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IRA Support for Solar Modules Exactly Matches China Price

Generous manufacturing incentives in the Inflation Reduction Act have resulted in many solar factory announcements in the US, with the total solar subsidy uncannily equal to the selling price of a Chinese module. Many of these factories will struggle to get built or will run at low utilization rates due to limited availability of upstream materials and fierce competition from Southeast Asia.

49GW

Annual US module manufacturing capacity announcements

$250 million per GW

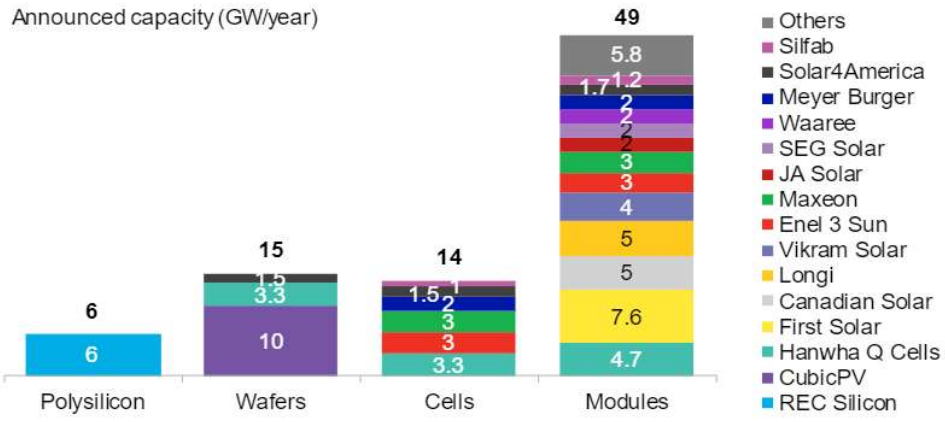
Approximate upfront cost to build a US silicon cell factory

$0.17/W

Current price of a Chinese solar module which equals the sum of all solar manufacturing subsidies in the Inflation Reduction Act

- Solar companies have announced almost 50GW of annual module assembly capacity in the US, 14GW of cells, 15GW of wafers and about 6GW new polysilicon. This is in response to the $0.17/W total manufacturing subsidy available in the US for polysilicon, wafer, cell and module production, which exactly matches the cost of making a module in China.
- Many of the announcements came from companies with little or no experience making wafers, cells and modules. Difficulties securing high-quality silicon inputs will likely mean that many factories will struggle to deliver, and some plants will never get built.
- Companies have made fewer upstream factory announcements in the US, given higher technical and physical barriers to set up polysilicon, wafer and cell factories.
- Generous subsidies and exemption from tariffs on cells made in factories in Southeast Asia with US-made wafers should encourage more US wafer production. Finding a suitable site to make wafers in the US takes time, however. Big wafer and cell makers that sell to the US might prioritize building wafer factories in Southeast Asia first to avoid new US duties.
- We remain skeptical on the success of new US polysilicon and cell capacity. Polysilicon factories take a very long time to build. Most, if not all, of the new cell factories in the US will be greenfield, in brand new buildings, which would require an upfront investment of around $250 million per gigawatt, BloombergNEF estimates.
- New cell factories in the US are exposed to the risk of being functionally obsolete in about five years and may not be able to compete with the newer, best-in-class factories that emerge in Southeast Asia and other regions.

Figure 1: US solar factory announcements



Source: BloombergNEF, company announcements

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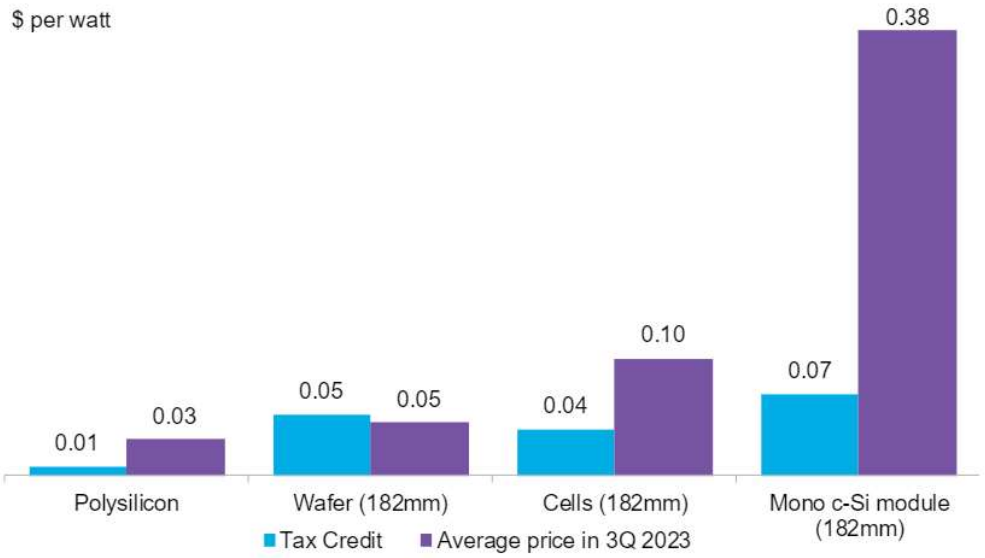
1. IRA matches costs of the integrated Chinese solar supply chain

US subsidies would match the costs of the entire vertically integrated solar supply chain in China.

