TRANSFORMING SOLAR Supply Chains

AN INITIATIVE OF THE CLEAN ENERGY MINISTERIAL

INTERNATIONAL COLLABORATION ON SOLAR MANUFACTURING

To the CEM Community:

The Transforming Solar Supply Chains Initiative was launched in September 2022 at the Clean Energy Ministerial in Pittsburgh, United States.

Since then, the initiative has hosted numerous workshops on solar manufacturing around the world, hosted a number of webinars and online conversations, and will be launching the report "Building Resilient Global Solar Supply Chains" at CEM14.

These policy briefs are intended to reflect the outcomes of the discussions and are intended to present considerations/discussion points for policy makers, on three key areas:

Recognising that countries and regions will adopt their own approaches, as befits their country contexts, international collaboration on solar manufacturing is key to guiding our respective policy actions to a larger whomle towards common goals. The bottom line is that open dialogue and exchange of ideas in multilateral forums, such as CEM, can create more optimal conditions for accelerating the growth of solar manufacturing worldwide.

Global Context

The global cumulative solar PV installed capacity has surpassed 1 TW, with around 173 GW of solar PV capacity installed globally in 2021, and 268 GW installed 2022. Solar PV is already the cheapest source of new electricity in many parts of the globe - according to IRENA, global solar PV CAPEX and LCOE cost have declined by 80% and 88% respectively over the period 2010-2021[1]. Increased deployment has the potential to further fuel the virtuous cycle, with increased installations driving down both manufacturing and installation costs and lower costs driving increased installations.

In fact, ISA projects 700-1900 GW of manufacturing capacity will be required per year by 2030[2]. However, the solar PV industry is currently extremely concentrated. Other countries and regions must increase their manufacturing output to meet these solar installation targets and to promote increased resilience and sustainability in global solar supply chains.

[1] "Renewable Power Generation Costs 2021", International Renewable Energy Agency (2022) https://www.irena.org/publications/2022/Jul/Renewable-Power-Generation-Costs-in-2021

[2] Building Resilient Global Solar PV Supply Chains, International Solar Alliance (2023). https://isolaralliance.org/uploads/docs/903389b6da9999d4c7056ca13af1fa.pdf

Policy Coordination

Challenges

The growth of solar manufacturing globally has been impressive, though highly regionally concentrated, with a CAGR of 24% in the last decade. However, manufacturing growth of the critical upstream materials of solar polysilicon and ingots/wafers outside of East Asia has lagged, and to achieve economic scale, requires a minimum scale of 5-10 GW [1], which is quite capital intense. As of 2022, only 4 countries/regions were consistently installing greater than 10 GW of solar capacity annually, making it challenging for manufacturers to justify the multi-billion capital investments. Furthermore, several countries continue to provide extensive subsidy support to fossil fuels, invest in uneconomic coal assets, and impose high taxes and other barriers to renewables investment, creating mixed signals for financial institutions, developers and manufacturers.

Secondly, financing for solar manufacturing remains limited to a handful of countries. Particularly for polysilicon, wafer/ingot and cell production, multi-billion dollar investments are required, which is challenging for smaller and less developed countries. One of the key conclusions of the Global Resilient Supply Chains report is that the total investment required is on the order of $150 Billion globally by 2030, compared to $110 Billion annually in coal supply investment[3], and over $400 billion in oil & gas investment.

Finally, direct support measures for solar manufacturing play a key role to incentivize the exponentially large scale up needed for new market entrants to be competitive. However, these measures can be perceived as protectionist. More dialogue between governments is needed to reaffirm that such policies will make a positive contribution to the growth of solar supply chains, rather than discourage fair and open trade.

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[1] https://www.iea.org/reports/world-energy-investment-2022/overview-and-key-findings

Considerations for Policy Makers

1) **Demand side creation –** Market signalling can stimulate solar manufacturing when governments set more aggressive solar targets, in line with ISA's "Total Transition" scenario (1900 GW of annual deployment by 2030). This would require countries to increase policy and financial supports for renewable energy, creating credible, ambitious solar targets and roadmaps and levelling the playing field so renewable energy faces comparable (or even advantageous) policy and market regimes with respect to fossil fuel assets.

   Countries may consider offering "guaranteed demand" to manufacturers setting up new capacity, as a buyer of last resort at a guaranteed price, but only after market forces have been exhausted.

   In order to allow demand creation to succeed, countries and national grid regulators will need to facilitate the grid integration of renewables, including transmission capacity and grid interconnect availability, for example by reducing the number of clearances and permits required and promoting grid-level flexibility (e.g., demand response and energy storage).

2) **Financing –** One of the key challenges to developing resilient global solar supply chains is limited financing for solar manufacturing investment, both capital and operating expense support, particularly in emerging markets. There is a tremendous opportunity for multilateral and bilateral institutions to provide financial backstops and guarantees to manufacturing investments, particularly in emerging markets. Furthermore, both countries and international institutions can gradually expand investments in clean energy manufacturing within their energy portfolios.

