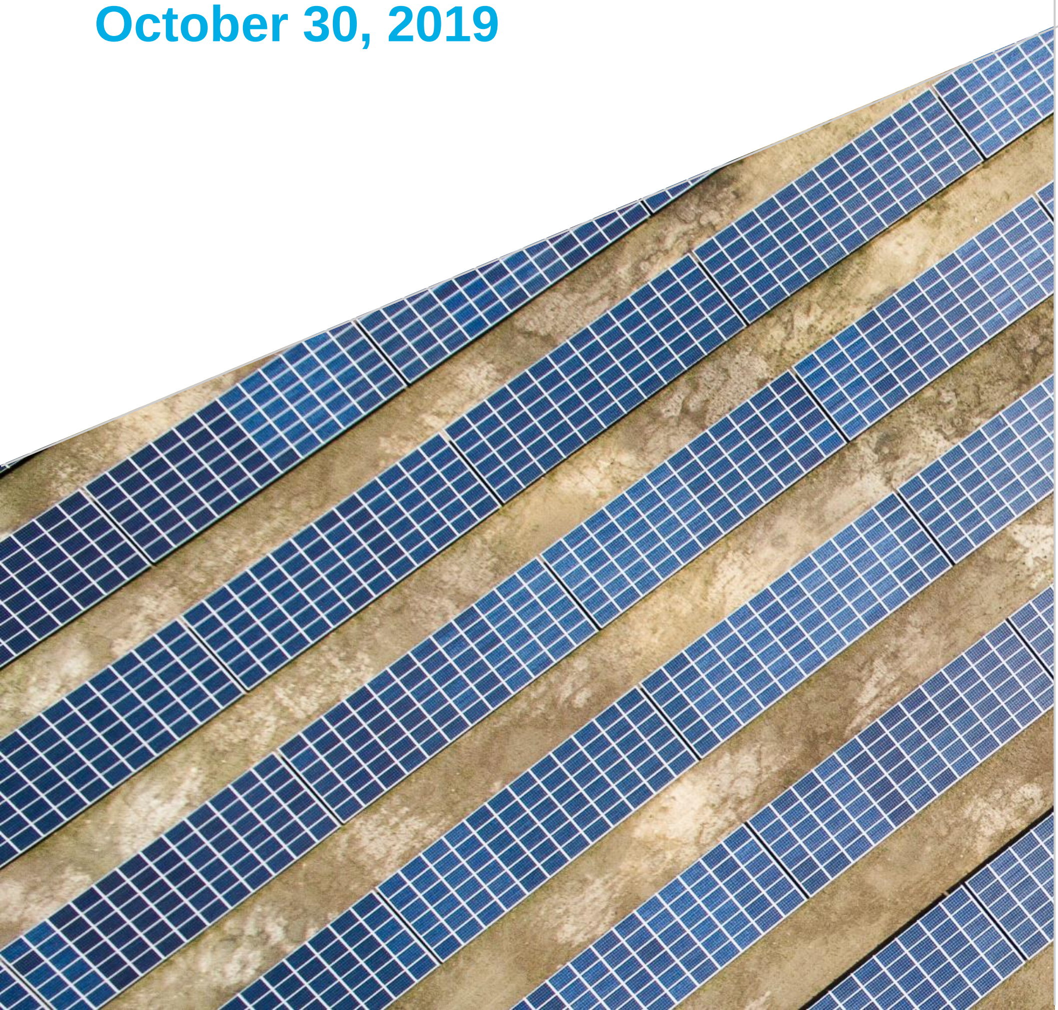
CIF CLIMATE INVESTMENT FUNDS

isa INTERNATIONAL SOLAR ALLIANCE

Global Solar Investment Report

State of solar markets and role of concessional finance in ISA member countries

October 30, 2019



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This report was produced by BloombergNEF and commissioned by the International Solar Alliance (ISA) and the Climate Investment Funds (CIF), a multilateral climate fund housed within the World Bank. It aims to improve understanding of the current solar market in ISA member countries and the financing of these projects to date. Based on BloombergNEF's New Energy Outlook modeling, it also presents how the solar markets may evolve out to 2030 and assesses the role that concessional finance, such as that offered by the CIF, can play going forward.

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About

The $8 billion Climate Investment Funds (CIF) accelerate climate action by empowering transformations in clean technology, energy access, climate resilience, and sustainable forests in 72 developing and middle-income countries. The CIF's large-scale, low-cost, long-term financing lowers the risk and cost of climate financing. It tests new business models, builds track records in unproven markets, and boosts investor confidence to unlock additional sources of finance. The CIF business model, which is based on the programatic approach as its primary model of delivery, leverages the expertise, standards, and global reach of the multinational development banks to drive climate action at scale through both advisory and investments at both the strategic planning and project implementation phases. The Climate Investment Funds encompasses four different programs: the Clean Technology Fund (CTF), the Scaling-Up for Renewable Energy Program in Low-Income Countries (SREP), the Pilot Program for Climate Resilience (PPCR) and the Forest Investment Program (FIP).

International Solar Alliance was launched on November 30, 2015 by India and France to implement the Paris Agreement and the ISA Framework Agreement came into force on December 7, 2017. The headquarter agreement with India was signed on June 6, 2018 when the ISA Secretariat acquired a judicial personality under the Framework Agreement. ISA held its first Assembly on October 3, 2018 and the second one is being held on October 31, 2019. To date, 81 countries have signed the Framework Agreement. ISA aims to provide a dedicated platform for cooperation among solar resource-rich countries where the global community, including bilateral and multilateral organizations, corporates, industry and other stakeholders can collaborate and help achieve the aim of increasing the use of solar energy in a safe, convenient, affordable, equitable and sustainable manner.

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Section 1. Executive Summary

Solar economics have transformed over the last decade, as the price of modules has fallen more than 80% since 2010. Global installed capacity has expanded in response to the cost reduction and policy support, and reached 531GW at the end of 2018 from only 44GW in 2010. ISA member countries have been part of this growth story, and together hosted 135GW of solar capacity at the end of 2018. However, there is still work to be done, particularly in the lower-income countries[1] among ISA's members. This report presents a first attempt to estimate the size of these immature markets as well as providing data and information on more established markets within ISA's member countries. Further efforts focused on data collection and availability will be key for policy makers and investors in gaining a better understanding of the less developed markets and supporting their growth.

135GW

Installed solar capacity in ISA member countries at the end of 2018

$862 million

Total amount of the CIF funding allocated to ISA member countries for solar projects since 2009

750GW

BNEF expectation of installed capacity in ISA member countries by 2030

The Climate Investment Funds (CIF), and concessional finance in general, can be key to addressing the challenges in these markets and unlocking demand and supply for solar energy through the use of various instruments in its toolkit. It can provide targeted, concessional capital (longer tenors, lower rates) to de-risk investments, and also help lay the policy and market foundations that attract solar investment in places where this is lacking.

This report presents the current cost and technology trends in the solar sector and an estimate of the market size in each ISA member country where data is available. It also analyzes the major finance providers in these markets before moving on to a forward-facing analysis of how these markets may look by 2030, and what the role of the CIF and concessional financing can be. The key findings are summarized under each of these headings below.

Global solar cost and technology trends

PV cost reductions continue. The price of crystalline silicon PV modules has dropped from $80/W in 1976 to $0.27/W in 2018. Prices continue to fall, and we expect them to average about $0.25/W by the end of 2019 and $0.14/W by 2030. The steep learning curve of PV – the cost reduction per doubling of deployed capacity, which BloombergNEF estimates at 28.5% – is the result of technology innovation, economies of scale and manufacturing experience.

Monocrystalline silicon is becoming the preferred technology. We expect monocrystalline silicon cells, as opposed to the incumbent multicrystalline silicon, to increase market share from 42% at the end of 2018 to 64% at the end of 2021. Mono cells are more efficient and use significantly less polysilicon than multi cells, and the best manufacturers now have costs below that of multi. Bifacial cells and modules, which capture energy from light striking the back as well as the front, are also expected to increase their market share and supply most of the market for ground-mounted PV systems.

Installed solar capacity in ISA's member countries

Out of the 531GW of global installed solar capacity, ISA member countries had 135GW at the end of 2018. Of this, the Asia and Pacific region had 101GW, with Japan, India and Australia as the largest markets. The other sizeable markets were France, U.K. and the Netherlands. The growth in these markets has been fueled by generous tariff policies in the past, with the exception

[1] As defined by World Bank 2020 fiscal year country classification.

of India where state-level auctions have been the main driver of project development. The Latin America & Caribbean region, and Africa, only hosted 7.8GW of this total capacity despite containing 53 of ISA's 77 member countries[2]. This shows that bulk solar has mostly been a technology for countries with middle to high incomes to date, despite its potential to provide energy for the lower-income countries.

Major finance providers

Although more concessional finance has been invested in OECD countries than in non-OECD markets, this is mostly because the total investment volumes in the former have been higher.

Concessional finance has had a bigger role to play in low and lower middle income countries[3], but distribution of the total funds still favors high income countries. Commercial banks have provided most of the financing in mature OECD countries[4] where the conditions for investment have been secure and attractive enough for these players, but the larger volumes mean that more concessional finance has been deployed in these developed markets. In other, less mature markets, the impact of development finance institutions (DFIs) is more apparent. Multi-national and national development banks have provided 95% and 38% of the total solar project costs in low and lower middle income countries respectively, compared with only 8% in high income countries.

Total funds that are channeled into low income countries are still a fraction of those in other markets. High income countries received $669 million from multi-national development banks between 2009 and 2018, compared with $127 million going to low income countries. These are markets where financial risk is considered very high, and therefore partnerships between private and public sector finance are key to mobilizing capital for solar projects.

To date, the CIF has supported around $2 billion in solar projects around the world and $862 million of this has been allocated to ISA member countries. India is hosting 76% of the total value of these programs.

Market projections

ISA member countries will have 750GW of installed solar capacity by 2030, based on BNEF's New Energy Outlook (NEO) analysis of the long-term future of energy. India will surpass Japan and become the largest market, with 265GW of solar projects by 2030. The rapid uptake of solar energy will help meet increasing electricity demand from air conditioning and electric vehicle charging, and will even be generated at approximately the right time of day. Batteries, with continued price reductions, will make integration of solar easier in the long term.

Looking forward: Potential sources of financing and how the CIF can play a role

In mature markets, where concessional financing is not needed at a similar scale before, the CIF can support the development of markets for new technologies like batteries to facilitate the integration of solar and other renewables and support further growth. This can also be done in parallel with support for PV in new solar markets, where funds are available.

In developing solar markets, the CIF can provide technical assistance and de-risk investments. In markets where there is a lack of enabling policies and power market structure to attract commercial investment, the CIF can be instrumental in providing technical assistance to

[2] As of October 2019, total member countries had increased to 81. ISA had 77 member countries at the time of writing this report.

[3] Based on World Bank 2020 fiscal year country classification.

[4] OECD members within ISA member countries are Australia, Japan, U.K., France and the Netherlands.

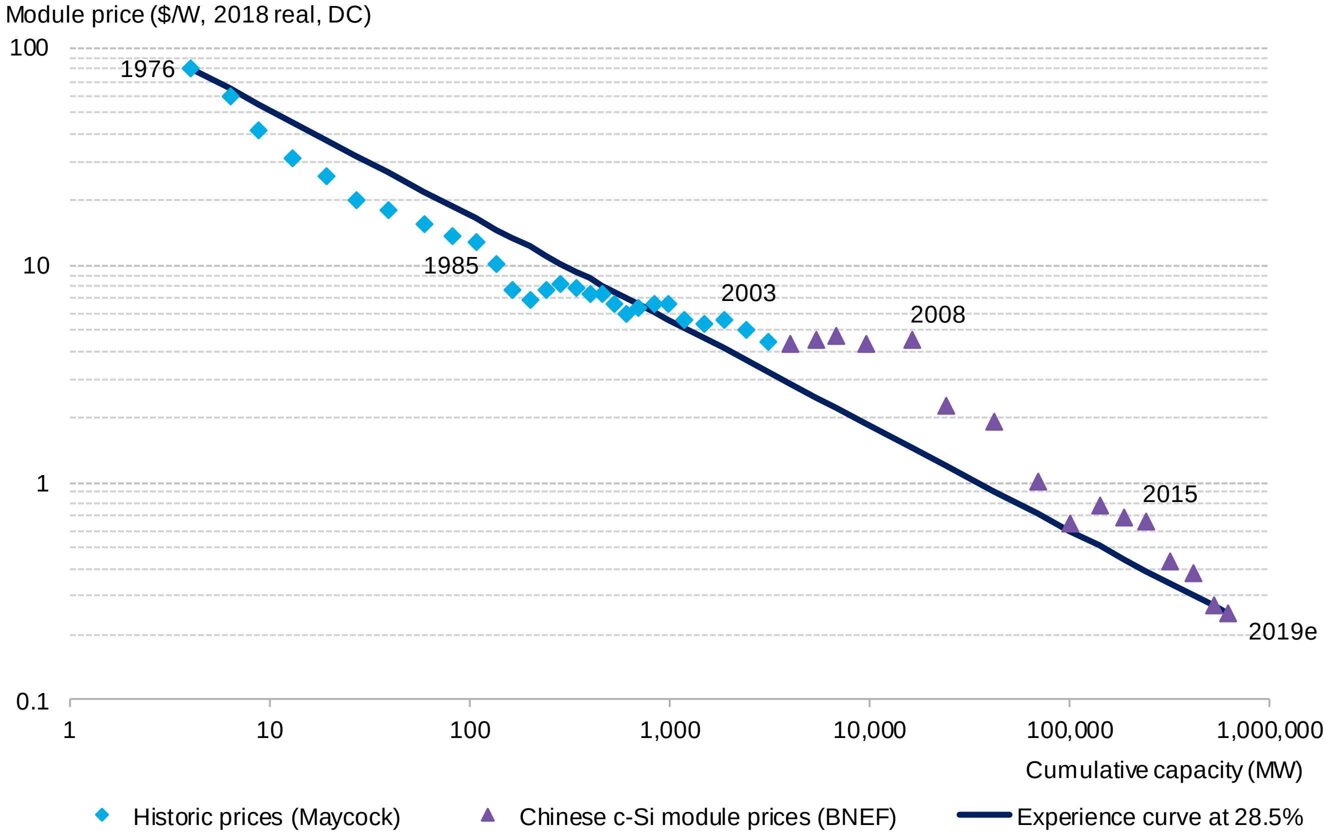
improve the investment climate. Supporting policy development and/or power sector reform are examples of how the fund can engage here. It can also provide de-risking tools to support long-term financing. These are areas the CIF has experience in and can therefore replicate the success of these programs in other markets for ISA member countries.