Manufacturing subsidies for solar components in the IRA are extremely generous. The tax credits would pay 18-116% of the market price for silicon components in 3Q 2023, depending on the input (Figure 2) and the most recent market price. In total, a silicon solar module made with US polysilicon, wafers and cells would receive $0.17/W in tax credits alone, which is approximately the selling price of a Chinese solar module in China or Europe in July 2023 (link). In other words, US subsidies would match the costs of the entire vertically integrated solar supply chain in China.

Figure 2: US IRA solar manufacturing tax credits and average 3Q 2023 component prices



Source: BloombergNEF. Note: Conversion factor of 2.6g per watt used for polysilicon. Assumes a conversion factor for wafers of 7.69 piece per watt based on PERC cell efficiency of 23.3%.

International responses to IRA subsidies

In Germany, the Federal Ministry of Economics and Climate Protection (BMWK) has invited expressions of interest (link) for receiving grant funding for flagship solar factories in structurally weak regions of Germany and the European Union. These must have at least 2GW/year of module production capacity, up to a total of 10GW/year. The funding will be "equivalent to that available in a third country outside the European Economic Area", which we interpret as a promise to match the IRA.

2. US solar manufacturing ambitions

Technical barriers to assemble modules are very low, but difficulties securing cells and other components will likely mean that many factories will struggle to deliver.

Manufacturers have announced 49 gigawatts (GW) of annual module capacity in the US since the passage of the Inflation Reduction Act. The biggest announcements came from US-headquartered First Solar, which plans to add a total 7.6GW of new annual module capacity using its cadmium telluride thin-film technology (which is fully integrated and effectively makes its own cells from raw materials and does not require polysilicon, wafers or separate cell capacity). Longi, Canadian Solar and Hanwha Q Cells each plan to add roughly 5GW of new yearly capacity. Many of the announcements came from companies with little or no experience assembling modules. The technical barriers to assembling modules are very low, but difficulties securing high-quality

silicon cells and other non-silicon components will likely mean that many of these factories will struggle to deliver. Some factories will never get built. The US has imposed prohibitive tariffs on silicon cells from China and is expected to introduce prohibitive tariffs on cells from Southeast Asia in June 2024.

Table 1: Possible silicon solar supply chains for US module assembly factories

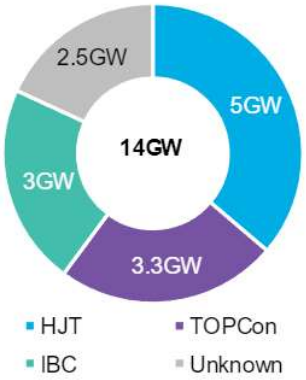
Wafers	Cells	Modules	Company examples
US	US	US	Hanwha Q Cells
China	US	US	Maxeon, Enel 3 Sun
China / Europe	US	US	Meyer Burger
Southeast Asia	Southeast Asia	US	Longi, JA Solar, Jinko Solar
China	China / India	US	Waaree, Vikram Solar
China / Europe	South Korea / Southeast Asia	US	Hanwha Q Cells

Source: BloombergNEF. Note: Companies listed have set up different supply chain alternatives, the options listed in the table are only examples.

We expect most US cell factories to end up making their own wafers in the US or in Southeast Asia.

There are higher technical and physical barriers to setting up polysilicon, wafer and cell factories. We expected more wafer announcements. Hanwha is the only sizable manufacturer that plans to make wafers in the US so far. Smaller manufacturers including Vikram Solar, Convalt Energy, and Solar4America have future ambitions to make wafers, and we expect some large manufacturers to join them. Generous subsidies and the incentive to avoid tariffs on cell factories from Southeast Asia with US-made wafers should encourage more US wafer production (*US Climate Bill to Drive Local Solar Manufacturing Smartly* (terminal)). However, it is not easy to find a site with good infrastructure, relatively cheap power, and a workforce ready to be trained.

Figure 3: Cell technology announced for US plants



Source: BloombergNEF. Note: IBC stands for interdigitated back contact. HJT is silicon-on-silicon heterojunction.