3) **Direct Policy Supports for Solar Manufacturing**

   While individual countries may see fit to provide supports for domestic industries in the form of tax credits, grants, accelerated depreciation and other incentives, it is crucial to support open supply chains while "growing the pie" for new entrants. For example, a country with 10 GW of annual installations may wish to tender 30 GW of solar per year, and preserve the initial 10 GW (e.g., through government or state-owned enterprise procurement) for domestic manufacturers, rather than preserving the entire demand to domestic manufacturers.[4] There should be open dialogue among regional and global bodies to ensure markets remain open and materials and intermediate products can continue to flow from countries with natural competitive advantages to other countries with advantages in different steps in the value chain.

   Furthermore, it is crucial for countries to offer a steady, consistent roadmap for renewable energy investments and avoid "policy whiplash" with supports being introduced then withdrawn on an annual basis. Countries should assess the need for both capital and operating expense supports to facilitate the achievement of adequate manufacturing scale. As the manufacturing ecosystem grows, the need for continued support should be regularly assessed, and if no longer required, support measures should be gradually phased down rather than abruptly ended.

[4] This is quite relevant in developing countries like India, Indonesia, Turkey, South Africa, Nigeria, etc. where the government or government-owned entities are by far the largest power purchasers. This exact method is what Turkey did which is probably the most successful example (so far) outside of China/SE Asia.

Technology Transfer

Challenges

Currently, research on solar manufacturing (and other clean energy technologies) is concentrated in a handful of countries and even universities worldwide. For example, in 2019-2021, 92% of solar-related patents were filed in just three countries, with 77% in just one[5]. Emerging markets that have significant plans for solar installation may have limited expertise and R&D funding to develop solar supply chains domestically. Commentary from recent industry roundtables suggest that research on next-generation higher-efficiency technologies, including interdigitated back-contact cells, which supersede existing crystalline silicon cells are even more concentrated[6].

Furthermore, critical equipment (particularly in the polysilicon, wafer/ingot and cell manufacturing) are often bottlenecked, with a small number of suppliers worldwide. Emerging markets may be challenged in procuring or gaining access to Equipment is not licensed but procured and, equipment typically comes with a baseline process and turnkey options exist for all key c-Si PV supply chain segments. As such the prior sentence lacks relevance to this statement. These technologies, which may limit their deployment strategies and the rate of adopting solar at scale, negatively impacting their ability to meet energy access and net zero targets.

For some countries, there may be a mismatch between their solar ambitions and the availability of skilled labour for solar manufacturing. Many countries seeking to develop solar PV manufacturing capabilities will require skills development and training to ensure they can produce solar equipment or components economically, while meeting international standards for quality.

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[5] Renewable Energy Patents Evolution (IRENA) https://www.irena.org/Data/View-data-by-topic/Innovation-and-Technology/Patents-Evolution

[6] Stakeholder workshops were hosted by the CEM Transforming Solar workstream on 12 January (UAE), 28 February (online) and 20 March 2023 (Brazil).

Considerations for Policy Makers

1) Countries where solar energy has the potential to be a significant element of their energy mix or those that possess competitive advantages in minerals, R&D capabilities and low-cost energy should be supported in developing solar PV manufacturing capabilities with technology and workforce development.

2) Greater levels of dispersing cutting edge research is needed across countries and regions, particularly into emerging markets. This could be facilitated amongst international researchers, universities, professors and students. Mechanisms akin to an international technology integration platform could also help coordinate international research collaboration programs, building on the success of existing partnerships, such as the European Technology & Innovation Platform for Photovoltaics.

3) Better access to the latest and highest efficiency renewable energy (RE) technologies and improvements in their intellectual property (IP) protections in emerging markets will help diversify and develop global solar supply chains. Countries and multilateral development banks could further assist by providing support or developing policies for technology licensing or IP capability building in emerging markets.

4) Countries with well-established solar PV manufacturing industries can collaborate with emerging markets to share knowledge, expertise and funding to help foster advanced manufacturing capabilities and processes in complementary markets. This could be achieved through skills development and training programs.

5) Leverage government procurement to drive innovation and the need for improved products in country, e.g., products that require minimum energy or resources use and minimum energy requirements. Mandating higher or better performance products will help catalyse improved capabilities and technology transfer across the solar PV supply chain. Governments or regions could also work together in creating compatible policy frameworks or initiatives to enable access to licenses, intellectual property and expertise in facilitating these procurement strategies.

Further Reading/Resources

Sectoral perspectives on diversifying solar supply chains – a summary of stakeholder workshops (2023), CEM – Transforming Solar.

Building Resilient Global Solar PV Supply Chains (2023), International Solar Alliance

https://isolaralliance.org/uploads/docs/903389b6da9999d4c7056ca13af1fa.pdf

ESG Standards Harmonization

Challenges

In pursuit of net zero goals, there are calls to support low carbon manufacturing in general, and solar manufacturing is no exception. Furthermore, as large-scale solar installations increasingly reach their end-of-life stage, concerns are increasing about recyclability, waste, and the total life cycle footprint of solar modules and other components.