The CIF will have the largest impact in countries where the enabling environment has developed but there is a lack of market experience in solar projects. Here, the CIF can help by managing risks in emerging markets and providing cheaper financing with longer tenors. This will help support the first movers and eventually encourage the involvement of commercial finance.

Section 2. Global Solar Cost and Technology Trends

Since 1976, we have seen a rapid fall in the price of crystalline silicon PV modules, from $80/W to $0.27/W in 2018 (Figure 1). Prices are falling further in 2019, and we expect them to average about $0.25/W over the year with more efficient monocrystalline silicon becoming the dominant module technology in 2020. The combination of price and volume data describes a learning rate – the cost reduction per doubling of deployed capacity – of about 28.5%. This steep learning curve is the result of technology innovation, economies of scale and manufacturing experience.[5]

Figure 1: PV module experience curve



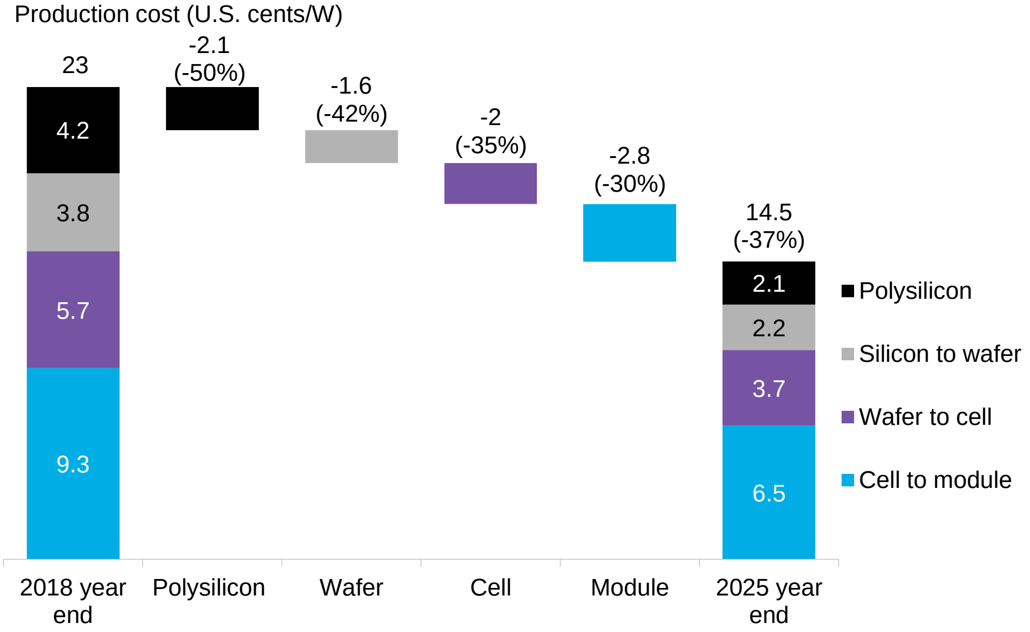
Source: Paul Maycock, BloombergNEF

The learning curve uses price as a proxy for cost, because average price data for solar modules is much more available than cost data, and margins are usually slim. However, price is more volatile, varying with temporary fluctuations in demand and supply. Assuming that best-in-class module production cost was $0.23 at the end of 2018, we can corroborate the top-down PV

5 An example of technology innovation in the past three years is the switch from multi- to monocrystalline silicon, enabled by the wide adoption of diamond wire saws.

experience curve by looking bottom-up at manufacturing innovation, and have identified a further 37% reduction in c-Si module prices to 2025 (Figure 2).

Figure 2: Forecast of best-case integrated production cost for c-Si



Source: BloombergNEF

More efficient polysilicon use and increasing share of monocrystalline silicon have brought down module costs.

One factor is the more efficient use of polysilicon. Figure 3 and Figure 4 show that since 2011, manufacturing the same capacity of solar components has used less polysilicon every year – 33% less for multicrystalline silicon, and 43% less for monocrystalline silicon. This is the result of higher power output per piece of wafer, year by year, and improved slicing methods that reduce waste during cutting. We expect further material savings to be made by 2025, as wafer thickness is reduced from the current range of 180-200 micrometers (μm) to 110-130μm.

Figure 3: Unit polysilicon consumption of silicon wafers – multicrystalline silicon

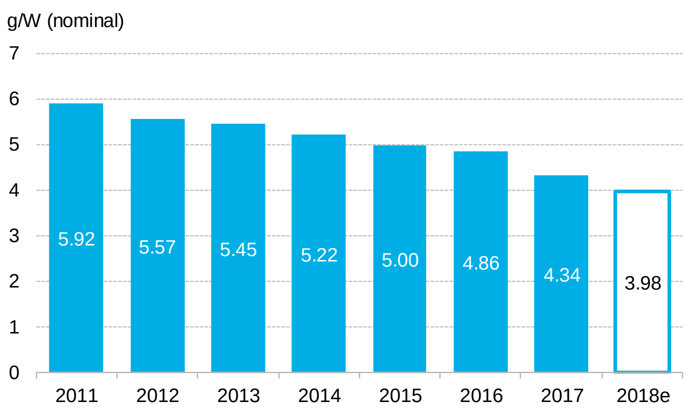
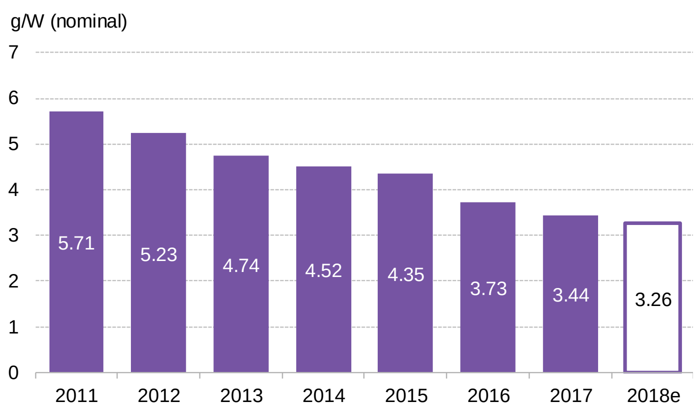


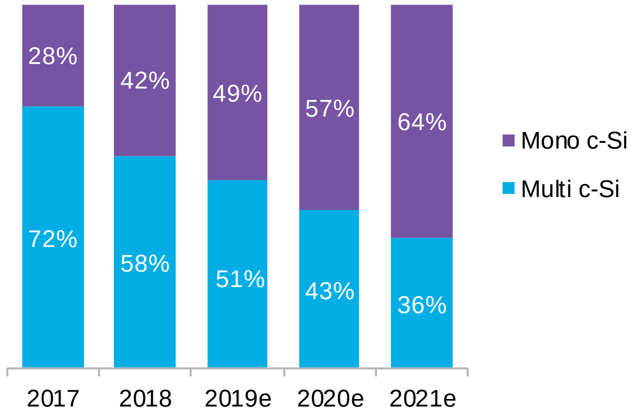
Figure 4: Unit polysilicon consumption of silicon wafers – monocrystalline silicon



Source: BloombergNEF

Another driver of reduced polysilicon use is the increasing proportion of monocrystalline silicon, on the market (Figure 5). Mono is more efficient, and uses much less polysilicon, but has historically been more expensive to manufacture. In 2018, the best mono manufacturers have started to achieve costs lower than multi manufacturers, but still sell at a premium price because the higher efficiency saves on other capex elements. In 1H 2019, mono modules are supply constrained, whereas multi modules are not and are priced at a discount, making total capex about the same. Nearly all mono modules today use PERC (Passivated Emitted Rear Cell) technology, which adds an extra layer under the wafer to improve performance and increase efficiency.

Figure 5: Split of the crystalline silicon PV market between mono and multi technologies



Source: BloombergNEF

Further incremental innovations to module design include half-cut cells that have lower current across each cell, reducing losses to resistance, and shingled designs that reduce the area of modules lost to ribbons between cells. The experience curve broadly captures these improvements, made possible by innovations in conductive and non-conductive adhesives.

Figure 6: Mono PERC bifacial module with half-cut cells

Source: Longi Solar

A non-incremental improvement to module technology is the rise of bifacial modules. These swap the usual opaque backsheet for a second sheet of glass or, more rarely, a transparent polymer, which allows the cell to capture energy from light striking the back as well as the front. How well this improves cell performance depends on the albedo of the ground, but 10% is a reasonable claim for modules mounted on soil or grass, with perhaps more for those set above sand and water. Around 3GW of bifacial modules were sold in 2018, and we expect the market to grow.

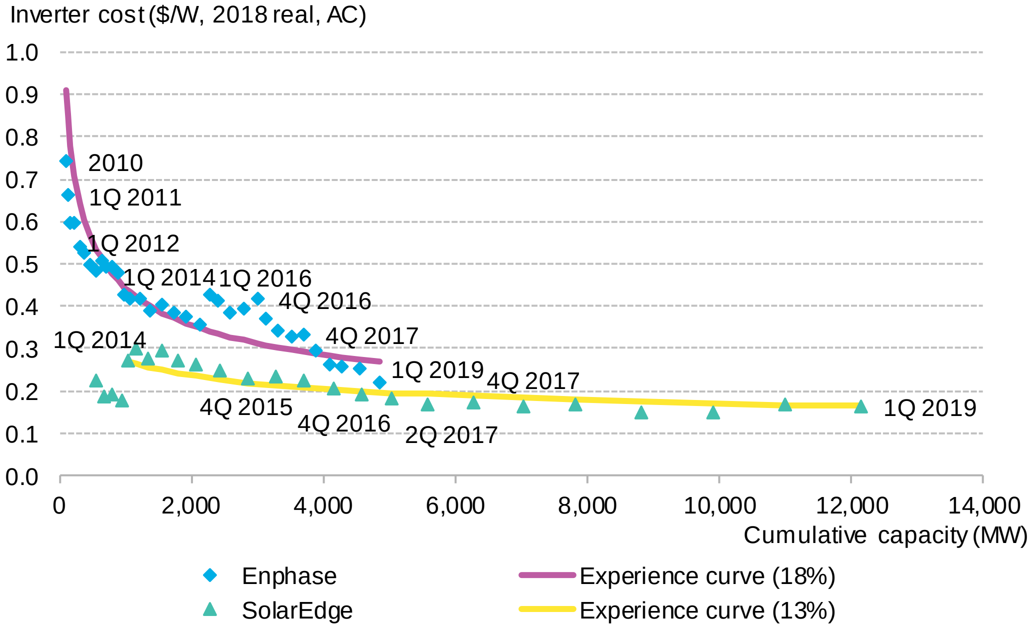
Other possible breakthrough technologies come in the form of perovskites: lead compounds that have produced solar cells with higher efficiencies in laboratory settings. However, with lifetimes of under 10 years, so far there has been no serious interest from incumbent module manufacturers to commercialize this technology. A more likely, if less spectacular, alternative is the addition of thin-film, or micromorph, silicon as a second layer on crystalline silicon. But this “heterojunction technology” has been extremely difficult to take from the laboratory to the factory.

It is more difficult to establish learning rates for the rest of the components that go into a solar project – the inverter, the mounting structure, cables, groundwork and engineering or installation. However, these too are getting steadily cheaper. For example, it is difficult to estimate learning rates for large central and string inverters as if they were a commodity because there are many different specifications and product categories. We also expect inverters to get more complicated, with additional ability to detect faults, control system output and manage storage charging and discharging.

It is difficult to establish a learning curve for inverters as these are not commoditized and have many different specifications and product categories.

It is much easier to track pricing data for the module-level power electronics produced by SolarEdge (Nasdaq: SEDG) and Enphase (Nasdaq: ENPH). Figure 7 shows that these also follow what looks a lot like an experience curve, with learning rates of 18% for Enphase and 13% for SolarEdge. Unlike most inverter makers, these two companies supply a device for every module, so their costs go down as modules become more efficient or larger. However, there are complications – Enphase's costs per W(DC) have come down partly because it supplies many of its microinverter units integrated with modules, and as module capacity goes up, the wattage covered by one unit goes up. SolarEdge's costs have gone up slightly due to changes in product mix and the effects of a global shortage of power components used in inverters and automotive control systems. The component shortage is expected to be solved with increased production in the next two years, and inverter prices are likely to come down as a result. We assume a learning rate for inverters of 20%, driven by competition between manufacturers.

Figure 7: Enphase and SolarEdge experience curve – cost of goods sold (COGS) by cumulative shipped MW



Source: BloombergNEF, Enphase, SolarEdge company filings. Note: The selling prices shown above are for distributed inverters with module-level control. Enphase reports in MW(DC) as most of its inverters are sold integrated with modules, SolarEdge reports in MW(AC).

The other three categories of costs in Figure 8 – balance of plant (BOP), engineering, procurement and construction (EPC), and development costs (others) – are mostly related to the physical size of the plant or are fixed values in terms of dollars. As modules get more efficient, BOP, EPC and the cost of project development get spread over more power, leading to lower per-watt costs. We assume that average module efficiency increases from 17.7% in 2018 to 21% in 2025, then to 24.4% by 2040. This is an annual increase in efficiency of 1.6% over 24 years and captures both the ongoing improvement of all different types of solar cells, and the rising market share of monocrystalline silicon solar cells which we expect to dominate the PV market by 2025.