Big wafer and cell makers that sell to the US, such as Longi or Jinko Solar, have prioritized building wafer factories in Southeast Asia to avoid new US duties on their cells from the region. Most of these companies are Chinese-owned, and probably restricted their US plans to modules only due to political tensions between the US and China. Even for US module factories, China-based firms have partnered with a US company to limit political risk, as with Longi and Invenergy's joint venture for a 5GW/year factory in Ohio.

CubicPV, a start-up combining perovskite and direct wafer tech, plans to have 10GW of annual wafer slicing capacity in the US using conventional technology. The company claims to have enough investor interest to finance the site construction, and probably is building in expectation that local demand for silicon wafers in the US will grow quickly over the next couple of years. But we expect most of the US cell factories to end up making their own wafers in the US or in Southeast Asia. Buying wafers from China is also possible and is subject to a 25% import tariff, which is not prohibitively high, but there is a risk of further tariffs in future.

Challenges building polysilicon and cell factories in the US

We remain skeptical on the success of new US polysilicon and cell capacity. Polysilicon factories take at least two years to build, probably longer. A few polysilicon makers in the US have reportedly shown interest in partnering with ingot and wafer makers for US production, but none in expanding polysilicon capacity.

Most, if not all, of the new cell factories in the US will be sites that need to be built from scratch, which requires an upfront investment of about $250 million per GW, according to BNEF estimates at *Building Solar Factories to Rival China Won't Be Cheap* (web | terminal). The permitting and construction of cell factories in the US also takes at least two to three years.

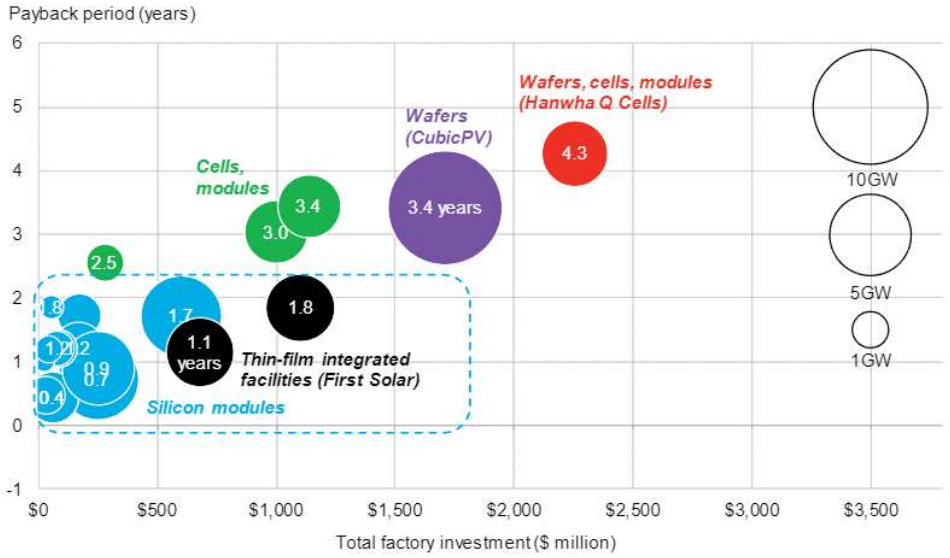
Solar cell manufacturing is a horrible business for the manufacturers, with the standard technology currently upgrading from mono PERC to the slightly more efficient TOPCon. These generational upgrades happen every 2-5 years and render old factories obsolete or in need of significant refitting. US cell factories would be exposed to this dynamic too, as manufacturing capacity in Southeast Asia is likely to continue to expand, using the newest tech. However, the planned technology is mostly next generation (Figure 3), with HJT hyped as the probable successor to TOPCon.

Possibly the US will use modules with less advanced cell technologies for longer than the rest of the world.

If integrated cell and module factories in the US run at full utilization, factory payback periods could fall inside the roughly five-year technology cycle for solar. Payback periods for integrated cell and module factories, as well as Hanwha's wafer, cell and module plant would range from two to just over four years, according to BNEF calculations, assuming that the selling price of modules covers factory operating expenses (Figure 4).

Possibly, the US will use modules with less advanced cell technologies for longer than the rest of the world. Module buyers will likely prefer US-made modules, even if they have lower efficiency. First Solar's thin-film panels have lower efficiencies than silicon modules, but the US-based manufacturer has been very successful in signing massive long-term supply agreements.

Figure 4: US solar factory payback periods by factory type, size and investment amount



Source: BloombergNEF, company announcements. Note: Annual revenues from the 45X production tax credits in the Inflation Reduction Act or IRA used to calculate factory payback periods. Assumes full utilization. Also assumes operating costs are covered by the module selling price. BNEF factory capex estimates used if investment figure not reported.

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