As one solution, ESG standards for solar manufacturing can ensure environmental quality, worker safety, and other objectives that are outside the scope of normal technical standards. ESG standards have an economic impact, as they improve the acceptability, cost, and land use impacts of solar development. The private sector (especially corporate end users of solar energy) is another driver of the demand for applying ESG to the equipment of utility and commercial scale solar projects. Broadly speaking, ESG contributes to Quality Infrastructure (QI) , a policy objective which goes hand-in-hand with the energy transition.

To meet ESG standards, whether voluntary or in response to regulatory and/or enforcement action, the solar PV value chain will need greater diversity, transparency and traceability than currently exists. As the supply chain grows and diversifies, the ability to certify compliance with ESG standards should be a goal for all solar purchasers and manufacturers.

However, if multiple regions develop ESG standards and related traceability protocols without an eye to harmonization and compatibility, market fragmentation could potentially undermine the supply chain. Solar products are increasingly a global and export-oriented industry. Separate standards in different regions can inhibit trade between countries, reduce manufacturing efficiency and therefore competitiveness, and increase the compliance burden on manufacturers. All of this would slow the energy transition globally.

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[7] Quality Infrastructure is the system that ensures that products and services are safe and of high quality. It covers from standardisation and conformity assessment (testing, inspection and certification) to accreditation, metrology and market surveillance. Source: Boosting solar PV markets: The role of quality infrastructure (2017), IRENA

Considerations for Policy Makers

1) When setting or adopting standards for recyclability, low-carbon attributes, worker safety, etc., it is important to ensure mutual compatibility between jurisdictions. In particular, standards should be used to improve the ESG performance of the solar industry in all countries.

2) Countries and industry should support each other in improving widespread understanding and compliance with international standards, particularly amongst manufacturers in emerging markets, to support stronger trade and deployment of solar around the globe.

3) ESG standards for solar products that require a robust level of transparency, due diligence, and third-party audits will enhance the traceability, environmental performance, social responsibility, and equity in the solar supply chain.

4) Countries that adopt ESG standards should seek to employ common data sources, such as the IEA PVPS Task 12 Life Cycle Inventory, as well as common methodologies regarding life cycle analysis scope and boundaries and follow the type I ecolabel standards of ISO 14024 (life cycle based, multi-attribute, transparent criteria, third party verified).

5) A number of activities can help to facilitate a globally harmonized approach to PV sustainability standards, including:
   a. Standardized and segregated training courses for managerial and technical Solar PV workforce
   b. Increased engagement of countries in technical bodies of standard setting organizations such as ISO, IEC etc. and explore manners to facilitate consolidation approaches.

c. Development of a comprehensive Quality Infrastructure (QI) to operationalise and enforce the standards. Such a QI should:
    i. Include standards, testing, certification, inspection, calibration, and accreditation;
    ii. Be harmonized and cover the entire supply chain; design, manufacturing, installation and decommissioning of equipment as well as end-of-life aspects; and
    iii. Be incorporated in existing and emerging regulatory and policy frameworks supporting PV value chains and markets.

Further Reading/Resources

Boosting solar PV markets: The role of quality infrastructure (2017), IRENA
https://www.irena.org/publications/2017/Sep/Boosting-solar-PV-markets-The-role-of-quality-infrastructure

Quality Infrastructure for Renewable Energy Technologies: Guidelines for Policy Makers (2015), IRENA
https://www.irena.org/publications/2015/Dec/Quality-Infrastructure-for-Renewable-Energy-Technologies-Guidelines-for-Policy-Makers

Quality infrastructure for smart mini-grids (2020), IRENA
https://www.irena.org/publications/2020/Dec/Quality-infrastructure-for-smart-mini-grids

The EPEAT ESG/low carbon standard for PV

https://globalelectronicscouncil.org/epeat-solar-panels-inverters/#:~:text=EPEAT%20for%20Solar%3A%20Updates&text=The%20new%20EPEAT%20Criteria%20allow,3%20emissions%20from%20solar%20installations

ISO 14024 Type I Ecolabel Standards

https://www.iso.org/standard/72458.html

Transforming Solar: Supply Chains

The goal of the CEM Transforming Solar: Supply Chains Workstream is to foster the adoption of policies that transform the global solar supply chain to be more diverse, transparent, and environmentally and socially responsible. Ultimately, the development of resilient supply chain capacity throughout the world will ensure that solar energy can scale at pace globally, and will be accessible to all as an essential tool in addressing greenhouse gas reduction and mitigating climate change.

Member countries as of July 2023


Australia


Brazil


Germany


India


UAE


United States

Coordinators

Partner Institutions

European Solar Manufacturing Council
SolarPower Europe
Ultra Low Carbon Solar Alliance