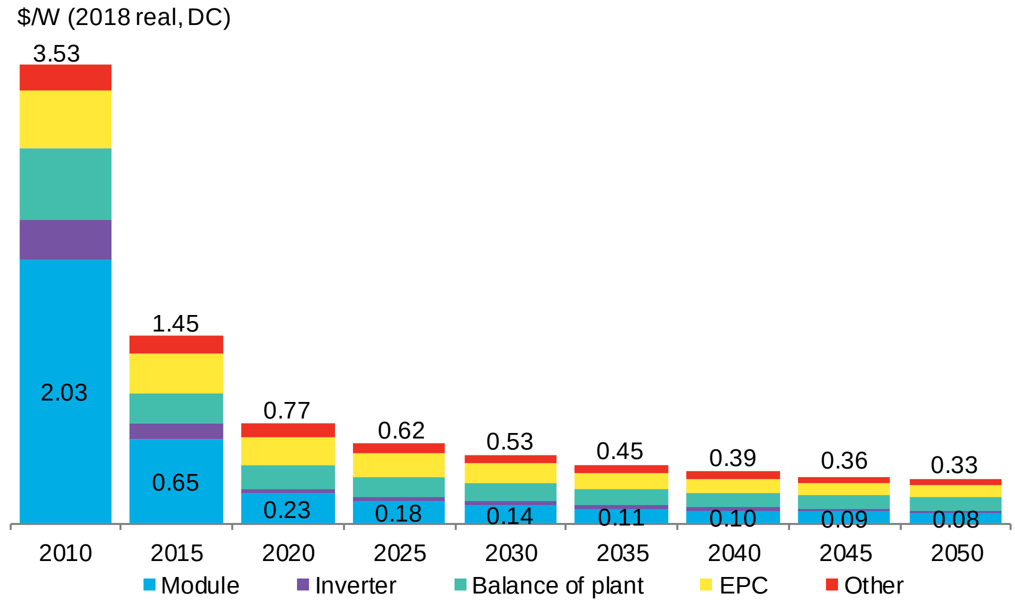
Project engineers have found numerous ways to reduce other costs. These include using machines to install modules, shifting utility DC system voltage to 1,500V instead of 1,000V, and tweaking the inverter load ratios to use less inverter per module. We assume that costs for these decline 2% per year on top of the efficiency improvements.

We expect capex of PV projects to be $0.53/W in 2030.

Combining module, inverter, balance-of-plant and engineering costs, our global capex benchmark shows a cost decline to $0.53/W in 2030 (Figure 8). With a steeper learning rate, modules fall in price faster than other components in a typical PV project, going from 58% of total system capex in 2010, to 31% in 2019 and 25% in 2040. Therefore, more power from the same area of modules will have a greater value in terms of reducing the per-watt costs for area-related and other spending insensitive to power.

Single-axis tracking systems are widely used in the U.S. and we expect more adoption in other sunny countries. Trackers are popular because they can boost yield by 10-20%, but this comes with an increase of roughly 5 U.S. cents per Watt in capex compared with a fixed-tilt system. Tracker companies may find it difficult to reduce costs, as their product is essentially metal and motors. However, they are improving their yield and reliability by investing in new algorithms and machine learning. One example is NEXTracker's TrueCapture system.

Figure 8: BNEF global benchmark capex forecast for fixed-axis utility-scale PV systems



Source: BloombergNEF

Today, we still see some difference in solar capex between markets. There have been record-breaking prices in the Middle East, with the latest auction in Dubai receiving $0.0169/kWh as the lowest bid[6]. These prices will have to call for capex levels that are significantly lower than our benchmarks.

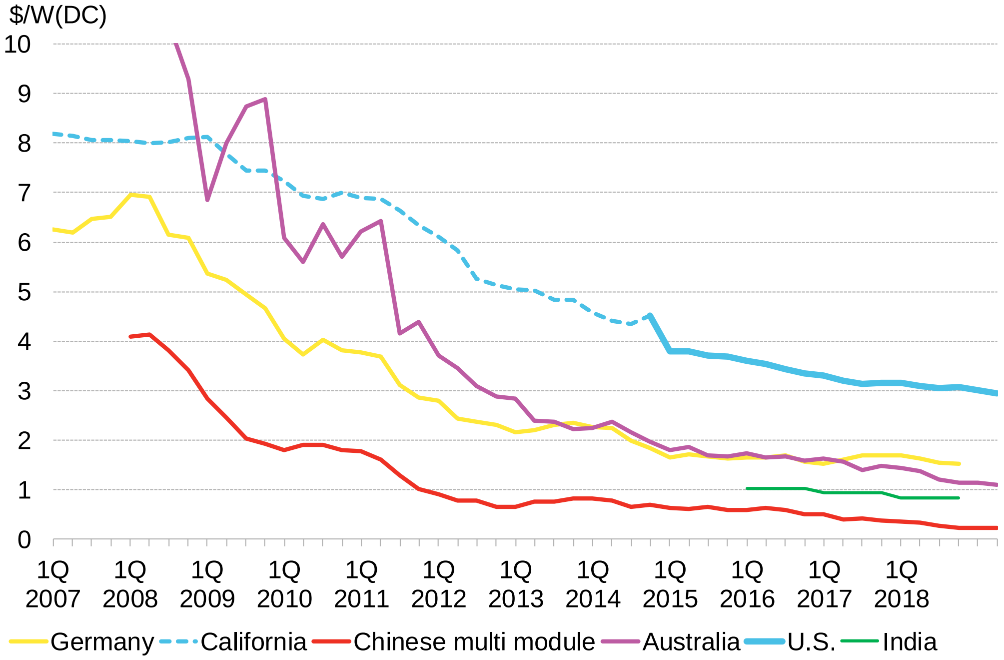
Indian developers in 2019 say that it is feasible to build a good utility-scale PV system for under 60 U.S. cents per watt – 27% lower than our benchmark capex of 82 cents per watt. It appears that utility-scale PV systems are being built very cheaply in India, due to low land and labor costs,

[6] The final results were not announced yet during the preparation of this report.

good economies of scale in large auctions, fierce competition among relatively inexperienced engineering firms to do the work, and a relaxed attitude to component bankability. We assume that Indian solar prices also converge to global levels by 2030. There seems no reason to believe India will remain cheaper than the rest of the world forever, as Indian engineers become experienced and demand higher salaries to build better projects, and the supply of relatively cheap land near the transmission grid dries up.

Figure 9 shows the development of PV prices in the residential segment. In 2011, Australian installers insisted that it was completely impossible to build solar for German prices; but in 2012, the government reduced incentives sharply, and by 2014, Australian and German prices were very similar, and have been ever since. Indian prices have come down from $1.01/W in 2016 to $0.83/W in 2018 although customers generally pay much lower than these prices due to government subsidies which are dependent on the system size and the province.

Figure 9: Residential PV system prices in different markets



Source: Energysage, METI, Solarchoice.au, BSW-Solar, company filings, BloombergNEF.

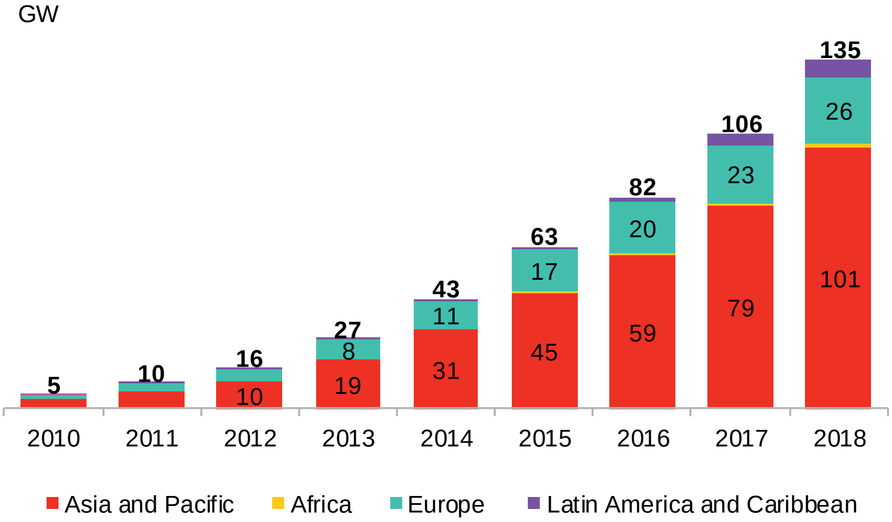
Section 3. Looking back: Installed solar capacity in ISA member countries

3.1. Methodology and results

BNEF's solar team tracks PV build in 121 countries, broken down into residential, commercial and utility-scale projects and focusing on markets with annual build rate of over 50MW. Our database of installed capacity is enhanced by our Climatescope project which provides data for smaller markets that we do not track on a quarterly basis. Climatescope is a unique country-by-country assessment, interactive report and index that evaluates the investment conditions for clean energy in emerging markets.

These two datasets provided data on the solar markets of 42 out of the 77 ISA member countries[7]. (See Appendix 1 for a list of these countries). For 31 countries out of the remaining 35, we compiled data from Chinese statistic collection firm Sinoimex to estimate their market size. Sinoimex provides data on export destinations of solar PV cells and modules from China. The data is converted from $ values into MW by assuming an average selling price[8].This provides a good proxy for markets where data availability is poor, as 73% of global module supply in 2018 was manufactured in China.

Figure 10: Cumulative installed PV capacity in ISA regions



Source: BloombergNEF. Sinoimex Note: For detailed results of each country, see Appendix 1.

The Asia and Pacific region had 75% of all solar installations in ISA member countries, with Japan, India and Australia as its largest markets (Figure 11). All these markets and those in Europe, including U.K., the Netherlands and France (Figure 13), benefited from generous policy support in the past. India is the exception, where state-level auctions at competitive prices were

[7] As of October 2019, total member countries increased to 81. ISA had 77 member countries at the time of writing this report.

[8] Average selling prices of $0.53/W, $0.43/W, $0.36/W and $0.31/W were used respectively for 2015, 2016, 2017 and 2018.

the main source of solar installations. Brazil and Chile were the largest markets in Latin America and Caribbean, hosting 85% of the installations in this region (Figure 14). Africa, with only 1.3GW of solar in total, was more fragmented with Tanzania, Senegal and Namibia as its largest markets (Figure 12).

Figure 11: Major solar markets in Asia and Pacific

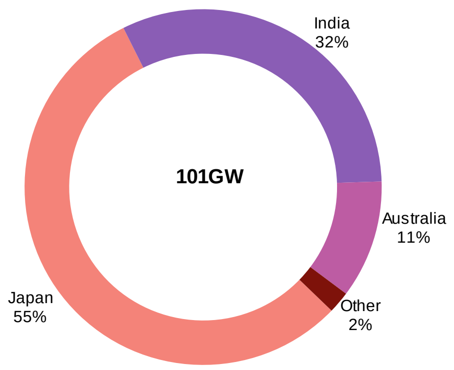


Figure 12: Major solar markets in Africa

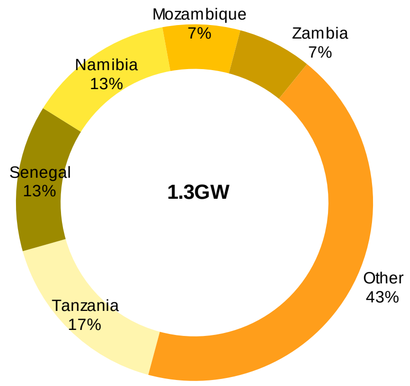


Figure 13: Major solar markets in Europe

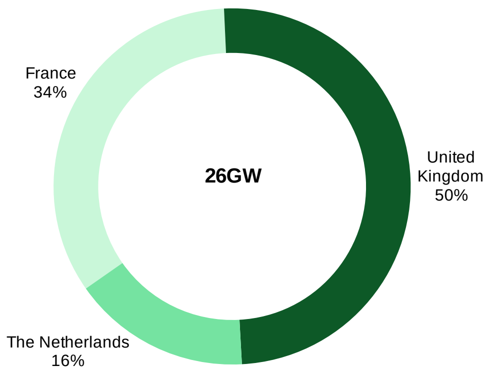
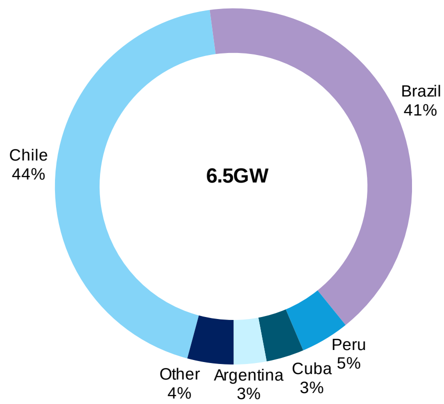


Figure 14: Major solar markets in Latin America & Caribbean



Source: BloombergNEF, Sinoimex. Note: The data reflects cumulative installed capacity by the end of 2018. See Appendix 1 for the list of countries in each region.

3.2. Country analysis – OECD countries[9]

In general, the challenges of building solar projects in countries with developed economies are well understood and the dynamics of solar markets in non-OECD countries tend to be different to those in OECD countries. Past policy support has been generous in Japan, France, Australia, U.K. and the Netherlands, although all are moving towards auction-based mechanisms which encourage developers to compete on price with one another. The result is much lower prices paid, ultimately, by consumers of power. For example, France's tenders for large ground-mounted projects started in 2017 and were won at a weighted average price of 62.5 euros ($68.7) per MWh. By the December 2018 round, prices dropped to an average of 56.8 euros ($62.4)/MWh,

[9] ISA member countries which are also in OECD include France, the Netherlands, U.K., Japan and Australia.

although they rose again in summer 2019 to 59.5 euros ($65.4)/MWh. In September 2019, Japan concluded an auction at 10,500 yen ($97.7)/MWh, compared with the last feed-in tariff of 18,000 yen/MWh in early 2018.

Australia is a thriving solar market for both small-scale and large-scale solar. The small-scale market is being driven by modest export tariffs for electricity sent to the grid, plus high prices for electricity that can be saved on power consumed immediately. The large scale market is being driven mainly by power purchase agreements offered at undisclosed prices by utilities and corporates.

The banks lending to solar projects in ISA-member OECD countries are, almost without exception, commercial banks with other interests in the country. Concessional finance is not required for these projects as market risks are low and investor confidence is high, making it easy to access cheap capital. The solar markets are mature and respond rapidly to favorable policy or commercial environments with solar growth.

3.3. Country analysis – non-OECD countries

Outside the OECD the picture is more complicated for ISA member countries. We discuss a number of markets with highest installed capacity within each region below.

India seized the opportunity of a major drop in the price of modules to use auctions to increase its solar capacity from 1.3GW at the end of 2012 to 32.2GW at the end of 2018. Again, auction prices have come down a lot, although as of September 2019, a new record low had not been set since May 2017, suggesting the market may have matured and developers are less inclined to bid purely speculatively. Prices discovered in 1H 2019 auctions were in the range $35.0/MWh - the record low - to $46.3/MWh.

Grid-connected rooftop solar deployment in India has been supported with $625 million of funding committed by the World Bank Group and disbursed by the State Bank of India. The project was launched in 2016, and as of the end of 2018, around $123 million of project finance had been approved to support over 235MW of commercial rooftop solar, including on facilities owned by Yamaha Motors, Hindustan Aeronautics and transit firm Gurgaon Rapid Metro.

Both commercial and development banks have been involved in the Indian solar market's growth, with the top lenders State Bank of India and Yes Bank. However, German giant KfW and the Exim Bank of the U.S., as well as the World Bank Group, have provided tranches of concessional debt to support projects.

Since the majority of Indian solar projects are utility-scale, it has been possible for banks to become involved. By contrast, Bangladesh's roughly 339MW of installed PV at the end of 2018 is mostly small, probably offgrid and deployed in agricultural projects, with only 42MW of large projects. Infrastructure Development Co Ltd of Bangladesh (IDCOL) and the Asian Development Bank have been involved with the large scale plants, and a further 100MW is in the pipeline. In August 2019, it was announced that SREP funds of $185 million would also be used towards utility-scale projects, as well as some rooftop installations in the country.

IDCOL[10] is also partially responsible for the uptake of small solar in Bangladesh via the Solar Home Systems (SHS) initiative starting in 2003. This uses local partner organizations to find customers for grants and soft loans to deploy small solar for rural electrification. By January 2019, about 4.13 million solar home systems were deployed under the program, replacing kerosene for lighting for 18 million people or 12% of Bangladesh's population. IDCOL has invested $600 million in loans and given $96 million in grants since 2003.

In Bangladesh, a network of local partnership organizations has been used to channel development finance into small solar systems and enabled what is probably the largest offgrid renewable energy program in the world.

Cuba's solar market is also entirely small-scale. The country has imported over $11 million of Chinese PV products per year since 2015, suggesting that it now has about 220MW of solar. There is one 10MW grid-connected project portfolio, financed by the Abu Dhabi Fund for Development and commissioned in July 2019, after being planned by the International Renewable Energy Agency (IRENA) since at least 2015.

Brazil had about 2.7GW of installed solar capacity at the end of 2018, nearly all built in 2017 and 2018 under two main government programs. Firstly, 2.2GW of large solar projects were deployed through multiple rounds of auctions, with local and Spanish developers competing to supply power. The 29th energy auction was held on June 28, 2019 and awarded 204MW of solar projects at an average price of 67.5 Brazilian reias ($17.5)/MWh, with developers planning to sell most of their power for more than this on the spot market to improve returns. This reveals the strategy that many solar project developers are starting to pursue to bid aggressively: to secure a long-term, low-price PPA for a small share of a power plant's total generation and rely on Brazil's higher wholesale prices for profitability.

Local and Spanish banks, China Investment Corp and China Development Bank, as well as the usual development banks, have financed projects in Brazil. One difficulty may be with future projects relying heavily on merchant revenues for returns, since these are exposed to the risk of power prices falling.

The small-scale segment in Brazil is booming, thanks to a net metering scheme introduced in 2012, which has finally had an effect due to rising electricity prices and falling solar prices. From the data on Chinese exports to Brazil, at least 2GW of small solar is likely to have been built in 2019.

Chile is another large-scale solar market, with most of the 2.8GW built so far in the form of large projects. Although development organizations including Overseas Private Investment Corp., IFC, the World Bank, the Inter-American Development Bank and KfW have financed solar projects in the country since 2009, they have been much less active since the end of 2015. Global commercial banks have provided most of the debt to solar projects since.

The United Arab Emirates has only a handful of projects, but they are enormous. The largest is Abu Dhabi's Sweihan at 1.2GW, commissioned in early 2019 after a competitive tender awarding a price of $24.2/MWh plus peak pricing in summer. There is also 460MW spread across two plants in Dubai, and a 100MW solar thermal plant in Abu Dhabi. The Emirates has plenty of sources of domestic financing, but Japanese banks Mitsubishi UFJ, Sumitomo Mitsui and Norinchukin are the most active lenders to solar.

[10] IDCOL was established by the Government of Bangladesh and funded by the World Bank, Global Environment Facility (GEF) and other development banks.

Tanzania is mostly a small-scale market with the Rural Electrification Expansion Project - delivered through its Rural Energy Agency- behind the majority of the installed capacity.

Tanzania had about 215MW of solar installed as of the end of 2018, and again, is almost exclusively a small-scale market. Tanzania's state-owned Rural Energy Agency (REA) is probably behind most of this capacity via its Rural Electrification Expansion project, which strives to provide electricity to an additional 1.3m people in rural areas between 2013 and 2022. The project is expected to cost $225 million in total, and has received $200 million from the World Bank Group to date. Tanzania has a long-term target of reaching 100% electrification by 2030.

Senegal had 174MW of solar at the end of 2018, of which 141MW is large-scale. This is partly driven by national utility Senelec, which is trying to switch away from expensive diesel-generated power. Since 2016, Senelec has signed PPAs for 164MW of operational/commissioned solar capacity, including the 23MW Dias PV plant commissioned by a division of French utility Vinci Energies earlier in 2019. Senelec has also recently signed PPAs for two upcoming PV plants in Kahone (35MW) and Touba-Kael (25MW), and will purchase power from the PV plants at tariffs of $42.59/MWh and $44.62/MWh respectively. Both tariffs represent record lows in West Africa, achieved through unique financing arrangements under the World Bank Group's Scaling Solar program. Reports from last year indicate that a third PV plant will also be tendered under the program, opening up the possibility for even lower tariffs.

Namibia has about 173MW of solar, mostly built in 2017 and 2018, according to Chinese export data. Over 112MW of this is utility-scale, mostly developed by the Ministry of Mines and Energy and state utility NAMPower. The French Development Agency and Standard Bank Group have contributed debt to solar projects in this country.

Section 4. Looking back: Investment and Major Finance Providers in Each Region

4.1. Clean energy investment and major finance providers in ISA member countries

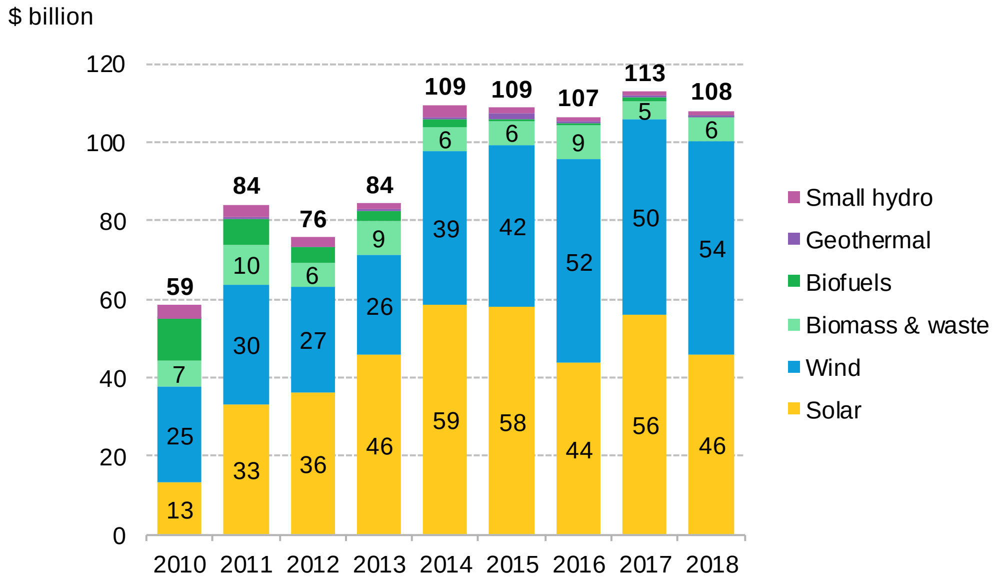
BloombergNEF's database of clean energy investment covers all solar, biomass and waste-to-energy, geothermal and wind generation projects of more than 1MW; all hydropower projects of between 1MW and 50MW; all wave and tidal projects and all biofuel projects with a capacity of one million liters or more per year. Where deal values are not disclosed, BNEF assigns an estimated value based on comparable transactions. This is a dynamic database and the figures are regularly updated as visibility in the sector improves, information flow gets better and new deals are discovered.

Based on BNEF's tracked investments, ISA countries have attracted a total of $848 billion between 2010 and 2018 for clean energy projects. Global investment has been $3,347 billion globally in the same period. The solar market has been hottest during this period with a 46% share of the overall investment in ISA member countries. Wind followed, attracting 40% of the funds during this period.

As clean energy investment costs have plummeted, more capacity can be installed with the same amount of money.

Although investment during this period stayed relatively flat, this only tells one side of the renewables story. The cost-competitiveness of renewables has improved significantly in the last decade, leading to more capacity that can be installed with the same level of investment. The cost of a PV project almost halved from 2013 to 2018, from $1.6/W to $0.89/W. Using these benchmark project costs, the $46 billion in 2013 would have funded 29GW of solar projects, compared with 52GW in 2018.

Figure 15: Clean energy investment in ISA regions by sector



Source: BloombergNEF

Most of the clean energy investment in the last decade has been driven by debt provided by private financial institutions in ISA member countries (Figure 16). These organizations took advantage of the attractive returns these projects offer by providing financing and deploying billions of dollars. Figure 16 and Figure 17 present the top 20 debt providers in ISA countries (with and without OECD countries), according to BNEF's project database. The total funds committed by these institutions made up just over 55% of the total debt that flowed into the ISA countries in the period 2009-2018[11].

Figure 16: Lead debt providers in ISA member countries, 2009-2018

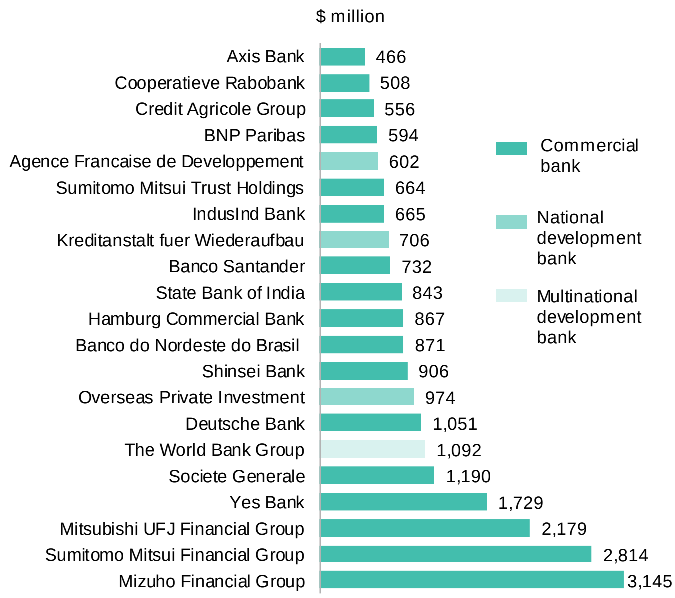
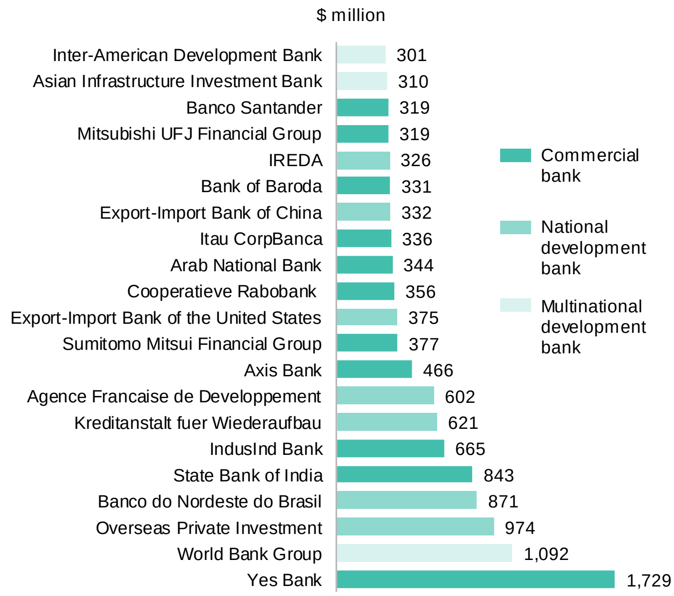


Figure 17: Lead debt providers in ISA member countries, 2009-2018 (excluding OECD countries*)



*Source: BloombergNEF. Note: Based on disclosed project data tracked by BloombergNEF. Excludes deals smaller than $1 million. *OECD countries include Japan, Australia, the Netherlands, U.K. and France.*

The top three debt funders for projects in ISA member countries were all commercial Japanese banks. The role of concessional finance was more apparent when OECD countries were excluded from the analysis.

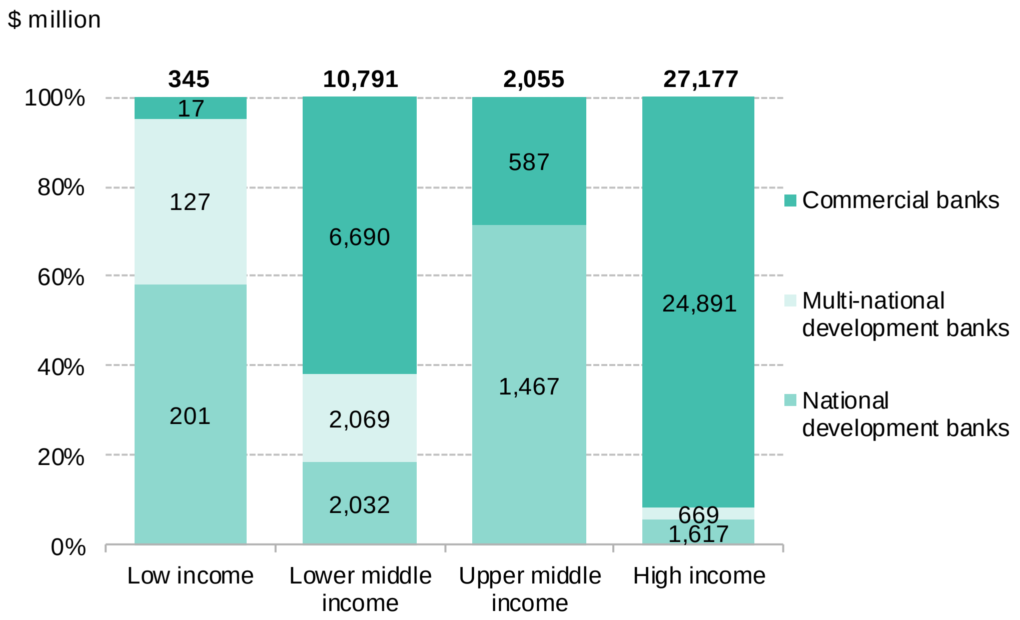
The top three commercial banks, all based in Japan, provided around 20% of the total funding from the top 20 lenders. Of this funding, 83% stayed within Japan's borders and funded local projects, with the remainder going to high-income countries such as Australia, U.A.E. and Chile. Lower income economies rely on public-sector financing more, as private sector investors may shy away from lack of policy support and market risks. Figure 17 shows the more prominent role development finance institutions (DFIs) play in non-OECD markets. Three of the top five debt providers in this case were development banks, with the World Bank Group in first place for the most debt provided by a non-commercial bank.

Figure 18 further highlights the role that the DFIs play in low-to-middle income countries, but also demonstrates that, in absolute terms, advanced economies dominate investment in solar energy. In particular, the countries in the low income group have yet to attract significant investment. These are markets where returns will have higher risk profiles and therefore partnerships between private and public sector finance institutions can be vital to mobilize capital. This can be achieved

[11] Please note that funds from the CIF are used to co-finance projects with other development finance institutions and therefore may be blended in with some of the other institutions' figures presented in this report.

through risk-sharing, blended finance and other tools that DFIs can offer, such as capacity building. This is discussed further in Section 6.

Figure 18: Share of debt finance by DFIs across country income groups in ISA member countries



Source: BloombergNEF. Note: Based on World Bank 2020 fiscal year country classification. See Appendix 2 for the classification of ISA member countries under different income groups.

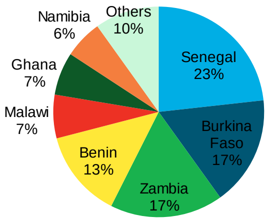
4.2. Major finance providers in ISA's regions

In **Asia and Pacific** region (Figure 21), we excluded financing of projects in Australia and Japan as these are large mature markets mostly driven by debt financing from commercial banks, similar to the landscape for **Europe** (Figure 23). With Australia and Japan excluded, investments in India dominated this region. Four out of the five top lenders in the Asia and Pacific region were Indian commercial banks which exclusively funded projects within their national borders. This comes as no surprise, as India is an increasingly important and mature solar market. The country has an ambitious target of reaching 175GW of renewable energy capacity by 2022, with solar making up some 100GW of that. The cumulative solar capacity reached 32GW at the end of 2018, from only 5.6GW at the end of 2015.

India was also the main market for the World Bank Group. Out of $711 million BloombergNEF tracked under the Group's financing in the Asia and Pacific region, $457 million was invested in India[12], with the remainder allocated to Egypt. Similarly, 92% of the debt provision from German

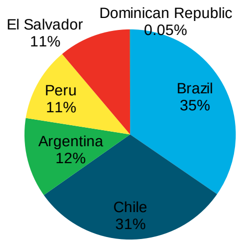
[12] This figure might be an underestimate as BloombergNEF does not track investments with deal values of less than $1 million. India has received substantial support for its rooftop segment from DFIs (including the CIF), however these projects are unlikely to be captured in our database as they would have project values below the threshold of $1 million.

Figure 19: Share of DFI solar investment by country in Africa (2009-2018)



Source: BloombergNEF. Note: Includes investment from the DFIs in the top 10 list only.

Figure 20: Share of DFI solar investment by country in Latin America & Carribean (2009-2018)



Source: BloombergNEF. Note: Includes investment from the DFIs in the top 10 list only.

Kreditanstalt fuer Wiederaufbau (KfW) and Export-Import Bank of the United States was allocated to the Indian market.

Debt financing in **Africa** has been mostly dominated by non-commercial banks (Figure 22), although total investment has been a fraction of that in the other regions. DFIs from around the world have deployed some capital in these markets, with Agence Francaise de Developpement the most active with $168 million deployed. Senegal, Zambia, Burkina Faso and Benin received 71% of the investment by these institutions (Figure 19).

Interest from the commercial banks in this region has been limited by the immaturity of the solar markets, as there simply are very few investable large projects. Solar activity in this region (particularly sub-Saharan Africa) consists largely of small-scale off-grid projects that commercial banks generally steer away from. The only two commercial banks which have been active, according to the BNEF database, were BNP Paribas and the Standard Bank Group. The former provided financing to a 15MW plant in Burkina Faso and the latter to a 46MW one in Namibia.

In **Latin America and Caribbean**, DFIs have played a major role in debt provision, with five out of the 10 top debt providers being national or multinational development banks (Figure 24). Brazil was the biggest recipient, scooping up 35% of the capital deployed by the most active DFIs (Figure 20). Banco do Nordeste do Brazil (BNB), Brazil's regional development bank which funded national projects exclusively, was the largest single debt provider in the region. BNB was closely followed by Overseas Private Investment Corporation (OPIC), U.S. government's development finance institution. Peru and Chile were OPIC's focus markets in this region.

Chile's strong sunshine and large open spaces make it very suitable for solar power. The country secured the largest portion of DFI funding after Brazil amongst ISA's member countries within this region and was also the main recipient of the World Bank Group's funding here. In 2018, the country ranked first in Climatescope, a study conducted by BloombergNEF annually on the attractiveness of developing nations for renewable energy investment. Chile has built a strong enabling framework, with a series of effective policies and relative overall economic stability.

The Export-Import Bank of China, the next DFI with most funds allocated in Latin America and Caribbean, made it through the list by financing the 300MW Cauchari project in Argentina. Itau Corp Banca, a large commercial bank based in Chile, was the most active private debt financier in this region, providing capital to projects within the country.

Figure 21: Major debt providers in Asia and Pacific (excluding Japan and Australia)

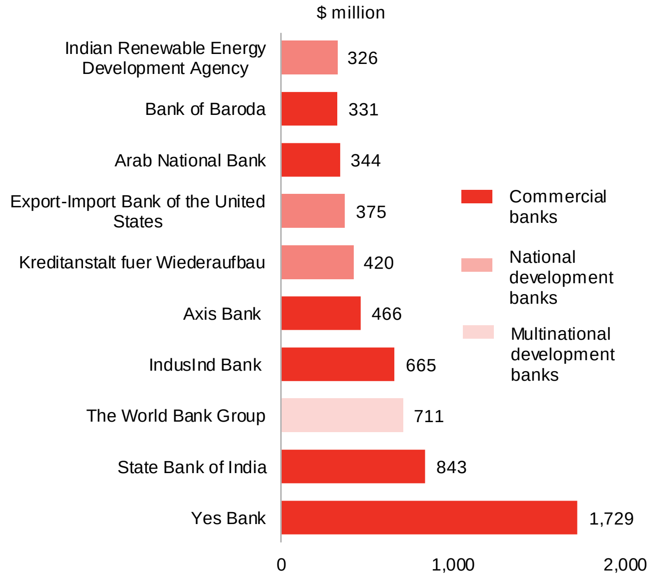
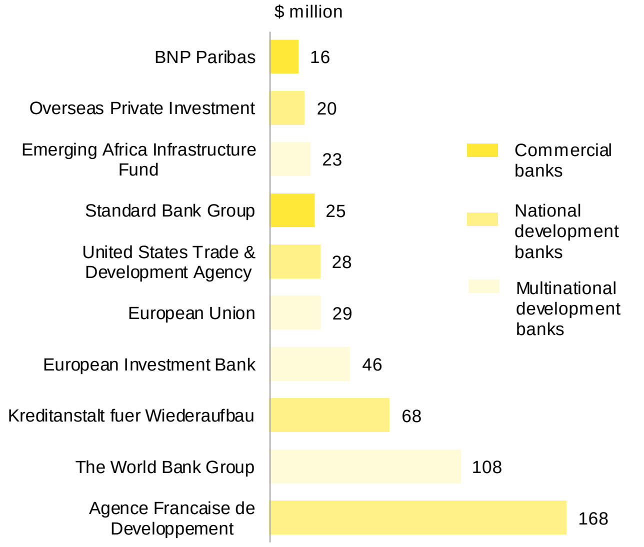


Figure 22: Major debt providers in Africa



Source: BloombergNEF. Note: Based on disclosed project data tracked by BNEF. Excludes deals smaller than $1 million.

Figure 23: Major debt providers in Europe

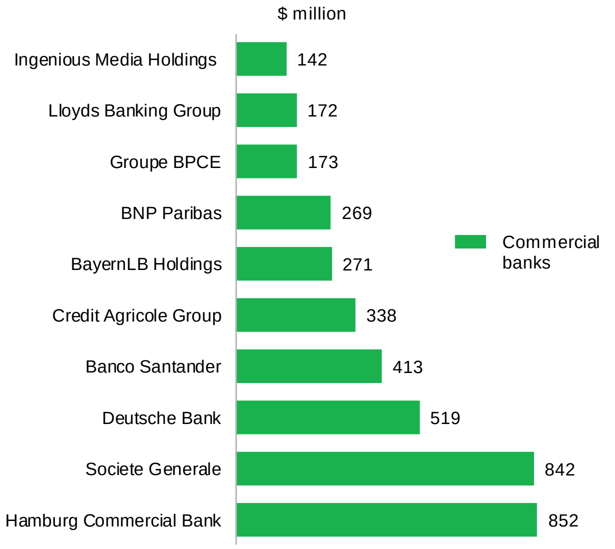
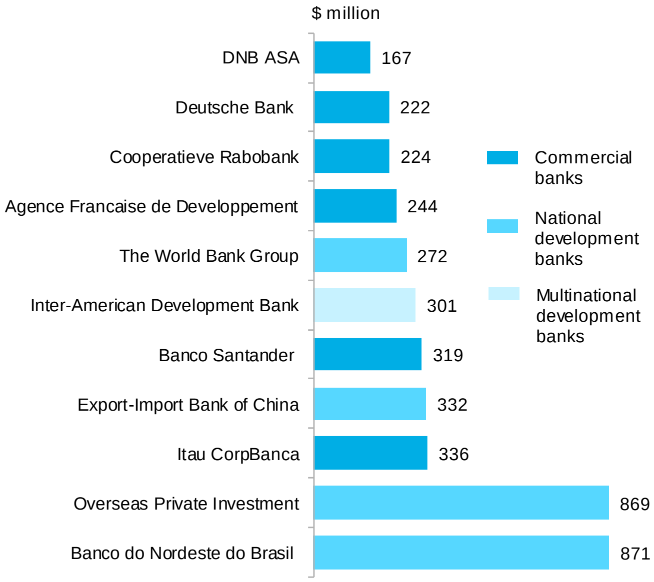


Figure 24: Major debt providers in Latin America & Caribbean



Source: BloombergNEF. Note: Based on disclosed project data tracked by BNEF. Excludes deals smaller than $1 million.

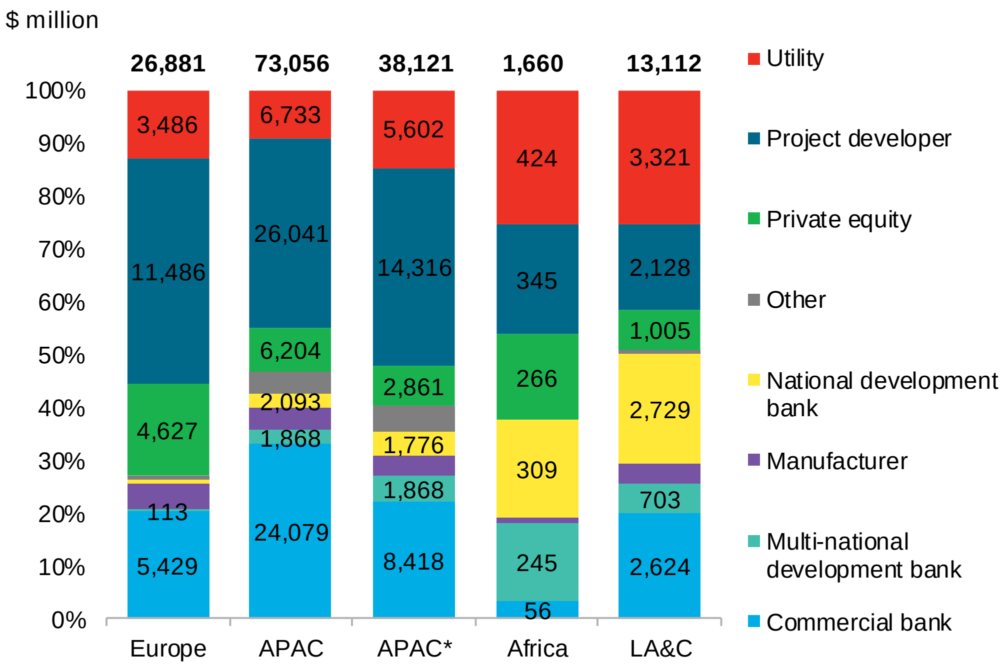
When both debt and equity financing is considered, utilities and project developers have played a critical role in the development of the solar markets across all ISA regions (Figure 25). These organizations financed between 40%-60% of the total value of the projects between 2009 and 2018, according to the BNEF database.

The role of national and multinational banks has been more varied across the different regions, with African and Latin America & Caribbean countries relying significantly more on these institutions to build clean energy projects than anywhere else. In Latin America and Caribbean, 26% and 33% of the total investment came from DFIs, compared with only 1% and 10% in Europe and Asia and Pacific (excluding Australia and Japan) respectively.

Most of the immature markets are supported by foreign aid and development bank concessionary loans, and commercial bank involvement remains minimal. Even when commercial banks are interested in lending to solar projects, the market conditions make this challenging. Nigeria, for example, has a number of banks keen to invest in solar projects, but the interest rates they can offer are reportedly above 25% due to the double-digit central bank interest rates. In addition, these loans have extremely short tenors (between 6 months and 3 years) which makes projects unviable. This makes utility-scale projects reliant on concessional financing, mostly provided by the World Bank Group.

Despite a proportionally higher contribution of DFIs in these markets, total deployed capital from DFIs in Africa in particular ($554 million), has been a fraction of that in other regions ($3,432 million in LA&C and $3,643 million in Asia and Pacific), highlighting the imbalance in the capital disbursement and the significant challenges around availability of capital, market and project level risks, in addition to the lack of an attractive investment climate in these markets.

Figure 25: Disclosed new build solar investment by investor type in ISA member countries (2009-2018)



*Source: BloombergNEF. Note: * Excludes Japan and Australia.*

4.3. The CIF's role

The CIF lending has a multiplier effect through unlocking capital from other sources and resulting in investment levels that are substantially higher than its initial spend.

Established in 2008 as one of the oldest and largest fast-tracked climate financing instruments in the world, the $8.3 billion CIF provides developing countries with grants, concessional loans, risk mitigation instruments, and equity that leverages significant financing from the private sector, DFIs and other sources. CIF encompasses four different programs: the Clean Technology Fund (CTF), the Scaling-Up for Renewable Energy Program in Low-Income Countries (SREP), the Pilot Program for Climate Resilience (PPCR) and the Forest Investment Program (FIP). CTF and SREP have been driving forward solar projects with a total budget of around $2 billion.

Out of the $2 billion funding CTF and SREP have, $862 million is allocated to ISA member countries[13] (Table 1). **India** hosts 76% of this $862 million under six different CTF programs. Rajasthan Renewable Energy Investment Program (RREIP) is the largest of these with $195 million of CTF funds allocated[14]. The sunny state set a target of reaching 25GW solar capacity by 2022, through its 2014 Solar Energy Policy. RREIP is helping to implement this master plan through a multi-tranche financing facility. As part of this program, CTF and the Asian Development Bank have been supporting Rajasthan Renewable Energy Corporation for the design, planning and implementation of the 2.2GW Bhadla solar plant, 745MW of which is already commissioned.

Table 1: The CIF funding for solar in ISA member countries

Country	Total funding ($ million)
India	655
Mali	41
Bangladesh	32
Haiti	28
Maldives	26
Chile	22
Cambodia	16
Rwanda	15
Liberia	7.6
Vanuatu	7.3
Nigeria	6.3
Tanzania	4.5
Ethiopia	1.9

Source: the CIF

The technical assistance provided by CTF and ADB has been key to the success of the project and is likely to pave the way for other large sites in India. Partnerships between the public and private sector in the early development phase and investment into the transmission infrastructure has reduced project-level risk and attracted private sector investment into these solar assets. The Bhadla Phase III auction produced a record-low tariff at the time of $38/MWh.

CTF is also funding two separate programs focusing on rooftop solar in India, with a total value of $300 million. India has a target of installing 40GW rooftop systems by 2022, but only 1.3GW has been installed by the end of 2018, mainly due to a lack of availability of cheap financing. Capital made available by development banks is starting to turn this around and improving developer and consumer interest in rooftop installations. CTF, in partnership with the State Bank of India, has delivered 300MW of systems so far and has been providing concessional financing to boost investment in this market. The involvement of CTF has significantly reduced financing costs for projects. Previously banks were offering loans with a 10-14% interest rate depending on the credit rating of the borrower, but the availability of CTF funds meant that these rates were reduced to 8.5-9.5%, improving the viability of the projects.

In parallel to supporting the growth of the solar sector in India, CTF has also been focusing on batteries which would complement the large amounts of solar energy delivered to the grid. Innovation in Solar Power and Hybrid Technologies project, with a $50 million contribution from CTF, aims to demonstrate the operational and economic feasibility of solar and battery solutions, with a view to scaling up the applications in the near future.

In **Mali**, SREP has provided a concessional loan of $25 million to fund the 33MW Segou PV plant, Mali's first utility-scale plant. In addition, SREP allocated a $15 million fund for a rural

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[13] Only includes funding for programs that are dedicated to solar in the ISA member countries. Actual funds may be higher due to regional and cross-sectoral programs. Note that some of these funds may not be captured in the figures we present in this section. This is because our dataset contains project-level data for those plants that have reached financial close and have capacities of over 1.5MW.

[14] Total program budget is $800 million.

electrification program that aims to improve electrification and increase renewable energy capacity, particularly solar. According to World Bank data, only 43% of the population has access to electricity in the country, which hosts a vibrant off-grid sector with numerous isolated grids operated by local private operators. The investment costs are subsidized by the rural electrification agency, which in theory should incentivize the use of technologies such as solar. However most operators rely on diesel. An increasing number of hybrid systems are being deployed through the help of programs such as this one.

Backing for small and utility-scale systems has also been provided through SREP funds in **Bangladesh** via two programs totaling $32 million. One of them is financing solar powered drip irrigation projects, with a budget of $22 million. At least 2,000 systems, in an area where grid electricity does not exist and diesel is used, will receive grants for solar.

The rest of the funds in Bangladesh are being used on a site in Feni district, initially to fund a 50MW plant. The site has a total capacity to host 150-170MW of PV. The project aims to bring online the 50MW plant by providing access to capital, de-risking investments and conducting resource assessments. This will be treated as a pilot for expanding into the rest of the site and allow the grid operator to develop the capacity to integrate solar into the network. The program will also help Infrastructure Development Corporation Limited (IDCOL) manage a facility for financing renewable energy and stimulate the domestic financing market.

In **Maldives**, the Accelerating Sustainable Private Investment in Renewable Energy (ASPIRE) project aims to increase PV generation in the country through private sector investment and reduce the reliance on diesel generators. The CIF is supporting the market at various stages to achieve this goal, including providing technical assistance to create favorable conditions for private investment, helping to build institutional capacity, identifying and implementing projects and providing capital for the financing. The program has a budget of over $13 million.

Case study 1: CTF's technical assistance in developing Kazakhstan's clean energy policies

CTF played a key role in supporting the development of Kazakhstan's clean energy policies. CTF, EBRD and IFC allocated funds for various technical assistance projects, including advising the government on developing feed-in tariffs and on drafting legislation to implement the renewable energy law. These supported Kazakhstan to kick start its renewable energy sector.

The technical assistance provided by CTF to the government led to the country's 2013 renewable energy law, which introduced feed-in tariffs for renewable energy projects and established purchase obligations for all power produced by renewable energy plants for 15 years. Working closely with the country's Ministry of Environmental Protection, CTF also supported the EBRD and IFC in developing a Green Economy legislation, which included rules for emission trading schemes and renewable energy support.

These efforts laid the foundation for private and foreign investors in the renewable energy sector, before Kazakhstan moved to an auction mechanism in 2018. The country had over 200MW of installed solar capacity at the end of 2018.

Case study 2: De-risking investments and building capacity in Morocco

To date, Morocco has been the second largest recipient of CTF funding after India, with the majority of funds being allocated to solar thermal projects Noor I, II and III. According to interviews BloombergNEF conducted previously for CTF, its support has been instrumental to the growth of Morocco's solar thermal sector.

Morocco had no significant investment in large-scale solar thermal prior to 2010 and, at the time, no large-scale solar thermal towers had been constructed anywhere in the world. As a result, CTF concessional financing not only improved trust within Morocco to grow this sector, it also lent credibility and support to a new technology. In addition to technological risk, solar thermal also suffers from a problem of scale. The minimum feasible size for a tower plant is at least 100MW, and a major financial commitment is required from the very start. It is for this reason that CTF concessional financing was important in attracting the right stakeholders to finance the remainder of the projects.

Another feature of the funding awarded by CTF was that it allowed the Moroccan Agency for Sustainable Energy (Masen) to sculpt repayment according to the seasonality of revenues. This is particularly important for solar thermal projects, which produce more or less power depending on solar radiation of different seasons and may also take a long time to ramp up after commissioning. Masen was also able to assume other risks due to concessional financing. The foreign exchange risk for the developer was taken on by Masen, which allowed bids in the developer's currencies. Allowing for payments in hard currency is critical in lowering bids in markets that are not mature, as international investors tend to be averse to currency risk.

Masen estimates that CTF concessional financing reduced the bid price for Noor I by 20-30%, while emphasizing the attractiveness of both the rate and tenor of the loan. Noor developer ACWA Power gave an even more pessimistic view of the project's financial viability in the absence of CTF concessional financing, stating in no uncertain terms that the projects would not have advanced without the CTF.

Noor II and III were commissioned in 3Q 2019, and a fourth phase, Noor Midelt, was tendered and won by a consortium of EDF EN and Masdar at a price of just $70/MWh. The Midelt project will be a hybrid of PV and solar thermal, probably using PV to generate during the day while the solar thermal plant heats molten salt to run turbines at night, and probably also running the solar thermal field's parasitic loads on PV. However, the ultimate impact of these solar thermal projects on the wider market remains to be seen. Masen reported a 15% drop in cost from Noor I to Noor II. Noor III had a slightly higher tariff than Noor II but this was due to the leap from parabolic trough to solar power tower designs.

Section 5. Looking forward: Market projections

The market projections for ISA member countries presented in this section are based on the New Energy Outlook (NEO) 2019 report. This is BloombergNEF's annual long-term analysis of the future of energy. Focused on the electricity system, NEO combines the expertise of over 65 in-house country and technology specialists in 12 countries to provide a unique assessment of the economic drivers and tipping points that will shape the energy sector to 2050.

The first tipping point is the moment when new-build renewable power becomes cheaper than building and operating a new fossil-fuel power plant. It appears that this tipping point is now mostly behind us. We estimate that today, more than two-thirds of the global population lives in countries where solar (and/or wind) is the cheapest source of new bulk generation. We expect the last exceptions to this rule to tip within the next five years. This includes Japan and Southeast Asian countries where coal still has an economic edge.

The second tipping point occurs when it gets cheaper to build a new PV plant than to run an existing coal or gas plant that provides bulk electricity. Once solar's levelized cost of electricity falls below the short-run marginal cost of an existing fossil fuel plant, it makes economic sense to replace it with a new unit of renewables capacity, if it is not needed to ensure security of supply.

We use this tipping point analysis, together with electricity demand-side factors such as electric vehicles and air-conditioning, to inform our view on what the energy landscape will look like out to 2050. We only present the results for the solar sector in this report, but NEO also focuses on other technologies that are driving change in markets, such as onshore and offshore wind and batteries.

Global results

Global solar capacity will reach 2.4TW by 2030, according to BloombergNEF's New Energy Outlook analysis.

We expect global solar capacity to increase from 532GW[15] at the end of 2018 to 2.4TW by 2030 (Figure 26). About 38% of the 2030 total is expected to be small-scale or rooftop PV (Figure 27) and 62% utility-scale PV with a capacity greater than 1MW. We see just 7.4GW of solar thermal capacity in 2030 (although since the 2019 NEO report, we have updated solar thermal projections to 8.9GW, largely due to the Noor Midelt project in Morocco looking more likely to materialise as a hybrid solar thermal - PV complex).

The market for solar new build grows fairly steadily at a rate of 5% year-on-year from 2018 to 2030, and the global PV market exceeds 200GW per year for the first time in 2029, although active government policy in multiple markets may well bring this point forward. The NEO methodology cannot predict future bold policy moves, and historically solar booms have often exceeded analyst expectations.

[15] This figure includes 6GW of solar thermal capacity.

Figure 26: Global cumulative installed solar capacity for different regions by 2030

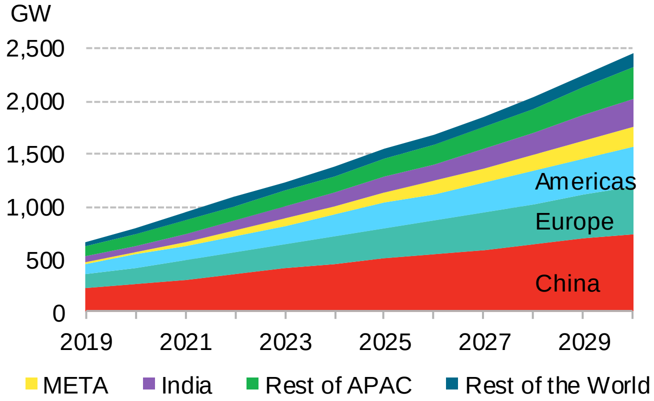
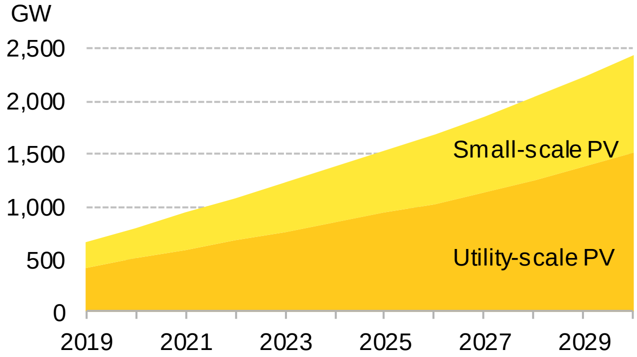


Figure 27: Global cumulative installed solar capacity for different technologies by 2030



Source: BloombergNEF. Note: META - Middle East, Turkey and Africa. APAC- Asia Pacific.

China will be the largest solar market in the 2020s with an annual build-rate of at least 39GW.

We expect **China** to be the largest market for solar in the 2020s, maintaining a new build rate of at least 38.6GW per year split evenly between small-scale and large-scale. In the short term, this is supported by Chinese policy that guarantees solar projects the same price as coal-fired power in their region for 20 years, provided the grid allows access. The LCOE of Chinese solar is expected to be lower than that of new coal in most of the country by 2022. China isn't particularly sunny, but historical average capacity factors of 10-12% are expected to increase to 15% as project design improves and curtailment decreases. The country reduced solar curtailment to 3% in 2018, from 5.8% in 2017, largely due to better scheduling and location of new plants near load centres.[16] Despite this solar growth, China's huge power market is unlikely to reach saturation; solar supplies just 8% of generation by 2030 and 14% by 2050.

Our modelling shows that **Europe** transitions its energy system furthest and fastest. By 2024, renewables supply more than half of European electricity and up until 2030, the continent installs around 15GW of utility-scale solar per year, and another 12GW of rooftop PV.

The Americas region has 372GW of installed capacity by 2030, meeting 9% of electricity consumption. U.S. is the largest market here, adding an average of 14GW of annual capacity until 2030 and reaching 235GW by then. Electric vehicles and batteries help solar achieve a deeper penetration in the electricity mix. The former shifts electricity load for charging to match cheap solar hours (smart charging) and the latter helps solar to be used when needed.

Mexico builds 49GW of PV by 2030 and its power sector becomes increasingly decentralized as more renewables connect to the grid. Behind-the-meter PV grows from virtually nothing today to meet around 5% of demand by 2030. Solar's case is strengthened by its correlation to air-conditioning load. Demand for air-conditioning changes the shape of Mexico's electricity demand profile, accentuating the country's daytime peak, in line with maximum output from PV. The share of solar in total electricity generation jumps from 1% in 2018 to 21% in 2030.

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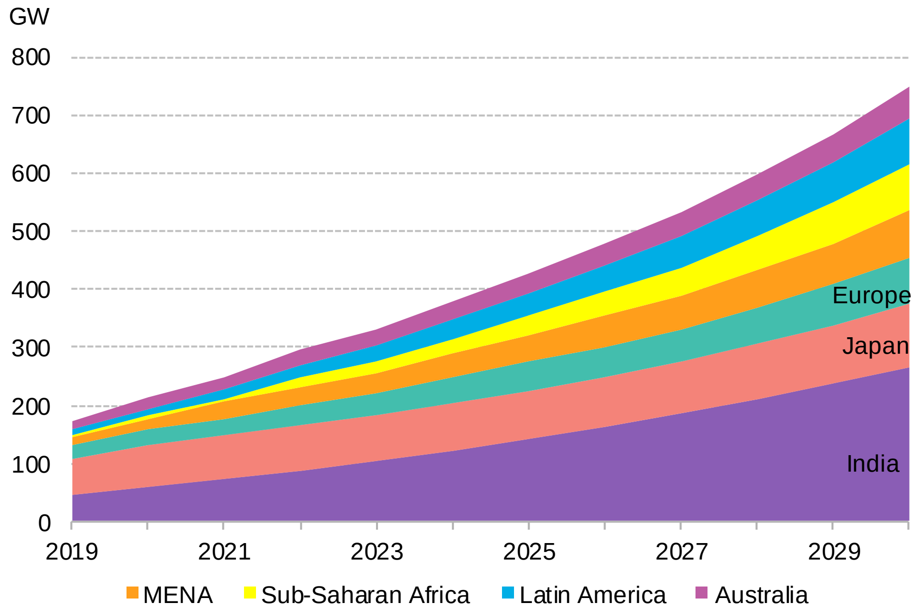
16 For more see http://www.nea.gov.cn/2019-03/19/c_137907428.htm

Results for ISA member countries

ISA member countries will have 750GW of installed capacity by 2030 with India as the largest market.

Cumulative installed capacity in ISA member countries reaches 750GW by 2030 (Figure 28), corresponding to 31% of global solar capacity by this point. Of this, 265GW will be in **India**, the second largest market globally and the largest within ISA members. Annual solar installations (mostly utility-scale) grow steadily as power demand grows in this market. PV is already the lowest-cost source of new electricity in the daytime, and makes up 233GW of the 486GW of total new capacity added in the country between 2019 and 2030. PV supplies 15% of India's generation in 2030.

Figure 28: Cumulative installed solar capacity in ISA regions by 2030



Source: BloombergNEF. Note: Europe only includes France and U.K. See Appendix 3 for a list of countries modelled under each region. This may differ slightly from ISA's list of member countries and its classification of regions.

Solar uptake in Japan slows down in the first half of 2020s as subsidies are phased out for new PV. The growth of the sector resumes in the second half of the decade as unsubsidized PV gets cheaper than new coal.

Japan loses its current position as the largest solar generator of the ISA members to India in 2022, but remains the second largest solar base within ISA members out until 2030 with 109GW of capacity. The growth of PV happens in two stages. We expect uptake to slow after 2021 as the country phases out feed-in tariff subsidies for new PV. Growth restarts in the second half of the 2020s as unsubsidized PV gets cheaper than new coal. Large renewable energy build starting in the late 2020s coincides with the retirement of aging fossil and nuclear plants.

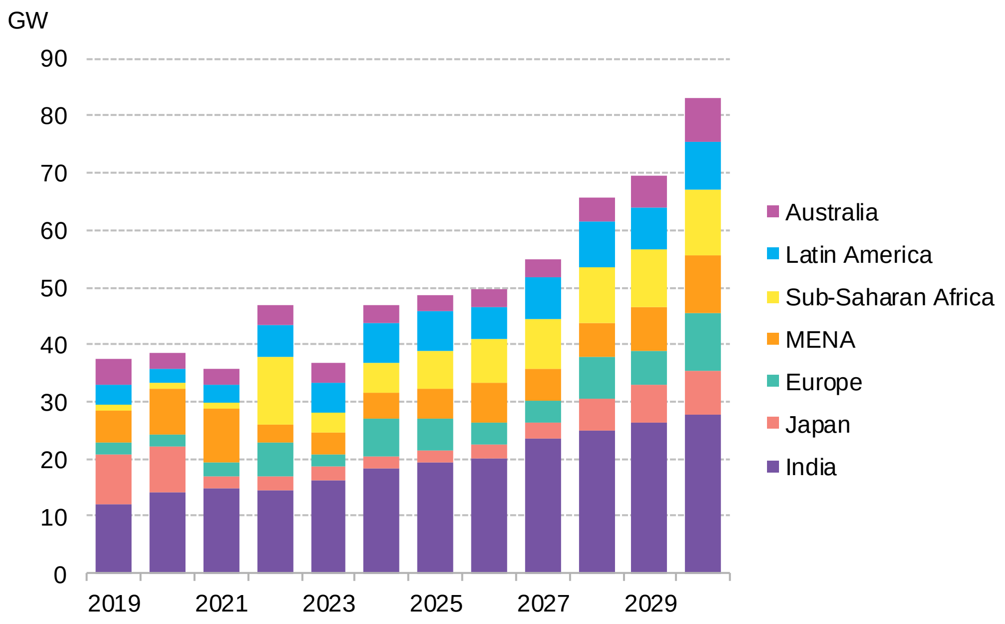
The results for **Europe** only reflect U.K. and France as the Netherlands is not modelled separately in our NEO analysis. These two countries reach 33GW and 48GW of solar capacity respectively by 2030 and make up 9% of the solar capacity in ISA member countries. Our modelling suggests that in the U.K., the cost of new PV beats gas plants (tipping point 2) only in 2035 and therefore the growth until this point is modest. The first half of the 2020s only see 6GW of solar built. France adopts PV faster, assuming that the government goes ahead with planned retirement of its nuclear plants. The average annual size of the market is 3GW between 2019 and 2030.

The **MENA** region reaches 81GW of solar at the end of 2030, helping to meet rapidly growing electricity demand driven by rising consumption levels, growing population and economic expansion. Behind-the-meter generation does not play a major role, as uptake so far has been hindered by low retail prices that dis-incentivize small-scale PV across the region. Just 1.3GW was installed at the end of 2018. The gradual removal of end-user subsidies for fossil electricity, together with falling technology costs, spur the uptake of small-scale systems, but their contribution remains limited, at 17% of the cumulative installed solar capacity in 2030.

After U.S. and Mexico, **Brazil** becomes the largest market in the Americas region. An average of 3GW of PV is added in Brazil each year up to 2030, which meets 9% of electricity demand by then. Small-scale PV plays an important role in Brazil's long-term energy outlook. Starting at around 500MW in 2018, it grows steadily to 24GW in 2030 – about 12% of all capacity added over the period. High retail electricity rates, strong solar resources, falling PV system costs, and improved access to capital combine to drive rapid consumer uptake.

After this analysis was completed, BloombergNEF discovered from Chinese export data that there is a boom in the small-scale segment in Brazil during 2019. The surge in installations is probably due to a net metering program, which allows electricity consumers to run their meters backward when their solar system is exporting power. The Brazilian authorities will seek to rein in the boom by changing the law by March 2020 but before that, BNEF expects at least 2GW of small solar capacity to be added.

Figure 29: Annual solar capacity additions in ISA regions until 2030[17]



Source: BloombergNEF. Note: See Appendix 3 for a list of countries modelled under each region. This may differ slightly to ISA's classification.

[17] Please note that the sudden increase in Sub-Saharan Africa capacity additions in 2022 is a result of the mismatch between our short-term analyst forecasts until 2021, and what our long-term model builds to meet demand in 2022. We will improve our methodology for next year to make sure that capacity additions are smoothed out.

Section 6. Looking forward: Potential sources of financing and role of the CIF

Concessional finance can support the development of solar in immature markets, by de-risking investments through addressing market-specific challenges such as lack of liquidity, currency risk and limited loan tenors.

Our NEO modelling suggests that 750GW of installed capacity can be reached by 2030 in ISA member countries, requiring an investment of $378 billion by then. Some of these funds may only be unlocked through the involvement of DFIs. Solar is now an established sector, and concern over the technology has been largely addressed through large-scale adoption in mature markets where commercial banks provide most of the financing.

This mainly leaves market-specific challenges that will need to be managed in developing markets, such as local currency fluctuations, interest rates and financial stability of the state-run utilities. The lack of long-term power purchase agreements (PPAs) in some of these markets also adds another layer of complexity for providing long-term financing.

Concessional finance, such as that offered by the CIF, can play a critical role in addressing some of these challenges. DFIs can also help improve the enabling environment such as policies and the structure of the power market for solar, as well as building capacity and experience to facilitate its progress. These are discussed in more detail below.

Market-specific challenges

Lack of liquidity

There is usually insufficient liquidity to back large-scale projects in developing markets, particularly those with low incomes. This becomes a major challenge for the development of solar markets in these countries. The CIF and its funds can help address this issue by bringing in capital and blending it with other development banks to offer cheap financing. This will help kick-start the sector through pilot projects and provide the experience to facilitate the development of further projects through enhanced private sector participation.

Limited loan tenor

Solar developers typically need loan terms of at least 10 years, which may be unavailable in developing countries, particularly for technologies the local banks do not have experience with. The CIF, together with other developmental organizations, can provide debt terms with longer maturity periods. This better aligns a project's operational life with repayment terms, improving cash flows and the equity returns from the project. There are many examples of this, including the program in Kazakhstan, where CTF provided debt financing to renewable energy projects with tenors of up to 20 years in a market where local commercial banks were only offering four to five years. Other examples include projects in Morocco, Mexico and Thailand.

Inflation and currency fluctuations

Inflation and currency risk can be another deal breaker for solar development in a market. As equipment is generally purchased in U.S. dollars, depreciation that may happen between signing a PPA and purchasing the equipment can increase project costs and therefore developer risks. Borrowing in U.S. dollars coupled with an offtake agreement that also pays in this currency can reduce these risks significantly. PPAs that are based in dollars are becoming more common in countries with high currency risk. Examples include projects under the World Bank Group's Scaling Solar Initiative, and the solar auction in Cambodia.

Even if the CIF does not provide the entirety of the debt financing, blending its capital with other lending institutions can still partially address these risks.

High interest rates

High interest rates in developing countries can also hinder solar's growth, making financing expensive and projects unviable. The interest rate on capital is more important to solar projects than to fossil fuel plants, because nearly all the cost of solar is upfront. DFIs can offer loans that are significantly lower than the market rate. In the long term, these institutions, partnering with local banks, sharing expertise and providing them with tools such as loan guarantees, can be key to integrating them in the solar market and driving its growth.

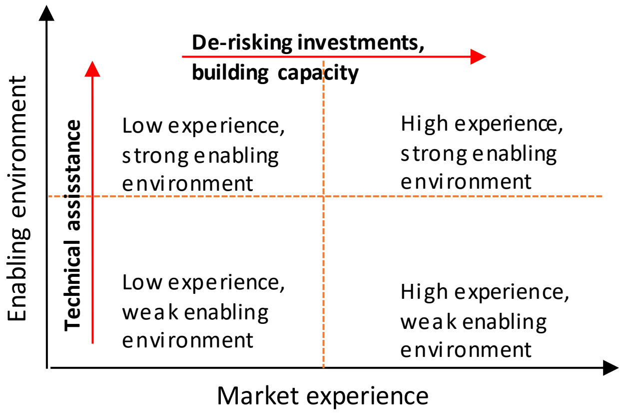
Enabling environment and experience

Concessional finance can provide technical assistance and/or de-risk investment, depending on the stage that countries are at with their solar policies and their experience of implementing solar projects.

DFIs and concessional finance, such as that offered under the recently launched CIF Technical Assistance Facility for Clean Energy Investment (CIF-TAF)[18], can also help improve the solar-specific investment climate (i.e. enabling environment) in order to attract commercial investment and develop the sector through increased participation of the private sector. According to BloombergNEF, the enabling environment and the experience in solar installations will be key in determining opportunities for concessional finance and whether capital should be deployed in support of solar.

A strong enabling environment would include policy mechanisms to support adoption (e.g. auctions, net metering, tax incentives etc.), a power sector that is not dominated by a monopoly and is open for private generation, and/or ambitious renewable energy and emission reduction targets. A market with these characteristics is the most attractive for solar investments. Markets with greater experience in solar installations would also be welcoming for investment as they would be associated with lower risks, technology costs and costs of capital. Figure 30 shows an analytical framework that can be used to identify what the roles of DFIs can be in different markets.

Figure 30: DFIs' roles in markets with different levels of enabling environment and market experience



Source: BloombergNEF Note: Arrows indicate role of DFIs in moving markets in each direction.

[18] The recently launched CIF-TAF aims to support countries in pursuit of their energy transition goals by: i) strengthening policy and regulatory framework; ii) building capacity of key stakeholders; and, iii) enabling transactions in renewable energy and energy efficiency sectors through design of tools like new business models and innovative instruments, among others.

The impact of concessional finance will be less significant in attracting commercial finance to a market with **weak enabling environment and low experience**, compared to one with a strong policy mechanism and the right power market structure (i.e. strong enabling environment) to incentivize investment. In these environments, development institutions can play a vital role in providing technical assistance to support policy development and/or power sector reform to improve investment conditions.

Concessional financing can have the most impact for attracting commercial finance in countries where there is little experience of implementing solar projects, but which are currently implementing policies like auctions to incentivize new build (**mid-to-strong enabling environment and low experience)**. Here, DFIs can support the first movers by reducing financing costs and de-risking investment through various instruments, eventually encouraging involvement of commercial finance.

Concessional financing is unlikely to be needed in countries with **strong enabling environments and high experience** of implementing solar projects. Here, auctions are generally the main source of new investment, and the low prices that result, without DFI involvement, are an indication that developers can secure what they need from commercial banks. These markets would most benefit from supporting less mature technologies like batteries that would help the integration of solar energy into the grid. BNEF has tracked a price decline of approximately 85% for lithium-ion battery packs from 2010 to 2018 as a wave of new manufacturing capacity has come online in China and elsewhere. This presents a new opportunity for development institutions to focus on, particularly where the need for their support for solar growth is significantly diminished.

Small-scale PV

Small-scale PV presents a big opportunity for development institutions to have an impact. Particularly in sunny markets where demand is not growing very fast, concessional finance can set up programs to replace existing incumbent technologies.

In markets where electricity demand is not growing very fast, DFIs can focus their efforts to replace existing incumbent technologies with rooftop PV. This presents a good opportunity in low-income, sunny ISA member countries which may have challenges around grid access. The main obstacle in this solar segment is availability of financing, particularly because offtake agreements are with individual electricity users rather than a government or a utility. In these cases, DFIs can deploy their concessional capital to support projects that finance these small-scale installations. Partnerships with local banks may prove to be beneficial, as they have better knowledge about the bankability of the offtakers.

Development institutions have already helped to finance small-scale PV in a few markets, such as Lebanon. The Lebanese central bank, with the support of the European Union and the United Nations Environment Program, has enabled six commercial banks to offer low-interest loans (at 0.6%) for periods of up to 14 years to clients that will use them to finance self-consumption PV projects and energy efficiency measures.

A similar initiative was funded by the World Bank Group and the International Development Association, which was referred to in Section 3. This program used local partner organizations to find customers for grants and soft loans to deploy small-scale PV to replace kerosene. By January 2019, about 4.13 million solar home systems were installed under the program, replacing kerosene for lighting for 18 million people or 12% of Bangladesh's population.

Section 7. Appendix

7.1. Appendix 1 – Country-level results

Table 2: Cumulative installed solar capacity in ISA member countries (MW)

Country	2010	2011	2012	2013	2014	2015	2016	2017	2018	ISA Region
Algeria	0.0	20.0	20.0	150.0	161.0	288.0	363.0	363.0	363.0	Asia and Pacific
Argentina	0.0	1.0	6.0	8.0	8.0	8.0	8.2	8.2	191.0	Latin America and Caribbean
Australia	564.5	1,391.4	2,430.2	3,207.7	4,028.3	4,911.8	5,804.9	7,083.4	10,858.0	Asia and Pacific
Bangladesh	1.0	50.0	77.1	111.4	145.5	200.3	236.1	296.9	339.0	Asia and Pacific
Benin	0.0	0.0	0.0	0.0	0.3	2.7	2.7	2.7	2.7	Africa
Bolivia	0.0	0.0	0.0	0.0	0.0	5.0	5.0	5.0	70.0	Latin America and Caribbean
Brazil		1.2	3.1	5.8	14.0	31.7	72.6	1,375.5	2,663.3	Latin America and Caribbean
Burkina Faso	0.0	0.0	0.0	0.0	0.0	0.0	0.0	34.8	34.8	Africa
Burundi	10.0	10.0	10.0	10.0	10.0	10.0	10.0	18.0	18.0	Africa

Cambodia	0.0	0.0	0.0	0.0	1.0	2.9	6.4	20.4	20.4	Asia and Pacific
Cameroon	0.0	0.0	0.0	12.0	12.0	12.1	12.2	23.4	23.4	Africa
Cape Verde	0.0	0.0	0.0	0.0	0.0	0.1	0.3	1.4	1.4	Africa
Chad	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	Africa
Chile	0.0	0.0	2.4	15.1	498.1	795.6	1,715.6	2,347.1	2,816.9	Latin America and Caribbean
Dominica						0.2	0.9	1.7	5.4	Latin America and Caribbean
Comoros						0.5	1.1	1.2	1.5	Africa
Congo						10.1	19.9	25.6	39.7	Africa
Costa Rica	0.0	0.0	1.0	1.0	1.0	1.0	1.0	5.4	5.4	Latin America and Caribbean
Cuba						14.7	88.3	193.7	219.8	Latin America and Caribbean
Dijibouti						7.5	10.1	13.7	21.0	Africa
Dominican Republic	0.0	0.0	0.0	1.5	1.5	3.0	36.0	36.0	88.0	Latin America and Caribbean
Egypt	20.0	20.0	20.0	20.0	20.0	20.0	20.0	50.0	170.0	Asia and Pacific
El Salvador	0.0	0.0	0.0	0.0	0.0	11.7	14.8	60.0	60.0	Latin America and Caribbean
Equatorial Guinea						2.1	2.5	2.5	2.5	Africa
Ethiopia	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	Africa

Fiji						2.1	5.6	7.3	9.8	Asia and Pacific
France	1,167.7	2,298.7	2,956.7	3,912.7	4,811.7	5,402.7	6,289.7	7,151.7	8,876.7	Europe
Gabonese Republic						0.1	0.5	0.6	1.0	Africa
Gambia										Africa
Ghana	0.0	0.0	0.0	2.5	2.5	2.5	22.5	22.5	42.5	Africa
Grenada						1.3	1.4	1.5	1.7	Latin America and Caribbean
Guinea	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	Africa
Guinea-Bissau						0.1	0.1	0.8	0.9	Africa
Guyana						0.3	1.0	3.4	7.5	Latin America and Caribbean
Haiti						4.6	8.9	16.7	28.9	Latin America and Caribbean
India	139.0	481.5	1,333.0	2,421.0	3,509.3	5,578.4	10,858.8	21,120.2	32,226.9	Asia and Pacific
Ivory Coast	0.0	0.0	0.0	0.0	0.0	2.5	8.3	14.9	23.9	Africa
Japan	3,268.3	4,414.1	6,446.2	13,090.5	22,755.9	33,916.8	41,931.6	49,321.0	56,043.1	Asia and Pacific
Kiribati						0.6	0.6	0.7	0.9	Asia and Pacific
Liberia	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	Africa
Madagascar	2.0	2.0	3.0	5.0	7.0	9.0	11.0	13.0	15.0	Africa
Malawi	0.0	0.0	0.0	1.0	1.0	1.0	1.0	1.0	1.0	Africa

Maldives						1.1	7.9	10.3	19.2	Asia and Pacific
Mali	0.0	0.2	0.2	0.2	1.2	1.2	1.4	1.4	1.4	Africa
Mauritius						0.7	4.1	7.2	77.6	Africa
Mozambique	0.0	0.0	0.0	0.0	0.0	8.4	20.6	33.5	92.0	Africa
Myanmar	0.0	0.0	0.0	0.0	0.0	61.5	104.4	203.1	244.8	Asia and Pacific
Namibia						7.3	26.2	67.5	173.4	Africa
Nauru										Asia and Pacific
Niger	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	7.0	Africa
Nigeria	0.0	0.0	0.0	0.0	0.0	20.0	46.0	56.0	83.0	Africa
Palau						0.4	0.4	0.4	0.6	Asia and Pacific
Papua New Guinea						3.9	9.3	14.2	18.6	Asia and Pacific
Peru	0.0	0.0	80.0	80.0	96.0	96.0	96.0	96.0	285.0	Latin America and Caribbean
Rwanda	0.3	0.3	0.3	0.3	9.0	9.0	9.0	12.1	12.1	Africa
Sao Tome and Principe						1.8	3.3	5.8	8.8	Africa
Saudi Arabia	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	80.0	Asia and Pacific
Senegal	0.0	0.0	0.0	0.0	2.0	2.0	54.0	94.0	174.0	Africa
Seychelles										Africa

Somalia	0.0	0.0	0.0	0.0	0.6	1.3	2.3	2.3	2.3	Africa
South Sudan	0.0	0.0	0.0	0.0	0.0	2.8	3.7	3.9	4.6	Africa
Srilanka	0.0	1.4	1.4	1.4	1.4	1.4	91.4	151.0	221.0	Asia and Pacific
Sudan	0.0	0.0	0.0	0.0	0.0	2.2	8.8	15.9	40.5	Africa
Suriname	0.0	0.0	0.0	0.0	0.0	0.1	0.8	1.0	1.3	Latin America and Caribbean
Tanzania	0.0	0.0	0.0	0.0	0.0	35.9	85.6	153.9	215.5	Africa
The Netherlands	87.8	147.8	364.8	739.4	1,014.4	1,481.4	2,015.4	2,715.4	4,217.4	Europe
Togolese Republic						19.4	32.7	45.8	63.0	Africa
Tonga						0.6	1.7	4.6	5.1	Asia and Pacific
Tuvalu										Asia and Pacific
Uganda						1.0	11.0	11.0	11.0	Africa
United Arab Emirates	0.0	0.0	0.0	0.0	0.0	1.0	24.0	239.0	513.0	Asia and Pacific
United Kingdom	108.3	1,017.8	1,792.2	2,893.9	5,464.9	9,747.2	11,817.2	12,698.1	13,017.1	Europe
Vanuatu						0.5	1.8	3.9	4.8	Asia and Pacific
Venezuela	0.0	0.0	0.0	0.0	0.0	1.0	1.0	1.0	1.0	Latin America and Caribbean

Yemen	0.0	0.0	0.0	0.0	2.0	2.0	2.0	2.0	2.0	Asia and Pacific
Zambia	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	88.0	Africa
Zimbabwe	0.0	0.0	0.0	0.0	0.0	4.5	8.7	15.2	27.3	Africa

Source: BloombergNEF, Sinoimex

7.2. Appendix 2 – Classification of ISA's member countries by income group

Low income	Lower middle income	Upper middle income	High income
Benin	Bangladesh	Algeria	Argentina
Burkina Faso	Bolivia	Brazil	Australia
Burundi	Cambodia	Costa Rica	Chile
Chad	Cameroon	Cuba	France
Congo	Cape Verde	Dominica	Japan
Ethiopia	Cote d'Ivoire	Dominican Republic	Netherlands
Guinea-Bissau	Djibouti	Fiji	Palau
Liberia	Egypt	Gabon	Saudi Arabia
Madagascar	El Salvador	Guyana	Seychelles
Malawi	Ghana	Maldives	United Arab Emirates
Mozambique	India	Mauritius	United Kingdom
Niger	Myanmar	Namibia	
Rwanda	Nigeria	Peru	
Senegal	Sri Lanka	Suriname	
Somalia	Sudan	Tonga	
Tanzania	Vanuatu		
Uganda	Zambia		
Zimbabwe	Venezuela		

Note: This list only displays the ISA member countries where BloombergNEF database has tracked investment activity.

7.3. Appendix 3 – Classification of countries by region under NEO analysis

Table 3: Classification of countries by region under NEO analysis

Region	List of countries
MENA	Algeria, Bahrain, Egypt, Iran, Iraq, Israel, Jordan, Kuwait, Lebanon, Libya, Morocco, Oman, Qatar, Saudi Arabia, Syria, Tunisia, United Arab Emirates, Yemen
Sub-Saharan Africa	Angola, Benin, Botswana, Burkina Faso, Cameroon, Cape Verde, Central African Republic, Chad, Congo, Congo (Dem. Rep.), Côte d'Ivoire, Djibouti, Equatorial Guinea, Ethiopia, Gabon, Gambia, Ghana, Guinea, Kenya, Liberia, Madagascar, Malawi, Mali, Mauritania, Mauritius, Mozambique, Namibia, Niger, Nigeria, Rwanda, Senegal, Seychelles, Sierra Leone, Somalia, South Africa, Swaziland, Tanzania, Togo, Uganda, Zambia, Zimbabwe
Latin America	Argentina, Belize, Brazil, Bolivia, Chile, Colombia, Costa Rica, Cuba, Ecuador, El Salvador, Guatemala, Haiti, Honduras, Jamaica, Nicaragua, Panama, Paraguay, Peru, Uruguay, Trinidad and Tobago and Venezuela

Source: BloombergNEF

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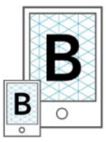

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